GOVERNMENT PRICE STATISTICS

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ECONOMIC STATISTICS

OF THE

JOINT ECONOMIC COMMITTEE

CONGRESS OF THE UNITED STATES

EIGHTY-SEVENTH CONGRESS

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GOVERNMENT PRICE STATISTICS

TUESDAY, JANUARY 24, 1961

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC STATISTICS OF THE
JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The subcommittee met at 10 a.m., pursuant to notice, in the Old Supreme Court Chamber, the Capitol, Hon. John J. Sparkman, presiding.

Present: Senators Sparkman and Bush; and Representative Curtis.

Senator SPARKMAN. Let the subcommittee come to order.

This morning the Subcommittee on Economic Statistics of the Joint Economic Committee opens public hearings on the price statistics collected and disseminated by the Federal Government. Price changes have an important bearing on many public and private economic policies, and have been a matter of continued interest to the Joint Economic Committee from its organization almost 15 years ago. These hearings will be based on a report submitted to the Bureau of the Budget by the National Bureau of Economic Research entitled "The Price Statistics of the Federal Government."

This report was prepared at the request of the Bureau of the Budget and enlisted the time and talents of a distinguished group of experts. At this morning's hearing, we welcome Dr. Raymond T. Bowman, Assistant Director for Statistical Standards, Bureau of the Budget, who will present the report, summarize it and give some of the background. As soon as the full committee's work in connection with the President's Economic Report is completed, and the report filed with the Congress, the subcommittee expects to hold additional hearings at which we shall hear from the members of the committee who prepared this report, various technicians from Government agencies involved, private experts and users of such statistics.

Dr. Bowman, it is a pleasure to welcome you again to a hearing of this subcommittee. You may proceed in your own way, and make such statement as you see fit. We are glad to have you.

STATEMENT OF RAYMOND T. BOWMAN, ASSISTANT DIRECTOR FOR STATISTICAL STANDARDS, BUREAU OF THE BUDGET

Mr. BOWMAN. Thank you, Mr. Chairman.

Mr. Chairman and members of the subcommittee, I want to thank you very much for your invitation to appear before your subcommittee.

On behalf of the Bureau of the Budget, I wish at this time to transmit to your committee, for subsequent review and appraisal, a report, "The Price Statistics of the Federal Government," submitted to the Bureau of the Budget by the National Bureau of Economic Research.

Senator SPARKMAN. The full report and its attachments will be printed as a part of these hearings.

(The report referred to will be found at the end of this day's proceedings, pp. 9–526.)

Mr. BOWMAN. Thank you, Mr. Chairman.

I understand that it is the intention of the Subcommittee on Economic Statistics to hold hearings at a later date at which the members of the Price Review Committee, which prepared the report, representatives of the appropriate Government agencies, and other technicians and economic analysts will be invited to testify. Such hearings will be of major importance in formulating the eventual recommendations and actions which will be required to achieve better price statistics. The interest of the Joint Economic Committee in the development of more adequate and better integrated Federal statistics has been of major assistance in the past. Your continued interest and expert discernment of the statistical needs, as evidenced by these hearings on price statistics, are extremely welcome. It is my expectation that these hearings will be as productive of real improvement as were the earlier hearings on a similar report analyzing the national accounts.

The report on price statistics is the work of a special committee of distinguished economists and statisticians appointed by the National Bureau of Economic Research under a contract made for that purpose by the Bureau of the Budget.

The title of the committee was the Price Statistics Review Committee of the National Bureau of Economic Research. The Committee included individuals of outstanding ability in the fields of economic and statistical analysis as well as extensive experience in the practical problems of compiling economic statistics both under the auspices of the Government and in private research organizations. It was thus a broadly representative group encompassing various professional points of view in regard to the price statistics field. The members of the committee were: Dr. George J. Stigler, University of Chicago, Chairman; Dr. Edward F. Denison, Committee for Economic Development; Dr. Irving Kravis, University of Pennsylvania; Dr. Albert Rees, University of Chicago; Dr. Richard Ruggles, Yale University; Dr. Boris Swerling, Stanford University; Dr. Dorothy Brady, University of Pennsylvania; Dr. Philip J. McCarthy, Cornell University.

The Price Review Committee also arranged for the writing of 12 papers dealing with special problems. These papers are not an integral part of the report, and their recommendations, except where specifically included in the report, must be considered as those of the respective authors. They contain a great deal of useful supplementary information on the price statistics of the Federal Government and make recommendations or provide comments on significant problems in the price collection and price index area. The National Bureau submitted them for consideration along with the Committee's report and I have attached them to the report presented to this hearing in the hope that they may be printed as supplemental material with it.

Representative CURTIS. Mr. Chairman, I want to be sure that is what he referred to earlier.

Senator SPARKMAN. As I understand, that is the material you referred to a while ago.

Mr. BOWMAN. Yes, sir, it was all together.

Representative CURTIS. Very good.

Mr. BOWMAN. Thank you, Mr. Chairman.

The authors and titles of their papers are:

Philip J. McCarthy: Sampling Considerations in the Construction of Price Indexes with Particular Reference to the U.S. Consumer Price Index.

Victor Zarnowitz: Index Numbers and the Seasonality of Quantities and Prices.

Harry E. McAllister: Statistical Factors Affecting the Stability of the Wholesale and Consumers' Price Indexes.

Eleanor M. Snyder: Cost of Living Indexes for Special Classes of Consumers.

John Flueck: A Study in Validity: BLS Wholesale Price Quotations.

Peter O. Steiner: Consumer Durables in an Index of Consumer Prices.

Albert Rees: Alternative Retail Price Indexes for Selected Nondurable Goods, 1947–59.

Zvi Griliches: Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change.

Walter Y. Oi, David E. Lund, and Paul P. Bestock: An Index of Motor Freight Rates.

Geoffrey Shepherd: Appraisal of Alternative Concepts and Measures of Agricultural Parity Prices and Incomes.

Earl R. Swanson: Unit-Value Pricing of Prices Received by Farmers.

Reuben A. Kessel: The Measurement and Economic Implications of the Inclusion of Indirect Taxes in the Consumers' Price Index.

I should like to explain briefly the background and circumstances under which the report was prepared.

The price statistics of the Federal Government make up an important segment of the factual data which constitute our economic and social intelligence. They are widely used not only by the Federal Government, but by all segments of our economy, business, labor, State and local governments, and research organizations.

In addition to the knowledge which they provide about the price movements themselves, they are also the link to measures of real output by their use as deflators and they help in the assessment of the growth in economic well-being generally.

The importance of these data for economic analysis has gained special recognition in recent years due to the general interest in evaluating the effects and forces of inflationary trends in our economy. Hearings of the Joint Economic Committee on the Relationship of Prices to Economic Stability and Growth for the 85th Congress and on Employment, Growth, and Price Levels for the 86th Congress focused attention on the need for reliable price statistics for the analysis of current economic problems of the highest importance.

A comprehensive critique of the Consumer Price Index was published by the President's Committee on Cost of Living in 1945 and a special subcommittee of the House Committee on Education and Labor held extensive hearings on the Consumer Price Index and issued a report in 1951. Other congressional reports, including those of this Committee, have touched on the problems of the various indexes discussed in the report submitted to you today.

The Bureau of the Budget is aware that notable improvements and modernizing changes have been made in the price statistics of the Government during the past decade. Nevertheless we believed, in view of the importance of the problems involved, that the time had come for a complete reexamination and reevaluation of the price statistics program of the Federal Government with a view to the development of recommendations for its continued improvement.

Such a review was appropriate at this time for the further reason that the Department of Labor was beginning a 5-year project to revise the Consumer Price Index and the results of the Review Committee's deliberations could be given consideration before the new index is published in January 1964.

The task outlined by the Bureau of the Budget and accepted by the National Bureau of Economic Research was broad in scope. It called for a review of uses, concepts, methods and research activities related to the Federal price-statistics program. No part of that program was excluded and the Review Committee was free to study related problems that it considered important and was instructed to take into account not only the needs of the Government, but also those of business, agriculture, labor, and the general public.

The Committee was asked to give special attention to the four major price series which the Government compiles. These are the Indexes of Prices Received and of Prices Paid by Farmers, compiled by the Agricultural Marketing Service, U.S. Department of Agriculture, and the Indexes of Consumer Prices and of Wholesale Prices, compiled by the Bureau of Labor Statistics, U.S. Department of Labor. The greater part of the report of the Review Committee relates to these indexes, although several other areas, such as export-import prices are also discussed.

The Price Statistics Review Committee met at approximately monthly intervals beginning in the autumn of 1959. Discussions were held with the staffs of the statistical agencies in Washington responsible for compiling the major price indexes and with officials of other agencies. A substantial amount of special work involving compilation of data and analysis was performed by the major price-statistics agencies at the request of the Committee, and staff members of the agencies cooperated fully in making their time available for discussion with Committee members.

A preliminary draft of the Committee's report was made available to the statistical agencies for comment and, after the receipt of such comments, the final draft of the report was transmitted to the Bureau of the Budget by the National Bureau of Economic Research on November 30, 1960.

The Bureau of the Budget believes this report from the National Bureau of Economic Research provides the expert guidance sought. Its recommendations deserve and will receive very careful consideration. It will be the task of the Bureau of the Budget, in consultation and cooperation with the price-statistics compiling agencies of the Government, to arrive at joint decisions as to what extent and in what manner the recommendations of the report can best be implemented.

The summary of the conclusions reached by this Committee is attached to this statement. At this time, the Bureau of the Budget is making no comments on these recommendations, since they are still under study. However, I shall be glad to place myself at the disposal of this subcommittee to appear again after other witnesses have been heard, and try to answer any questions which the subcommittee may care to ask.

May I repeat again my appreciation of the interest of this committee in the development of improved Federal statistics. Your attention to our problems is sincerely appreciated.

Senator SPARKMAN. Dr. Bowman, you have this summary. Would you read it? We will follow you.

Mr. BOWMAN. I would be happy to.

The Price Statistics of the Federal Government: Review, Appraisal, and Recommendations:

SUMMARY

The Price Statistics Review Committee has made a detailed study of the three main price indexes compiled by the Federal Government: the Consumer Price Index, the Wholesale Price Index, and the indexes of prices received and paid by farmers. Much of the report of the Committee is concerned with detailed questions (which, however, have substantial influence in the indexes) such as the appropriate detail of specification of the commodities whose prices are collected. Portions of the committee's recommendations aimed at improving the quality of the price indexes can be summarized as follows:

I. ALL INDEXES

1. Schedules of periodical revisions of weight should be adopted.

(I might say, Mr. Chairman, that it has been our practice to periodically revise the weights of the indexes about every 10 years. The Committee does suggest that it might be wise to consider some revision every 5 years.)

2. Probability sampling should be used, so that the precision of the index can be measured.

3. New commodities should be introduced more promptly.

4. The price collection agencies should be given funds for research divisions. The development of methods of coping with quality changes (some of which are discussed in the report) should be a major task of such divisions.

II. CONSUMER PRICE INDEX

1. The present index should be extended to include single persons as well as families, and the index should cover rural nonfarm as well as urban workers.

2. A more comprehensive index for the entire population, not only the wage and salary earners, should be made.

III. WHOLESALE PRICE INDEX

1. The structure of the overall index should be revised to reflect the prices of a condensed input-output table for the commodity producing industries.
2. The individual product prices should, where feasible, be collected from buyers (not from sellers, as at present) to get more information on actual transaction prices.

IV. INDEXES OF PRICES RECEIVED AND PAID BY FARMERS

1. The statutory prescriptions of the obsolete base (1910–14) and the inappropriate use of interest and taxes per acre, which are not prices, should be reconsidered.
2. The coverage of the indexes (particularly that of prices paid for living) should be increased.
3. The indexes for farms as production units should be segregated from the index for farms as consumer units.
4. The method of pricing should be shifted over to "specification pricing," and enumerative methods of collecting data should be adopted at least for commodities difficult to specify.

In addition to the committee's report, there are a dozen staff papers which deal with such problems as sampling, the differential movements of consumer price indexes for rich and poor families, quality changes in automobiles, and the validity of wholesale price quotations.

This addition to my statement is really the first chapter in the report of the committee and constitutes their summary.

Thank you, Mr. Chairman.

Senator SPARKMAN. Thank you, Dr. Bowman.

You stated that the Bureau of the Budget itself has not yet taken a position on the whole study, but that it is carefully considering it and that you will be prepared when we hold hearings later in the spring to appear and answer questions at that time.

Mr. BOWMAN. That is correct.

Senator SPARKMAN. We shall certainly expect to have you and we look forward to that occasion.

Is there anything further? Mr. Curtis.

Representative CURTIS. I would like to join with the chairman in thanking this group for this very splendid work. I want to find out if two points are included in these studies, and if they are not, possibly by giving this little warning that I would like to ask questions along those lines, the witnesses might be prepared to discuss the matters. It may be that they are covered.

One is the recent—and it is a fairly recent thing, the use of these various machines for computation and so on in the field of economic statistics—what has that impact been and what is it likely to be? I know in the Military Establishment they are getting to the point where with the use of machines they can get real inventory control. Is the impact of cybernetics discussed in the papers, just the bare bones; the impact of all these newly developed business machines, and how they improve gathering and collating our statistics, and how we might look forward to future improvement?

Mr. BOWMAN. It is not part of the paper, Mr. Congressman, but the electronic data processing equipment is being used in the compilation of price statistics.

The agencies, in particular the Bureau of Labor Statistics, will be able to indicate some of the newer things that are being done in the use of machine tabulations to handle the price data and to make some of the calculations that have to be made.

Representative CURTIS. Would you say it is true that a great deal of the advancement in economic statistics comes from the advancement in the electronic data processing equipment? Has that been one of the basic underlying factors in putting us in a position where we can do better?

Mr. BOWMAN. It has been a main element in getting things out more promptly, and also to handle complicated tabulations of one sort or another.

For instance, the census of population this time was for the first time in the history completely tabulated on electronic data processing equipment. In fact, a microfilm of the schedule that was made out by the enumerator went right into a machine (film optical sensing device for input to computers or Fosdic, for short), which converted it directly onto tape and the tape went to the computer. This has been a major improvement, and the data for 1960 will be available in half the time that it took for the 1950 census.

Representative CURTIS. The other question is this: I notice in the review of the various indexes a great deal of attention is being paid to quality change. I am not sure what language would be correct to use, so you can supply that, but does that include the increased variety or choice, frequently referred to by economists?

The thought I am getting to is this: In the consumer price index, take travel—the fact that I have a variety of schedules to choose from in going back to St. Louis, leaving at different times. The price itself would not reflect that choice that is available to me. Yet the choice is a cost item; the fact that there are a number of flights that I could take. In this element of quality, is variety—that is the term I have used—reflected? In these papers is thought directed toward that aspect of the cost of living?

Mr. BOWMAN. Variety is certainly one of the elements that is considered in the analysis of what might be called the environment in which prices are made. This is one of the problems of sampling prices. In other words, a sample of, let us say, the cost of living in 1850 and a sample of the cost of living in 1960 would be quite different because the various commodities that are available and the various services that are available are different. Yet, when you are making price comparisons, you have to be comparing the price of the same thing over the period of the comparison, or at least if not the same thing, you have to take into account the extent to which it has changed so that you measure the price change and not something else. This is the area in which the report of the committee will be subject, I am sure, to the greatest amount of controversial statements.

Everyone agrees that the problem of the quality change is one of the difficult problems in the development of price index numbers. Everyone does not agree as to how to take account of the quality change or just exactly how much of the change has been a change in quality.

In other words, it could be argued that there have been no increases in the price of automobiles over the last 30 years. That would assume that the whole change was a change in quality. There are different people who would argue different ways on this. One of the suggestions of the Committee is that we do not know enough about measuring quality changes yet to say specifically how quality changes should be taken account of in price index numbers. But certainly more research work should go on in this area. That is one of the reasons that they recommend this special research section of the price statistic units to study, in particular, quality change problems.

My own feeling is that this should not relieve some of the private research agencies from doing this sort of thing, because they are in a very good position to indicate ways in which we might measure quality changes.

Representative CURTIS. What I have referred to as variety would not really be quality, would it?

Mr. BOWMAN. I think you could interpret it as a type of quality, but it seems to me it would be the quality of the overall level of living, rather than the quality of particular items that would be affected.

Representative CURTIS. That would be even harder to measure. The real question, or the only question I really have for you at this time is whether the papers cover those aspects.

Mr. BOWMAN. The papers definitely cover the quality change aspect even to the mention of variety, and even to the mention of the problem of the fact that people's tastes themselves change. This makes it even more difficult to say what you mean by quality change.

The first item is not covered by the papers, but can be covered by one of the witnesses from the agencies.

Representative CURTIS. Thank you.

Senator SPARKMAN. Thank you, Dr. Bowman.

The record of these hearings will be published as expeditiously as possible so they can be available to interested parties, especially those invited to testify later when we resume these hearings. The circulation of the full text of the report of the Price Statistics Review Committee, and Dr. Bowman's statement, will enable later witnesses to develop carefully considered and helpful appraisals of its conclusions and recommendations for presentation to this subcommittee.

The subcommittee stands adjourned.

(Whereupon, at 10:35 a.m., the subcommittee was adjourned.)

THE PRICE STATISTICS OF THE FEDERAL GOVERNMENT

NATIONAL BUREAU OF ECONOMIC RESEARCH
NUMBER 73, GENERAL SERIES

10

THE PRICE STATISTICS OF THE FEDERAL GOVERNMENT

REVIEW, APPRAISAL, AND RECOMMENDATIONS

A Report to the Office of Statistical Standards
Bureau of the Budget

PREPARED BY THE PRICE STATISTICS REVIEW COMMITTEE
OF THE NATIONAL BUREAU OF ECONOMIC RESEARCH

DOROTHY S. BRADY
EDWARD F. DENISON
IRVING B. KRAVIS
PHILIP J. McCARTHY
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RICHARD RUGGLES
BORIS C. SWERLING
GEORGE J. STIGLER, *Chairman*

Together With Twelve Staff Papers

National Bureau of Economic Research, Inc.
1961

Relation of the Directors to the Work and Publications of the National Bureau of Economic Research

1. The object of the National Bureau of Economic Research is to ascertain and to present to the public important economic facts and their interpretation in a scientific and impartial manner. The board of directors is charged with the responsibility of insuring that the work of the National Bureau is carried on in strict conformity with this object.

2. To this end the board of directors shall appoint one or more directors of research.

3. The director or directors of research shall submit to the members of the board, or to its executive committee, for their formal adoption, all specific proposals concerning researches to be instituted.

4. No report shall be published until the director or directors of research shall have submitted to the Board a summary drawing attention to the character of the data and their utilization in the report, the nature and treatment of the problems involved, the main conclusions, and such other information as in their opinion would serve to determine the suitability of the report for publication in accordance with the principles of the National Bureau.

5. A copy of any manuscript proposed for publication shall also be submitted to each member of the board. For each manuscript to be so submitted a special committee shall be appointed by the president, or at his designation by the executive director, consisting of three directors selected as nearly as may be one from each general division of the board. The names of the special manuscript committee shall be stated to each director when the summary and report described in paragraph (4) are sent to him. It shall be the duty of each member of the committee to read the manuscript. If each member of the special committee signifies his approval within 30 days, the manuscript may be published. If each member of the special committee has not signified his approval within 30 days of the transmittal of the report and manuscript, the director of research shall then notify each member of the board, requesting approval or disapproval of publication, and 30 additional days shall be granted for this purpose. The manuscript shall then not be published unless at least a majority of the entire board and a two-thirds majority of those members of the board who shall have voted on the proposal within the time fixed for the receipt of votes on the publication proposed shall have approved.

6. No manuscript may be published, though approved by each member of the special committee, until 45 days have elapsed from the transmittal of the summary and report. The interval is allowed for the receipt of any memorandum of dissent or reservation, together with a brief statement of his reasons, that any member may wish to express; and such memorandum of dissent or reservation shall be published with the manuscript if he so desires. Publication does not, however, imply that each member of the board has read the manuscript, or that either members of the board in general, or of the special committee, have passed upon its validity in every detail.

7. A copy of this resolution shall, unless otherwise determined by the board be printed in each copy of every National Bureau book.

(*Resolution adopted October 25, 1926, as revised February 6, 1933, and February 24, 1941*)

NATIONAL BUREAU OF ECONOMIC RESEARCH, INC.,
New York, N.Y., November 30, 1960.

MR. RAYMOND T. BOWMAN,
Assistant Director for Statistical Standards,
Bureau of the Budget,
Washington, D.C.

DEAR MR. BOWMAN: I transmit herewith "The Price Statistics of the Federal Government: Review, Appraisal, and Recommendations," a report made by the Price Statistics Review Committee of the National Bureau of Economic Research at the request of the Office of Statistical Standards of the Bureau of the Budget.

The report has been approved by the Board of Directors of the National Bureau, in accordance with its usual procedure, as meeting the objectives of the National Bureau—"to ascertain and to present to the public important economic facts and their interpretation in a scientific and impartial manner." As the resolution of the Board governing the relation of the Directors to the work and publications of the National Bureau states, approval by the Board does not, however, imply that each member of the Board has read the report, or has passed upon its validity in every detail.

I request that the report be substituted for the preliminary draft transmitted to you on September 30, 1960. The present report is the final report of the Committee, subject only to necessary corrections, before publication, of any typographical or other errors that may have crept in during the final stages of its preparation.

Attached to the report are a number of Staff Papers prepared for the use of the Committee. The papers are not an integral part of the report, and responsibility for their contents rests with their respective authors. However, the papers contain a great deal of useful supplementary information and comment on the price statistics of the federal government and deserve consideration along with the Committee's report.

The price statistics of the federal government are of great importance. They are put to many uses by individuals, business enterprises, trade unions, and other private organizations, as well as by governments. Whatever can be done to improve these statistics and deepen users' understanding of them deserves serious attention. It is the hope of the Committee and of the National Bureau, as I am sure it is of the Bureau of the Budget, that this report will further such improvement and understanding when its contents are studied not only by the Bureau of the Budget and the federal agencies responsible for the price statistics, but also by other governmental agencies and the public at large. If the Bureau of the Budget does not make the report public, the National Bureau will undertake to do so in accord with our discussions.

As is stated in the Introduction to the Committee's report, arrangements between the National Bureau and the Office of Statistical Standards of the Bureau of the Budget for the preparation of the report were concluded on July 2, 1959. We are deeply grateful to the public-spirited members of the Price Statistics Review Committee, all of whom devoted a substantial portion of their time and energy during the year following to the difficult task of preparing the report; and to the many persons inside and outside the federal government who participated in the discussions, provided essential information, and reviewed drafts of the report. I want to add a special word of thanks to Professor George J. Stigler of the University of Chicago and the National Bureau Staff for his direction of the entire enterprise.

On behalf of the National Bureau, I would like to express our appreciation to the Office of Statistical Standards of the Bureau of the Budget for this opportunity to be of service.

Sincerely yours,

SOLOMON FABRICANT,
Director of Research.

NATIONAL BUREAU OF ECONOMIC RESEARCH, INC.,
New York, N.Y., November 30, 1960.

MR. SOLOMON FABRICANT,
Director of Research,
National Bureau of Economic Research,
261 Madison Avenue, New York, N.Y.

DEAR MR. FABRICANT: The Price Statistics Review Committee, organized by the National Bureau of Economic Research, herewith submits its report as approved by all members of the Committee. Attached also are the staff papers which are offered on the responsibility of the individual authors.

Sincerely yours,

DOROTHY S. BRADY,
EDWARD F. DENISON,
IRVING B. KRAVIS,
PHILIP J. MCCARTHY,
ALBERT REES,
RICHARD RUGGLES,
BORIS C. SWERLING,
GEORGE J. STIGLER, *Chairman.*

THE PRICE STATISTICS OF THE FEDERAL GOVERNMENT

Report of the Committee

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REPORT OF THE COMMITTEE

STAFF PAPERS

SUMMARY

The Price Statistics Review Committee has made a detailed study of the three main price indexes compiled by the Federal Government: the Consumer Price Index; the Wholesale Price Index; and the Indexes of Prices Received and Paid by Farmers. Much of the report of the committee is concerned with detailed questions (which, however, have substantial influence in the indexes), such as the appropriate detail of specification of the commodities whose prices are collected. Portions of the Committee's recommendations aimed at improving the quality of the price indexes can be summarized as follows:

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1. Schedules of periodical revisions of weight should be adopted.
2. Probability sampling should be used, so that the precision of the index can be measured.
3. New commodities should be introduced more promptly.
4. The price collection agencies should be given funds for research divisions. The development of methods of coping with quality changes (some of which are discussed in the report) should be a major task of such divisions.

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1. The present index should be extended to include single persons as well as families, and the index should cover rural nonfarm as well as urban workers.
2. A more comprehensive index for the entire population, not only the wage and salary earners, should be made.

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1. The structure of the overall index should be revised to reflect the prices of a condensed input-output table for the commodity producing industries.
2. The individual product prices should, where feasible, be collected from buyers (not from sellers, as at present) to get more accurate information on actual transaction prices.

IV. Indexes of Prices Received and Paid by Farmers:

1. The statutory prescriptions of the obsolete base (1910–14) and the inappropriate use of interest and taxes per acre, which are not prices, should be reconsidered.
2. The coverage of the indexes (particularly that of prices paid for living) should be increased.
3. The indexes for farms as production units should be segregated from the index for farms as consumer units.
4. The method of pricing should be shifted over to "specification pricing," and enumerative methods of collecting data should be adopted at least for commodities difficult to specify.

In addition to the Committee's report, there are a dozen staff papers which deal with such problems as sampling, the differential movements of consumer price indexes for rich and poor families, quality changes in automobiles, and the validity of wholesale price quotations.

I

INTRODUCTION

1. The Price Statistics Review Committee was formed under a contract which was entered into by the Bureau of the Budget and the National Bureau of Economic Research in July 1959. The salient provision of this contract, which established the mandate of the Committee, is:

> The scope of the review shall include but is not limited to the following:
>
> a. Uses of indexes
> b. Concepts and structure of existing indexes
> c. Timing of the collection and publication of the data
> d. Specification and collection problems
> e. Introduction of prices of new commodities and services
> f. Program of revisions in indexes
> g. Use of probability methods in collection of prices
> h. Consumer expenditure surveys
> i. Continuing research program in price index methodology
>
> This review shall include the Bureau of Labor Statistics' Consumer Price Index and Wholesale Price Index and the Agricultural Marketing Service Index of Prices Paid by Farmers and Index of Prices Received by Farmers, and the price collections related to these indexes which are useful for other purposes. The review may, in the discretion of the National Bureau of Economic Research, be extended also to other price indexes prepared by the Federal Government, and indexes not now prepared by the Federal Government but to the preparation of which consideration might be given.
>
> The review should take into account not only the needs of the Government but also those of the general public, including business, agriculture, labor, and private research organizations. Attention should be given to the need for data reflecting current economic conditions and also to the need for basic information required for meaningful historical analyses and studies of price and cost relationships. Some attention should be given to the special problems which arise as a result of the use of the indexes for wage adjustments and price supports.

2. The possible scope of the Committee's survey was therefore extremely wide: it included not only the study of the main price series compiled by the Federal Government but also the minor price series and important areas of economic life for which price series are not available. Yet even the exhaustive investigation of every procedure now undertaken in the compilation of a single major price index, and its comparison with alternative procedures, would require time and resources many times greater than we possessed.

3. Accordingly, we have been compelled to be severely selective in the scope of our survey. Our main efforts have been devoted to the three principal price areas:

The Consumer Price Index (CPI)
The Wholesale Price Index (WPI)
The Indexes of Prices Paid and Received by Farmers

Lesser attention is paid to import and export price indexes, construction cost indexes, and asset price indexes. Nor have we scrutinized every detail of the procedures followed in constructing the major indexes. The systems of weights have been examined only from the conceptual viewpoint, and many operational procedures have been passed over. Our intuitions as to where to concentrate our studies have no doubt been imperfect, but concentration was unavoidable.

Our decision to concentrate upon problem areas in the price statistics fields means that we have purposely passed quietly over aspects of the work of the price statistics agencies which are especially strong or worthy of commendation. We believe that such concentration is more useful than comprehensive but less intensive appraisal, but we regret the corollary that much fine work of the agencies is not discussed. This orientation should be kept in mind in reading our report.

4. The staff studies which accompany our report were prepared by the indicated authors and represent their individual viewpoints. The Committee accepts the views and findings in these studies only to the extent made explicit in the Report. These forbidding, if necessary, remarks should not conceal our large debt to the authors of the staff papers, and our gratitude to them for the important contributions they have made not only to our work but to the general field of index numbers. A special expression of indebtedness is due to Harry E. McAllister, who was also secretary of the Committee, and to Thomas F. Mosimann, who was our liaison representative from the Bureau of the Budget. We also wish to acknowledge assistance from Raymond W. Goldsmith and Nancy Ruggles.

5. Our debt to the price-collecting agencies—the Bureau of Labor Statistics, the Agricultural Marketing Service, and the Bureau of Foreign Commerce—and to other agencies (the Bureau of the Census and the Interstate Commerce Commission) is immense. These agencies have made numerous and extensive special studies, despite the heavy burdens of their official duties; they have instructed us in countless ways; and they have maintained unfailing cooperativeness under the ordeal of endless questioning. Their dedication to the improvement of the price indexes is one of our major resources in the area of price statistics.

II

GENERAL PROBLEMS IN THE PRICE INDEX PROGRAM OF THE FEDERAL GOVERNMENT

1. The Institutionalizing of the Indies

Every observer of the price statistics area must be impressed with the extent to which the leading indexes are becoming institutionalized. The CPI is becoming an integral part of the area of collective bargaining, through its extensive use in wage escalation. The WPI is receiving an increasing role in business contracts covering even fairly short periods of time. The Indexes of Prices Paid and Received by Farmers are at the foundation of agricultural price-support policies of the Federal Government.

Such a development is of course inevitable in an inflation-conscious age—after all, price indexes are made to be used. There is, however, a growing threat to the maintenance of the scientific quality of the indexes arising out of their use in private contracts and public policy. The important legal commitments which rest on the indexes normally lead the parties to press for strict comparability in the concepts and procedures employed in compiling the index. This attitude is easily comprehended: if the indexes are revised with the effect of costing one party to a commitment a large sum of money, the index appears to be contributing its own statistical uncertainties rather than removing those in the dollar quantities to which it is applied.

But this demand for strict comparability is shortsighted even from the viewpoint of the parties who use the indexes for legal commitments. It would be unwise to contract for 20 years with a person to be supplied with a 1960 automobile if one wished a given type of transportation: the strict "comparability" of the identical automobile over time would not conceal its increasing decrepitude. Index numbers also deteriorate with age—and often no less rapidly than automobiles. Strict comparability in the items priced and the weights assigned to commodities can be achieved only at the cost of making an index number increasingly obsolete. It would be possible to make up a consumer price index, for example, that priced only goods that were very similar in 1930 and 1960, but it would have to disregard the majority of the goods consumed in either year, and its course over time would be a mere caricature of the movements of a good consumer price index.

The periodic revision of price indexes, and the almost continuous alterations in details of their calculation, are essential if the indexes are to serve their primary function of measuring the average movements of prices. The users of the data—scientific as well as business or governmental—are entitled to responsible behavior on the part of the price collection agencies, and responsible behavior forbids frequent minor changes in methods and concepts. But they are not entitled to a hollow rigidity of form which deprives the indexes of their relevance. Responsible behavior in the calculations of the indexes consists primarily in presenting the indexes which, within the limits of the agency's powers, best measure the changes in the price of whatever the indexes seek to measure.

Certain problems which are posed by wage and contract escalation deserve more detailed notice here; the farm price indexes are discussed in Section VI.

Wage Escalation.—The CPI is now used in wage escalation contracts covering more than 4 million employees. "Escalation" contracts usually provide for periodic changes in money wages (usually quarterly) based on changes in the national CPI or, less often, in the CPI for an individual city, by a variety of formulas. There is some tendency for the use of wage escalation clauses to increase in periods of rapid price rise and to decrease in periods of relative price stability.

The desire of the parties to wage agreements for escalator clauses is to a large extent a byproduct of a desire for long-term agreements (agreements of more than a year's duration without provision for renegotiation of wage rates). Such agreements can be advantageous to both parties because they permit long-range planning and may reduce the costs of negotiation and particularly of strikes. The presence of an escalator clause is often a prerequisite to a firm long-term agreement from the point of view of the union, since in its absence price rises could erode real wages during the life of the agreement. The tendency toward long-term agreements seems to be increasing, and this will probably lead to increasing use of wage escalation for any given rate of price rise.

The CPI has had special relevance to wage bargains since its inception—it grew out of attempts to measure the "real" wages of shipyard workers during World War I, and its present coverage (urban wage and lower salary workers) still reflects this relevance. The index has since become important in wage and salary determinations for other classes of employees, however, and it has taken on important general policy and scientific uses which are not restricted to wage and lower salary workers. These widening uses raise a question of the propriety of the present restrictions on the coverage of the CPI, which we discuss in Section IV; here it is sufficient to note the implications of wage escalation contracts for the construction of the CPI.

1. A price index comparable to the present CPI, suitable to the current wage escalation clauses, should be maintained for several years even if an extensive revision of the scope of the index is undertaken by the BLS. With full notice of this policy, wage contracts can be drawn to provide for periodic revisions.

2. The long-term program of consumer price indexes need not and should not be determined exclusively or primarily by the current wage-escalation contracts. The most useful CPI *need not* be restricted to the present index population, since a subcomponent of a more comprehensive index can always be presented which will fully serve the purpose of wage escalation. The most useful CPI *should not* be determined only by wage escalation needs, for there are other policy and scientific needs of great importance.

We shall argue later for a CPI appropriate to the entire urban population that will probably serve equally well for wage contracts, because the consumption patterns and prices of the urban workers' families—over one-half of the urban population—are similar to those of the entire urban population. Since no index provided by the Federal Government will ever be exactly appropriate to the employees covered by any one wage contract, wage escalation does not prescribe a unique index. But even if this position is disputed, and a special wage earners' index is deemed a permanent need, its provision would be an economical byproduct of a more comprehensive index.

Contract Escalation.—The escalation of contracts for goods to be delivered at a considerable distance in the future is analogous in many respects to wage escalation. The main difference is that the global WPI is seldom used (and for reasons we discuss later should not be), and either individual prices or components of the index are employed. As a result much less pressure exists for formal continuity in the composition or coverage of the comprehensive index, and in fact the only important implication of contract escalation for the WPI is that individual prices and group indexes should be continued for several years after notice of a change of scope or structure is given.

2. The Publication of Methods

The periodical publication of the full description of the methods by which each of the major price indexes is constructed is a basic recommendation of our committee. The reasons for the recommendation are surely self-evident:

1. Unless the concepts and procedures are fully described, the users of the indexes will not know precisely what they are using.
2. Only if comprehensive descriptions are available will the professional economists and statisticians be able to judge the quality of the indexes, and to contribute to their improvement.

The BLS and the AMS publish a great deal of information on their concepts and procedures, but they fall considerably short of the status we believe essential. The descriptions are fragmentary and often lag changes in practice by many years, so there exists no unified and comprehensive description of any of the major indexes as of a given time. Portions of information vital to the assessment of the indexes and to many of their uses, such as the numbers of independent price quotations by commodity or industry and location, are not publicly available.

We realize that "full description" is not literally attainable: literally millions of numbers go into the construction of a major index within a few years, and innumerable events such as the burning down of a grocery store or the loss of a letter compel at least variation in practices. Indeed description itself is a high art, requiring a sense of salience and precision warmed by understanding—and an informed reader. But granted that fulfillment of our recommendation requires much difficult and discriminating effort by the price collecting agencies, we are convinced that no other single recommendation in our report is more important to the continual improvement of the indexes or to their proper use. Our price statistics program will be seriously deficient until full monographs, equal in scope to that describing the national income accounts, are published after every significant revision of methods or results.

3. Research Within the Price Collecting Agencies

The resources which have been made available to the price collecting agencies for research on the improvement of the indexes have been niggardly. A staff preoccupied with the very large task of speedily processing the indexes has not had the time or the detached position to review a program in its entirety, to reexamine basic conceptual problems, or to experiment with new methods of collecting and analyzing data. The indexes have improved over time, and the marvel is that they have improved as much as they have, not that they have not improved more. Yet data collection and data processing methods have been undergoing a major revolution within the last two decades, and almost every concept and process in compiling index numbers needs frequent review. We strongly recommend that research units be created within each agency, independent of but working in close cooperation with the operating units. Relatively small investments in such research units will yield large returns, whether measured narrowly by the development of more efficient methods or broadly by improvements in the quality of the price indexes.

4. Extension to New Areas

There are areas of great economic importance in which at present price statistics programs are either wholly absent or so incomplete as to call for a major reorganization and expansion of work. Five general price index areas, of which the first three seem especially urgent, are discussed briefly here and (for three areas) more extensively in Appendices A to C.

Before we turn to these five "index" fields, we wish to emphasize as strongly as possible the need for also collecting price data which are not closely geared to existing or proposed official index numbers. The strategy of price collection is now dominated by the official indexes, and only adventitiously will it yield other price data designed to serve the broader needs of econometric and historical research. For example, something as fundamental as the process by which new products gain acceptance and are diffused throughout the economy, and the role of price changes in this process, is little understood; and there is no provision in the current price collection programs for data which will illuminate it.

No price collection agency will have the resources to engage in exploratory work on a scale sufficient to fill the important gaps in our basic knowledge posed by evolving economic research, but even a modest amount of such work (perhaps designed with the aid of specialists in price research) would be a major contribution to our general scientific welfare.

i. EXPORT AND IMPORT PRICE INDEXES

With the rise in the importance of international economic relations in the American political and economic scene and more recently with the change in our balance of payments position, it has become even more essential to understand the factors that influence the ebb and flow of American foreign trade. Changes in prices in the United States relative to those of other countries and more particularly changes in the prices of goods that enter international trade are among the key elements in explaining variations in our trade position. Much of the current discussion on the American balance of payments deficit turns upon relative price changes at home and abroad.

The problem of constructing suitable import and export price indexes is discussed in some detail in Appendix A. Our recommendations can be summarized:

1. The export and import unit-value indexes should be brought into closer conformity with price indexes by increased utilization of price information from sources external to foreign trade statistics, particularly by use of BLS wholesale prices and the collection of some prices by specification from the field.

2. As soon as the basic price data have been improved, subindexes conforming to the Standard International Trade Classification should be developed. This does not mean that there must necessarily be a separate index for each SITC category, but indexes should be prepared for categories or combinations of categories that are important in United States trade. The indexes for total exports and imports for our trade with Latin America should be supplemented by similar indexes for other major regions.

3. Assuming that satisfactory price and quantity data are available, the present methods of the Bureau of Foreign Commerce, while obviously not the only acceptable solutions, represent defensible choices. The methods are well adapted to the special problems encountered in this area and to the uses to be made of the indexes.

4. The export-import price index work is now conducted with wholly inadequate resources. It may be necessary or expedient to transfer responsibility from an operating to a statistical agency to obtain the attention and resources for these indexes that we believe are essential.

ii. CONSTRUCTION PRICE INDEXES

New public and private construction has comprised almost one-eighth of the total value of the gross national product in recent years. Satisfactory price data in the construction area are thus of great importance for deflation of the national product as well as for the many important specific uses for which construction price (or "cost") indexes are needed. The behavior of construction prices is of extraordinary interest to the Federal Government itself because it is a large buyer of construction, heavily supports by grants-in-aid the purchase of construction by state and local governments, and has a primary interest in private construction through various direct loan and loan insurance and guarantee programs. The Committee believes that this is a price area of great importance, and one which cries for improvement.

The Committee's views on this area are detailed in Appendix B. We recommend a radical expansion and reorientation of the work in this neglected and difficult area. The Committee believes that the first step in obtaining a construction price index is the development of a detailed program to provide such an index. This program should be based on the assumption that a reasonable amount of funds will be made available to collect and process data to implement the program once it is drawn up. Under present arrangements the responsibility for developing such a program evidently lies with the Bureau of the Census in consultation with other interested agencies. The approaches described in Appendix B are intended to indicate the Committee's view that great improvements in present procedures are possible, not to limit in any way the development of an adequate program.

iii. DEFLATION OF THE NATIONAL INCOME ACCOUNTS

The national income accounts have become within a generation among the most basic and widely used economic data, for both policy and scientific purposes. The recalculation ("deflation") of these income and expenditure data in stable prices is essential to their uses, and as the accounts become steadily more detailed, their deflation makes for ever larger demands for price data. A highly classified set of accounts provides, indeed, a tolerably complete inventory of all possible prices (other than of assets) in the economy.

The "implicit" price deflators constructed by the National Income Unit are a set of price indexes which are being used increasingly more widely, and this trend will continue. They are, in principle, based upon given year weights (Paasche indexes), unlike most other price indexes, and therefore cannot be produced so currently as the conventional fixed weight indexes. We believe that these indexes are so important that their data requirements deserve explicit recognition and cooperation by the price collection agencies, and at several points in this report we give important instances of the need for enlarged price collection programs for this purpose.

iv. ASSET PRICES

Construction price indexes refer to *new* assets, and immediately suggest the question of the price indexes for other tangible assets, including real estate, vehicles, producer durable goods, and land. Prices of durable assets are essential in the derivation of estimates of national wealth and national balance sheets, and they are needed for deflation purposes in the increasingly important area of flow-of-funds analysis. Many policy and scientific problems (examples are studies of the process of inflation and of productivity and economic progress) to which national income accounts and balance sheets and flow-of-funds analyses make large contributions thus ultimately require asset price indexes. We discuss the scope and some lines of attack on this area in Appendix C.

v. TRANSPORTATION RATES

An index of freight rates of railroads has been published by the Interstate Commerce Commission since 1948; this is the only general freight rate index presently compiled. There are persuasive reasons for expanding this sector of price indexes. The transportation industries are sufficiently important in terms of both economic size and public policy decisions to justify a much more detailed knowledge of the changing structure of freight rates by commodity, area, and distance, and by type of carrier. The progressive refinement of the national income accounts will sooner or later lead to estimates of income originating in well-defined industry sectors, and freight rates will become necessary to relate selling prices of suppliers to buying prices of purchasers.

The extension of freight indexes to common carriers other than railroads should be a relatively simple and economical step: the extension to the motor trucking industry is illustrated in Staff Paper No. 1. The private carriers, and other carriers not subject to public regulation, pose immensely greater problems of data collection as well as serious problems of concept and procedure, but we believe that the importance of these sectors justifies extensive exploratory work.

III

PROBLEMS COMMON TO THE INDEXES

Certain problems are encountered in most or all of the price indexes we are reviewing. We treat these problems generally rather than discuss each problem in connection with each index, indicating special adaptations necessary to particular indexes.

1. Frequency of Revision of the Weight Bases

The practice of the price collecting agencies in revising the weight bases for the price indexes varies widely. The export and import prices are calculated as the geometric means of the indexes based upon weights of the given and preceding year. The construction cost index is implicitly a given year weight index. These are the only indexes not employing a fixed initial year weight base (Laspeyres index). The weight base of the Wholesale Price Index is generally revised on the basis of the most recent Census of Manufactures—the current weight base is 1954; the next weight base will be 1958. The Consumer Price Index is based upon 1952 weights—the previous base (aside from interim adjustments in 1951) was 1934–36 and the next base will be 1960–62. The Index of Prices Paid by Farmers has a 1955 weight base, that of Prices Received by Farmers a 1953–57 base. In these last two cases, the indexes were recomputed back to 1952.

A fixed-weight base is practically unavoidable so long as elaborate expenditure surveys or production censuses are necessary to provide the weights. The principle on which one should decide when to revise the weight base is that a revision is necessary when the weight base has changed appreciably. In a stable society, revisions could be extremely infrequent; in the rapidly changing American economy, a revision once in a decade or more (as has more than once been the case with the Farm Indexes and the Consumer Price Index) is too infrequent. The rapid pace of introduction of new products in the United States, the large demographic changes in recent decades, the revolution in production methods—these are instances of the changes that dictate frequent revision of weight bases.

If budgetary limitations prohibit frequent weight revisions, the practice of the Agricultural Marketing Service in revising the index back over part of the period since the previous revisions seems preferable to the BLS practice of treating the previous indexes as immutable. Such backward revisions will be improved if each year's weights are an average of initial and terminal year weights (combined with relative weights proportional to the propinquity of the given year to each terminal year).

Quite aside from the fact that we believe the United States can afford good price indexes, however, the budgetary restrictions are being relaxed by the improvements in survey methods for obtaining the basic information. It has become feasible to measure more frequently the changes in weights of at least the larger categories (such as electrical appliances in the CPI) and in the most rapidly changing detailed classes of weights.

We therefore believe that there should be an established program of periodic, comprehensive revision of the weights of the Consumer Price Index and the Farm Indexes at least once every decade (this is an outer limit on the period between complete revisions). In addition there should be smaller surveys (and weight revisions) at least every 5 years concentrating upon the more volatile categories of weights.

Even frequent revisions of weights, however, will not eliminate the need for frequent current substitutions of goods because of the continual disappearance of old and appearance of new goods, for reasons to which we now turn. The "fixed market basket" approach does not demand, or even allow, a strict identity in all goods between weight revisions.

2. Specification vs. Unit Value Pricing

In 1934 the Bureau of Labor Statistics adopted "specification" pricing, and since then has sought to price narrowly defined commodities and services to obtain price relatives for price indexes. The Agricultural Marketing Service, on the other hand, has used the average value (farmers' total receipts from or total expenditures on a category of goods divided by the count of units) to construct price relatives. The export and import price indexes are also based on unit-value relatives to a more limited extent.

The Committee believes that in principle the specification method of pricing is the appropriate method for price indexes. The changing unit values of a broad class of goods (say shirts or automobiles) reflect both the changes in prices of comparable items and the shifting composition of lower and higher quality items. The greater rise of automobile prices in the farm index of prices paid than in the CPI reflects the shift toward automatic transmissions and power braking and steering as well as any rise in the price of comparable automobiles. The basic logic of the fixed-weights base index requires that the "pure" price effect be isolated or the index will not measure the changing cost of this fixed weight base.

A special complication arises with the Farm Indexes (and also the export-import indexes) out of the desire to have a unit-value index which can be multiplied by an output index to obtain total receipts or total expenditures. Even if this is a legitimate condition to put on price indexes (a question we need not discuss), it is, however, neither necessary nor sufficient to construct unit-value indexes. It is not necessary because an adequate set of specification prices, joined to appropriately detailed output data, will yield total receipts or expenditures. It is not sufficient because unless one knows the behavior of prices and outputs of individual qualities of goods, it is usually impossible to construct appropriate average values which have the desired property.[1] Staff Paper No. 11 sheds light on this difficulty.

But the Committee also believes that the true difference between unit-value and specification pricing is one of degree rather than of

[1] Actually the unit values are often modes rather than means: the prices asked for are those of (unspecified) qualities bought in the greatest volume by farmers.

kind, and neither the BLS nor the AMS uses either method of pricing exclusively or in the most extreme possible form.[2] Thus the CPI uses average values for used cars, houses, and other categories, and the AMS has almost continuously refined the categories within which unit values are computed, for example by dividing a single category of refrigerators into four size groups. Yet both agencies depart from what we believe is the best practice.

In the case of the Farm Indexes, the classes over which unit values are computed are still often too wide. Automobiles are classified only into 6 and 8 cylinder (with prices collected for the lower priced brands); there is only one category each of men's wool suits and living room suites; tractors and crawlers are classified only by horsepower; etc. There is too much room, within these categories, for both misunderstanding by price reporters (who report by mail) and large shifts in the nature of goods priced over time.

It is less obvious that one can err in the direction of excessively fine specification, but we are convinced that the BLS has done so. Our discussion of the problems created by present BLS specifications applies primarily, though not exclusively, to the pricing of clothing, home furnishings, and appliances. It is true that the finer the specification, the more comparable the prices and therefore the better the measurement of "pure" price change. But the immense costs of extreme and geographically uniform specification are ignored by this view:

1. If uniform specifications are prepared in Washington for products which vary greatly over the United States, they must fail to represent large amounts of consumer expenditures.

2. Because of the centralization of specification writing, and the endless task of revising specifications as products change, the specifications lag behind changes in the market. Because it requires additional efforts for a busy field agent to obtain waivers or changes of specification, items are sometimes priced until prices are no longer available (which may be long after the commodity has dwindled to unimportance).

3. If the specifications are very strict, only a very few price quotations can be obtained from a given amount of field enumeration. Price changes are often associated with product changes, or with changes in the retail establishments patronized by the index population, which over time increasingly depart from narrow specifications.

The collection of prices for commodities of detailed specification results in a kind of stratification of reporters that changes over time. Because of the great variety of goods in the market and the frequent changes in styles, fashions, and models, the commodities described by detailed specifications cannot be found in all establishments at a given time or in the same establishments in successive periods. In order to provide for a sufficient number of price reports, the specification has to be generalized in various ways, but even considerable tolerances in the definition do not assure that articles "meeting specification" can be found in the same places at successive dates. The choice of the specification leads to a selection of outlets that cannot be described in explicit terms, but it is almost certain that these outlets become less and less representative over time. Specifications must be changed constantly in order to provide price statistics that are in

[2] See Staff Paper No. 2 for illustrative comparisons of prices collected by the two agencies.

some sense representative of the market. The effect of changing specifications on the index depends on the calculation procedures and involves the measurement of quality differences. When the calculations of price relatives are based on the prices of commodities with different specifications, the precision of the specifications has served only as a control on the agents' judgments on the equivalence of commodities at different dates.

Specifications are soon outdated and must be changed so frequently that their advantages in the recording of price statistics are offset by the difficulty, even impossibility, of assessing the effect of changes in the number of reporters and alterations in the details of the specification. A large part of the resources used in writing specifications, editing and reviewing the price data for errors in recording, and interpretation could be used in designing more general rules for the recognition of comparable qualities within the stocks of individual establishments, developing methods for the recording of qualitative characteristics of commodities and services, and analyzing the relation between the quality variations and price changes that take place over time.[3]

We do not conclude that specification pricing should be abandoned, but rather that it be reconstructed along more flexible lines. The basic goal of comparable price relatives can be achieved without imposing uniform, highly detailed specifications on the entire price collection area. Specifications should be set centrally (on a basis discussed in the section on sampling, III, 5), but they should not be "specifications in detail"; that is, men's dress socks or 10- 12-ft. refrigerators may be set centrally, but the field agents should be free to select those precise qualities for which they can obtain continuous and comparable price quotations because the commodities are continuously sold in the outlet. The precise specifications should be reported along with the prices, to provide a continuous and up-to-date stream of information on commodity appearances and disappearances (and thus assist in earlier revisions of central specifications). The actual cost of collecting comparable and also more representative price quotations will be substantially reduced by this controlled decentralization.

Because the procedures recommended in the preceding paragraph represent a substantial change from present procedures, it seems desirable to discuss them in some detail. We envisage specifications encompassing a broader range of qualities or varieties of a product than is now priced, but setting forth the features of the product that are to be held constant from one period to the next. For example, instead of requiring that a gas range be white porcelain, the specification would ask the agent to state whether the range being priced is white or in color and instruct her not to compare a colored range this month with a white range last month unless the white range was no longer sold in this outlet in appreciable volume. When a substitution was made, the

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[3] A change to less detailed specifications would make possible the more frequent and complete publication of the specifications used and of major changes in them, a step that would greatly increase the usefulness of the published item indexes. At present the user of an item index can get information on the nature of the item to which it refers only by corresponding with the BLS, and if the information requested is not current, it can be supplied only with great difficulty. The published item index on men's socks, for example, refers at times to work socks and at other times to dress socks, but there is no way at all for the user to determine this from the published material.

decision could be made in the processing of the field report whether to make a direct comparison, to make a comparison with a price adjustment for the change from white to color, or to introduce the colored range by linking. We believe that such procedures would continue to give commodity specialists adequate control of the pricing process. We also envisage the elimination of the specification of features that cannot be recognized by a well-trained agent in the field—for example, the number of pair of pajamas cut from a given length of cloth—and of features that are not relevant to the performance of the commodity or the satisfaction derived from it—for example, the exterior dimensions of a table model radio.

Uniform national specifications will still be needed for occasional studies of geographical price differences. Such studies, however, do not contribute directly to the production of the CPI, and the quality of CPI should not be impaired to facilitate them.

3. Quality Changes

If a poll were taken of professional economists and statisticians, in all probability they would designate (and by a wide majority) the failure of the price indexes to take full account of quality changes as the most important defect in these indexes. And by almost as large a majority, they would believe that this failure introduces a systematic upward bias in the price indexes—that quality changes have on average been quality improvements.

We have very little evidence at our disposal with which to support—or deny—the belief in progressive quality improvement. Indeed we are impressed with how little empirical work has been done on so widely held a view and potentially so important a problem. Even the concept of quality change is not free of difficulty. Changes in buyers' tastes will lead to the appearance of new goods—an uncontroversial example would be fashionable apparel—which are not improvements judged by either previous or subsequent tastes, and the line separating taste changes from quality improvements will depend on the time span invoked.

Great as the difficulties are, however, we think it is possible to go beyond the recommendation that more research be done on the problem.

One form of the quality problem is the appearance of new goods: television, blankets made of synthetic fibers, new drugs. We believe that new products can and should be introduced into the indexes much more promptly than they are at present, and the discussions of specification pricing (III,2), new goods (III,4), and sampling (III,5) indicate methods which we believe are operational. Staff Paper No. 2 should also be consulted on this range of problems. The procedures we recommend will not take full account of new products, but will serve to reduce greatly a lag that is now too large.

But the main quality problem will remain: how should one deal with the steady advance of medical knowledge; the annual appearance of new models of consumer durable goods; the appearance of new kinds of retailers; etc.? In general there is no known method of coping with these problems on a current basis, and the current price indexes must ignore them.[4] We are not so pessimistic, however, about beginning to treat of quality changes in the annual price indexes which we shall recommend as supplements to the current program. We believe that the following lines of attack deserve intensive and persistent experimentation.

(1) Often there is an array of varieties of a commodity available at a given time, such as automobiles or refrigerators. It is then possible to study the effects of (e.g.) weight, horsepower, and other characteristics upon the price of the commodity and thus to deduce implicit prices of these characteristics. The succeeding year, when the entire spectrum of characteristics has changed (for example, all cars have more horsepower), the implicit price relative for increased horsepower can be deducted from whatever price change actually occurred.

This method has been employed by several students of the quality problem[5] and is potentially of wide applicability. As an instance of its nature, Griliches has calculated the relationship between the prices and characteristics of new automobiles; his regression equation for 1950 prices is—

$$\log P = .365H + .111W + .192\ L - .054V_1 - \text{constant}$$

where

P is list price
H is brake horsepower (in 100 h.p.)
W is shipping weight (in 1,000 lb.)
L is overall length (in 10 inches)
V is a dummy variable V–8 engine ($V=1$) or 6-cylinder engine ($V=0$).

If this system of implicit prices for 1950 is applied to an index of automobile prices of the "low-priced three" cars, one finds that the corrected average price of an automobile fell by 18 percent from 1950 to 1959. The CPI reports an increase of 31 percent, and would have reported an even larger increase if list prices (which ignore all changes in dealers' concessions) had been employed since the retail automobile market was weaker in 1959 than in 1950. This method of estimating quality change deserves extensive exploration and application.

(2) Technological characteristics of products offer a second avenue to the estimation of quality changes. The technical characteristics are usually diverse, and hence impossible to sum, but often a single characteristic may be of special importance to the buyer. Use of this dominant characteristic as the measure of quality will be imperfect, but less so than complete disregard of quality change. Some instances of this method may be found in the consumer goods area: For example, if the average duration of a hospital stay for an appendectomy has fallen by half over a period, then the effective cost of the hospital service should be halved relative to the cost of a hospital stay of fixed duration.

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[4] Richard Ruggles believes that the current practice of ignoring quality improvement and new products (see sec. IV) is arbitrarily assuming these elements to be zero in their effect and that there would be an increase in accuracy of the price index if some other more reasonable but equally arbitrary allowance were made for these elements. He believes further that an arbitrary allowance for quality change and new products would put the user of the price index on warning as to the existence of such an arbitrary element in price measurements.

[5] Among them Andrew T. Court, "Hedonic Price Indexes," in *The Dynamics of Automobile Demand*, New York, 1939; Richard Stone, *Quantity and Price Indexes in National Accounts*, OEEC, Paris, 1956; and Zvi Griliches (Staff Paper No. 3).

(3) The collection and analysis of consumer appraisals of comparative qualities by means of attitudinal surveys deserve exploration. The collaboration of psychologists, technologists, and survey specialists could be brought to bear upon the question whether such surveys yield stable and meaningful results.

The foregoing discussion refers to consumer price indexes, where the cost to consumers of maintaining equivalent satisfactions provides the criterion for quality adjustment. In the case of producers' goods two alternative criteria are possible. One would make the criterion for determining equal quality the equivalence of ability to contribute to production, as indicated, for example, by the same operating costs per unit of output for a machine, or the same quantity required per unit of final product in the case of a raw material. The other, with which present practice in the wholesale price index in general seeks to conform, finds equivalence of quality in equal production cost. Choice between the two standards depends on the purpose for which the indexes are to be used, and feasibility of application, and the Committee is not prepared to take a stand on this issue. We do believe that better implementation of the present standard requires additional work, especially in the area of machinery and equipment, and that this would permit more complete coverage of prices in this difficult area. We also urge studies of methods of adjustment that would conform to the alternative criterion of an equal ability to contribute to production.

4. The Treatment of New Products

New products and services are constantly being introduced into the marketplace, as a result of new technology, changes in consumer tastes, and the rise of incomes. For every successful innovation, there are many that fail. The successes, however, may quickly win a major share of the market or completely displace old products. Some new products—television sets, for example—are radically different from anything previously available. Most new products, on the other hand, are simply new varieties of older products—for example, nylon socks or filter cigarettes.

The treatment of new products presents a serious problem for any price index. An attempt to introduce all innovations into an index as soon as they appear would clutter the index with the failures that never attain appreciable importance. On the other hand, if new products are introduced only when the old items are completely displaced, the index will become seriously obsolete and will fail to reflect the price movements of the "volume sellers" much of the time.

Inadequate recognition of new products can create systematic bias in a price index because there is a typical price history of a product over its life in the market. New products are usually introduced at relatively high prices and their prices fall as they gain acceptance, owing to the economies of producing them on a larger scale and to improvements in the technique of production that come with time and experience. The price of a mature product or service is likely to be at the lowest level in its history relative to other prices. Finally, in the "old age" of a product, its relative price will often tend to rise as the scale of production contracts and economies of scale are reduced. The recent history of local transit fares illustrates this last phase. (For commodities, two additional phases sometimes occur after production has ceased—the falling price of remainders and the rising price of antiques.)

The possibility of bias can be discussed in terms of this typical life history if we take as a point of reference an index that includes new, mature, and disappearing products in proportion to their importance in the market or in the expenditures of the index population. Relative to this standard, an index that overrepresents new products will tend to be biased downward and an index that underrepresents them will tend to be biased upward. This upward bias is distinct from, and for some purposes additive to, the result of failure to reflect the fact that at its high initial price a new commodity may be considered a better value by some buyers than the item it replaces.

Although in principle the treatment of new products may err in either direction, we believe that in practice the problem is decisively that of introducing new products too late and retaining old products too long. In the CPI, for example, new automobiles were not introduced until 1940, used automobiles (which workers then usually bought!) until 1952; refrigerators were introduced only in 1934; etc. Another way of documenting the delay is to notice that no instance of the premature inclusion of an unsuccessful new product is known to us.

The tendency for indexes to lag behind changes in the market arises for two different reasons. The less important is the way in which the concept of the Laspeyres or fixed-basket index is sometimes interpreted—so that substitutions or additions of items between major revisions are considered inherently undesirable and to be avoided if at all possible. We do not interpret the concept of the fixed basket in this way. Although it seems desirable to keep the weights for classes of commodities or expenditures fixed between revisions of an index, within these reasonably broad classes the compilers of the index should be free to add or delete items or to reassign weights so as to take account of the appearance and disappearance of products. This is in fact done in practice, and the main problem is to make the necessity for it understood by users of the indexes.

The more serious source of lag lies in the slowness with which knowledge of changes in the nature of goods on the market reaches the people who specify the items to be included in the indexes. Our observations suggest that in many cases the need to introduce a new variety of a commodity is felt only when it becomes impossible to price the old variety because it has disappeared from many outlets. In this case the BLS agent or the respondent to a mail questionnaire will report that it is not possible to provide quotations for the item specified, and a mounting pressure of such reports will lead to the specification of a substitute item. So long as it is possible to provide quotations for the disappearing items they will tend to be provided, even though the item is no longer the volume seller, because it is much simpler for the agent or the respondent to give the information requested without comment than to explain the offering of alternative data. Where the disappearance of an item is slow, or where two varieties coexist for long periods, this can result in very substantial lags in the introduction of new items into the index.

The Committee feels that the agencies constructing price indexes should give high priority to the exploration of methods of introducing new items into the indexes at an earlier date. Our recommendations with respect to sampling procedures (III, 5) will make some contribution to this desired end. In the case of the CPI, the agents of the BLS undoubtedly can anticipate many changes in items and specifications well before they are actually made. Under present procedures, they seldom have an opportunity to act on this knowledge until they are unable to secure quotations on the old item. One aspect of the problem is to find a way of marshaling the information on new products that is constantly available in the field and bringing it to bear on the problem of specifications.

A part of the problem of new varieties will take care of itself if the BLS accepts the Committee's recommendations on the relaxation of specifications for the CPI (III, 2). In effect we recommend permitting the price of a considerably wider range of varieties of an item from outlet to outlet and from place to place so long as the identity of the item priced is held unchanged in the period-to-period comparison in a given outlet. This would permit an agent to introduce new varieties as soon as they become volume leaders in a given outlet. The question of whether a new variety of a commodity is purchased by families in the index population would be handled in the sampling of outlets. The introduction of completely new items would have to be based on decisions made centrally as at present.

5. Price Indexes and Sampling

The data used in computing the value of a price index are ordinarily derived almost entirely from a highly complex network of samples—samples of goods and services, samples of localities in which prices are collected, samples of actual price reporters, and samples of points in time. It is therefore apparent that a value of an index depends upon the particular samples from which the basic data are obtained, and that different samples will lead to possibly different values of the index. Under such circumstances it is natural to ask how far an observed value can be expected to deviate from a "complete populations" index. Assuming that sampling procedures are employed which provide an unbiased, or "nearly" unbiased, estimate of the "complete populations" index, the customary answer would be specified in numerical terms as the sampling precision of the index. Such measures of precision are not available, at least in published form, for any of the currently prepared price indexes.

All producers of index numbers continually reaffirm their belief in the need for "good" data and hence for the use of "decent" sampling procedures. Furthermore, they state categorically that probability model sampling procedures should be employed whenever possible. They also, however, set forth three related arguments for not attaching measures of sampling precision to the end product. These are:

1. The Laspeyres fixed-base index, upon which most price indexes are modeled, requires that the prices of a sample, or fixed market basket, of goods and services be followed through time. Since the universe of commodities available to the consumer is continually changing, it is necessary to make a variety of adjustments in the sample and in observed prices to account for the disappearance of

old items, for the changing quality of continuing items, and for the appearance of new items. There presently exists no well-defined, "best" set of adjustment procedures and so the index is subject to a *procedural error*, which exists even though all commodities, localities, and price reporters are used in preparing the index. It is then argued that the sampling error is probably small in relation to the procedural error and that it is therefore neither necessary nor desirable to attempt to obtain estimates of its magnitude.

2. Because a complex set of adjustment procedures is required in order to follow the prices of an original sample of goods and services through time, it is frequently stated that it is actually impossible to define or estimate that portion of the sampling variability of an index that arises from the sampling of commodities. Hence it is impossible to define or estimate the sampling precision of the index itself.

3. A third argument admits that it might be possible to employ probability sampling for all components of a price index, and by inference therefore admits the possibility of computing a measure of sampling precision. But the great complexity of the design and data gathering operations for an index are then stressed and the conclusion is reached that the attainment of this goal would require the use of more or less unlimited resources.

The Committee accepts no one of these arguments in its entirety, and feels that it is both possible and necessary to estimate and publish the sampling precision of a price index.

The argument that it is impossible to discuss sampling precision because of the changing nature of the universe of commodities is clearly basic to a consideration of the other two arguments. This can be refuted as follows. Assume a set of adjustment procedures, designated by P, which are used to follow a sample of goods and services through time, where sampling variability arises only from the fact that a sample of items is selected at time zero. (The determination of the details of such a set of procedures is the concern of much of this report. If individuals and organizations cannot agree on at least the major outlines of a reasonable set of procedures, index numbers should not be computed with the present Laspeyres-oriented approach.) Then some well-defined sampling procedure will be used to select a sample of items from the universe of such items as it exists at time zero. If one now thinks of drawing an indefinitely large number of independent samples in accordance with the defined sampling procedure, and of following each of these through to time t in accordance with P, the resulting values of the index will define the sampling distribution of the index with respect to the sampling of items. The variance of this distribution is a perfectly acceptable measure of sampling precision for the index, and it includes a component for any non-uniqueness which may exist in P. Furthermore, an estimate of this variance can easily be obtained by the simple expedient of actually drawing two or more independent samples of items—i.e., through the use of *replicated samples*. It should be observed that the use of two independent samples, for example, does not mean that each sample must be as large as the desired overall sample of commodities. Each sample may be only half as large as the overall sample, and the published index would be the average of the two resulting indexes. Of course, the reliability of the estimate of variance would improve as the number of independent samples increases.

Assuming that it is both conceptually and economically possible to estimate the precision of a price index due to the sampling of commodities, we next consider the argument that this precision is dominated by the procedural error and can therefore be ignored. Some investigations reported in Staff Paper No. 4 suggest that the procedural error of current consumer price indexes may indeed dominate the sampling error,[6] for a value of the index some three years after the base period, although empirical investigations of the overall effect of procedural error are almost as lacking as those of sampling error. In the opinion of the Committee, this does not mean that sampling error can be ignored. In particular:

1. If the goal is to estimate the *level* of the "true" index at various points in time and if resources are fixed, then the most efficient way of improving the accuracy of these estimates would be to divert resources from the maintenance of a relatively large sample of commodities and to use these resources in basic research aimed at reducing the magnitude of the procedural error. It is clear that good estimates of sampling precision and of bounds on the procedural error are required in order to make judgments of this kind.

2. If the goal is to estimate short-term *changes* in the level of the "true" index, then it appears likely that sampling error will be more important than procedural error and hence an estimate of sampling error becomes essential.

3. The construction of a price index involves not only a set of adjustment procedures and the sampling of commodities but also the sampling of localities and the sampling of price reporters within these localities. Just as there must be a balance between the procedural error of the index and the error due to the sampling of commodities, so also must there be a balance between these errors and the sampling errors arising from the other parts of the design. Again it is impossible to discuss such a balancing operation unless some attempt is made to measure these components of error.

Not only are estimates of error for the various components of a price index needed for internal design purposes, but they must also be available in published form to assist those who wish to use the indexes in a critical fashion. Such publications should give precise descriptions of the methods used in drawing samples and of the formulas employed in estimating the population index. The publications of the agencies currently producing index numbers are too much oriented toward the general reader, and additional details must be presented for the benefit of the scientific community.

Although the Committee recommends that every effort should be made to use some appropriate form of probability sampling in the selection of each sample that enters an index design, particularly to guard against nonmeasurable biases from sampling and estimation, it recognizes that the sampling of goods and services poses an especially difficult problem. There are, however, convincing reasons for at-

[6] This observation relates to an all-item consumer price index. If attention were focused on subgroup indexes, then there might well be instances in which the sampling error would dominate the procedural error. Improvements in the accuracy of such subgroup indexes could then be obtained only by increasing the number of commodities drawn from particular subgroups. Considerations of this kind would increase the number of item in the total index over what is implied in the following discussion of the all-item index.

tempting to use probability sampling methods, at least as a guide, in the original selection of items. Some of these reasons are: (a) The replicated sample approach can provide an estimate of sampling precision for almost any type of sampling procedure, provided only that the procedure is defined in such a manner that repeated and independent drawings can be made, but it cannot even indicate the existence of bias. The only way to ensure that biases due to sampling and estimation are small or nonexistent is to use appropriate probability sampling methods. (b) A probability model will make clear the manner in which one can obtain two or more independent samples of goods and services. (c) Even the mere attempt to make the sampling of goods and services conform to some appropriate probability model will force one to think explicitly and to make decisions about problems of definition and estimation which exist no matter how such a sample is chosen, but which can too easily be ignored with judgment procedures.

The exact details of a method for selecting a probability sample from the universe of goods and services as it exists in the base period can only be obtained through careful investigation. However, the general format that possible procedures would probably follow can be indicated, using the Consumer Price Index by way of illustration. Items of expenditure, as determined, say, from Consumer Expenditure Surveys, are divided into major groups (food, housing, apparel, and the like), then into subgroups, sub-subgroups, and so on. Ultimately, this subdivision process leads to what may be termed specific items—e.g., oranges, frozen peas, radios, men's sport shirts, women's nylon stockings, auto registration, and men's haircuts. Presumably one would be able to obtain an almost complete enumeration of the universe of specific items and their associated base year expenditure weights. These specific items can then be grouped into strata, using any available information about substitutability, similarity of price movements, and other related variables. The *first* sampling operation would then consist of selecting one or more specific items out of each stratum. If this selection were made with probabilities proportionate to base year expenditure weights, an unweighted average of the price relatives of the sample specific items would provide an estimate of the weighted average of specific item price relatives for the entire stratum. (Banerjee and Adelman have discussed the details of related procedures, and references to their papers are given in Staff Paper No. 4.)

When one draws a specific item into the cluster, he has in most cases actually drawn an entire *cluster* of *specified-in-detail* items into the sample. Thus there are different varieties of oranges, men's sport shirts made from different material and differing in quality, and so on. The current procedure used in the Consumer Price Index calls for the selection of one or more specified-in-detail items from the cluster defined by each of the selected specific items, and this is the *second* sampling operation to be considered. The chosen specified-in-detail items are the ones on which price quotations are to be obtained. (Occasionally a specified item will also be a specified-in-detail item, but this will be the exception rather than the rule.) At this second level of sampling, the problems become much more difficult than at the first level. Complete lists of specified-in-detail items will be difficult, if not impossible, to obtain; some specified-in-detail items may not be purchased by the consumer group to which the index is supposed to refer;

and expenditure weights may not be available for many of these items. Possibly anything that one can do at this level (e.g., using a restricted list of specified-in-detail items instead of a complete list, or assuming equal base year expenditure weights when the actual weights are unequal) is going to be only an approximation to what one would like to do, but at least this type of approach can be described accurately and it should be possible to investigate the effects of some of the approximations that are used.

Even though it were possible to use probability sampling for all components of a price index, the Committee recognizes that "simple" estimates of error are required for most purposes. The necessity for designing a complex sampling operation so that "simple" estimates of error can be obtained has long been recognized. This need becomes overwhelming in the case of the price index where the number of commodities entering the index is large and where the quality adjustment procedure makes it difficult or impossible to apply variance estimating techniques derived from sampling theory to all components of the design. Furthermore, these estimates of error for a price index have to be made more or less continuously since the sampling errors can be expected to increase with the length of time from the base period. Some suggestions concerning this type of design for the Consumer Price Index are given in section VII of Staff Paper No. 4. Basically, "simple" estimates of error can be obtained through some form of replication such as was mentioned under commodity sampling.

Sampling considerations also suggest two possibilities for major changes in price index construction which should be given serious attention in the future. They are:

1. Index numbers of the Laspeyres type are based upon market baskets of commodities which remain essentially unchanged between major weight revisions, except for adjustments which are made either to account for the changing quality of items or to recognize marketplace substitution of "new" items for "old" items. Some individuals have advocated drawing a completely new sample of items at fixed intervals from the universe as it exists at the time of drawing, together with a chain approach for obtaining comparisons over longer periods of time, but this suggestion is not likely to be adopted in its entirety. It should, however, be possible to effect a compromise between these two extremes and thereby gain some of the advantages of each. Thus one could set up a rotation schedule so that each item remains in the index for some fixed period of time, say 1 year, or 2 years, or 3 years, and so that a fixed fraction of the items are replaced each month, or quarter, or year, by newly selected items. This type of approach would obviously require some departures from the strict Laspeyres concept of an index number, but then these departures are also required by currently used quality and new item adjustment procedures.

2. The Consumer Price Index is basically city-oriented. That is, indexes are computed for each city in the city sample, and these indexes are weighted to obtain the U.S. index. This emphasis on city indexes does not appear to be the most efficient way of obtaining the U.S. index. If one views the index in terms of U.S. average weights and average prices, then it is clear that quite a different sample should be used, for example, to obtain a "good" estimate of the average price of a newspaper than would be used to obtain a "good" estimate of

the average price of a used car or of a woman's coat. In other words, the size of the "best" city sample for an item depends upon the cost of obtaining a price quotation and upon the variability of the item's price from city to city, and thus the size of the "best" city sample will differ considerably from item to item. (This fact is recognized in the present CPI design through the use of different monthly pricing cycles for different items.) It is of course true that aggregation according to a Laspeyres index calls for price quotations to be weighted in proportion to population and to value, and that a complete set of value weights could not possibly be obtained for all cities in which one would be able, for example, to collect newspaper prices. But this difficulty might be overcome, for example, by deriving the Consumer Expenditure weights for the population of cities in a region rather than for a number of individual cities in the region. An added benefit of such a change in emphasis might well be that it would become more feasible for BLS to employ selected data from other sources in the index computations, e.g., from the Monthly Retail Trade Report of the Bureau of the Census.

6. Seasonality and Seasonal Adjustment

Each of the price indexes under review covers many commodities that are subject to substantial seasonal fluctuations in both prices and quantities consumed or sold. Seasonal changes in quantities are often, but not always, associated with seasonal changes in prices.

Amplitudes and patterns of seasonal variation differ greatly among the individual components and groups of items within each of the indexes. The seasonal movements of quantities are similarly diversified. Intra-annual fluctuations in both quantities and prices are particularly strong among the commodities in the CPI food group and the WPI farm products and processed food groups. Fresh fruits and vegetables have much larger seasonal amplitudes than other items, but meats, poultry, eggs, and milk, to name only some of the more important commodities, all show marked seasonalities. Substantial seasonal influences are, of course, also at work in apparel with its new spring and fall lines and summer and post-Christmas sales. For the major consumer durables, especially automobiles, model changes are very important. The timing of the seasonal peaks and troughs, expansions and contractions, varies greatly among the component price series, however, so that these movements, as now measured, offset each other to a large extent, leaving only relatively small seasonal changes in the index as a whole. (This applies to each of the price indexes reviewed.) Nevertheless, seasonal influences may and at certain times do dominate the behavior in the very short run of a comprehensive measure of average price changes such as the Consumer Price Index. The overall sensitivity to seasonal factors of the Wholesale Price Index seems to exceed somewhat that of the CPI, while the Indexes of Prices Received and Paid by Farmers (especially the latter) appear to be less subject to such influences.

All the major price indexes now in use are, in fact, a cross between unadjusted and seasonally adjusted indexes, although they are published as unadjusted series. They employ annual rather than monthly weights, which is roughly equivalent (to the extent that interseasonal movements in the base year are only seasonal in character) to using seasonally adjusted monthly weights. Prices of commodities that are traded in significant quantities throughout the year represent unadjusted prices, as do the available market prices of commodities that disappear during part of the year.

Price quotations for these latter ("disappearing") commodities—those which are not sold in certain months of the year or for which prices are not available in certain months even though some trade in them does take place—are either held constant at the last quotation in the off-season months, or extrapolated from the date of the last quotation by the index of supposedly related items. By either method, when they return to the market the actual quotation is introduced, and an abrupt break may appear in the series. The former method is used generally in construction of Indexes of Prices Received and Paid by Farmers, and for disappearing apparel items in the WPI. Until April 1959 it was also used for farm products and foods in the WPI. Since that date, prices of these items in the off-season have been extrapolated by the movement of the product class in which they fall. In the CPI, prices of several fresh fruits have been extrapolated in the off-season by the group index for total fresh fruit prices, and those of seasonal items of apparel by prices of year-round apparel items.

The problem of seasonally disappearing commodities cannot be avoided by seasonal adjustments, but the difficulties are less than in an unadjusted series: Monthly price fluctuations are much smaller, and movements of related commodities on which imputation may be based from the date before disappearance to the date of reappearance presumably are less dissimilar when differences in their seasonal patterns are eliminated. With adoption of a policy of annual revision (see III, 8), final estimates for disappearing commodities should be based on interpolation between the dates of disappearance and reappearance rather than on extrapolation from the former date. This will avoid a "break" in the revised series at the time the commodity reappears.

The Committee finds that the major purposes for which the price indexes are used—examination of cyclical and longer term price movements, wage and price escalation, and deflation of the national product and other important value series—are best met by seasonally adjusted indexes. This finding is hardly surprising, since it has already proven to be the case with other key economic series. We recommend that the responsible agencies prepare and publish seasonally adjusted series. Both the aggregate indexes and major subgroups should be presented on this basis.[7] The publication of the "unadjusted" price series should be continued on the present basis. These "unadjusted" measures, despite their ambiguities, provide information of value to users interested in seasonal price fluctuations.

There is no ideal method of dealing with the problem of seasonality of quantities: in the limiting case in which the budget of each season

[7] For certain commodities price changes are customarily made annually at the date of model change. In addition there may be a seasonal pattern superimposed that reflects varying discounts from list prices. When price movements have been predominately in one direction (recently upward) over a period of years, care must be taken to isolate the two types of price changes to prevent the seasonally adjusted price series from smoothing the annual price change over the year rather than appearing in the month in which list prices are changed. This point becomes especially important if the direction of annual price change should be reversed. Similar situations are met in many other series; the public education payroll component of personal income, in which major changes in level occur at the start of each school year, is a typical example.

was unique no interseason comparison of prices would be meaningful. But the most attractive theoretical solution lies in the direction of seasonal weights (see Staff Paper No. 5). With (say) four sets of seasonal weights, the comparisons from year-to-year would be unambiguous. The comparison of prices among seasons would not be so simple, but it would probably be possible to devise, through the data on consumption of nonseasonal goods, budgets with approximately equal levels of utility for the various seasons. We do not recommend adoption of seasonal weights for the current indexes, in light of the complications and costs that would be entailed, but in areas where seasonal weights differ greatly, this type of solution deserves serious consideration.

7. Consumer Durable Goods

The commodities which yield services over a substantial period of time—houses, automobiles, television sets, furniture—offer special problems for consumer price indexes. In principle, they may be dealt with by either of two general approaches.

The first is to include in the weights the purchases of the durable goods during the weight base period, and to price the goods currently. In addition, there will be separate weights for current operating costs of the durable goods possessed by members of the group covered by the index. The second method is to ignore purchases of durable goods, and instead to measure the cost of the use of the goods. The use cost in the base year will be the weight. The price index may be either rents charged for the use of similar goods or the prices of the components of this use cost.

Both the BLS and the AMS use the former, or purchase, method of dealing with durable goods. The method, however, encounters a number of problems.

1. The rate of purchase of assets fluctuates greatly in response to cyclical fluctuations in income and other factors, so purchases in a given year may be very abnormal. To avoid distortion, weights should be based on an average of several years. In its last revision of the CPI, the BLS used the experience of the entire 1940–50 period for housing (see 3 below).

2. The rate of purchases depends not only on the consuming habits of the population but also (and this is not true of other categories) on the rate of growth of the number of families, migration, the rate of shift from tenancy to ownership, etc. Index weights for individual cities in which there is a high rate of net immigration are thus larger for housing than they would be in cities with a stable population. The weights do not represent the expenditure pattern of those continuously living in the city but instead are weighted averages of such families and those recently immigrating. This is a tenable concept of the "average" family but it implies a corresponding standardization of rates of change of the population characteristic.

3. The proper weight for each expenditure category is net expenditure, after deduction of sales or trade-in of used assets. This is most important for automobiles and houses. For automobiles, BLS obtains net expenditures directly from the consumer surveys. For houses, duplication was eliminated by the following technique when the present weights were established. Home owners were asked when

they bought their present house. From their answers, an average annual rate of purchase in the 1940–50 period was computed, in which owners who bought more than one house during the period were counted only once. The weight for home purchases in each city is the estimated 1951 market value of homes times the annual rate of acquisition among home owners applicable to the city times the proportion of owners in the city.

4. The proper division between new and used items of the total weight assigned to each commodity should reflect the net purchases of each by the index group from other groups in the society. In a price series covering the entire population there would be a seller for each buyer and none of the weight would attach to used items since the group as a whole would have no expenditure (aside from transfer costs which should be weighted and priced). Where the index covers only part of the population this equality need not exist, and used items may receive some weight. However, the BLS procedure, utilizing gross purchases less trade-ins, assigns too high a weight to used cars and houses. (Thus 2.0 of the 4.8 percent assigned to automobiles is assigned to used cars.)

5. Use of most durable goods requires expenditures for fuel or power, replacement parts, and repairs. Changes in such requirements accompanying technical changes in the durable goods themselves must, under the expenditure method, be regarded as representing a quality change in the durable goods. However, no technique has been developed to adjust for such quality change.

6. When consumers pay interest on loans a question arises both as to the weight to be attached to the interest payment and to the price series to be used to measure the cost of interest. Not all consumer interest payments are due to purchases of durables, but most are. In the case of mortgage interest, the largest component, the BLS has developed ingenious and acceptable techniques for deriving the weight to be attached to interest, and adjusts the price series for interest as the dollar amount of mortgages changes with changes in the price of houses.

For the interest series itself the BLS uses interest rates on new mortgages, rather than average interest rates on all outstanding mortgages. Evidently, the consumer is viewed as "buying" the service of not repaying the debt for the entire period of the mortgage contract, at the time the mortgage contract is made. This Committee considers this treatment as artificial and unacceptable. The costs of borrowing so measured do not reflect changes in the actual costs incurred by the average consumer from month to month or year to year. We recommend substitution of average interest rates on all outstanding mortgages for interest rates on new mortgages in the CPI, and parallel treatment for other types of interest paid by consumers whether or not associated with the purchase of a commodity.

An alternative to the expenditure approach, which eliminates the difficulties cited but introduces others, is to measure expenditures for houses and other durable goods on a use basis, in deriving weights, and to measure changes in actual or opportunity cost of using the goods for the necessary price series. Thus, the Office of Business Economics values the services of owner-occupied houses by estimating the rent that these units would bring if rented. In deflating consumption ex-

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penditures, it then utilizes indexes of rents charged on rented units. The main difficulty in the latter approach is that the composition of owner-occupied and rented units is markedly different.

This Committee recommends that BLS investigate the possiblity of developing a rent series for units that are actually rented but are as representative as possible of owner-occupied units in structure and location. In some neighborhoods very few units are in fact rented, and those that are frequently are rented furnished, so that development of a representative sample will undoubtedly prove difficult. If such a series can successfully be constructed, it would offer the basis for an improved CPI, and make possible a significant improvement in the national accounts.

We know of no other application of the imputed rental technique except to durable goods for houses. Relevant rental values are not generally available for other durable goods because they are rarely rented or rented under atypical circumstances.

An alternative to the rental-value approach is that described in Staff Paper 6, which proposes an estimation procedure for the components of use cost resting on the principle of maintaining the real value of the consumers' assets.

If a satisfactory rent index for units comparable to those that are owner-occupied can be developed, this Committee recommends its substitution in the CPI for the present series for the prices of new houses and related expenses. We recommend further exploration of the possibility of using the approach described in Staff Paper 6 for possible adoption for other durable goods, and for houses if the rent approach is not successful, but are not prepared at this time to recommend that it be ultimately adopted.

8. Revision and Correction Policies [8]

Because of the institutionalizing of the indexes, the Bureau of Labor Statistics has adopted peculiar policies in dealing with the inevitable problem of errors and incomplete information. The BLS does not issue preliminary Consumer Price Indexes: errors are corrected in the index for the month in which they are discovered, unless the error in a major component or in a city or U.S. index exceeds a certain magnitude. Nor does it conventionally revise earlier figures (the "new unit" correction of the housing component for 1942–50 was the major exception). The principle is followed in the WPI, but preliminary and final figures are issued in consecutive months for this index. The AMS has published preliminary and revised figures, and revises backward up to 3 years (aside from major revisions of the entire index) in the light of subsequent data.

It is easy to sympathize with the motives which led to the BLS policies, but not with the policies. The decisive objection to the policies is that they lead to the perpetuation of known errors, and this is simply incompatible with scientific standards. We believe that the agencies can serve the legitimate demands of wage, contract, and parity escalation without being in such a straitjacket.

[8] In view of the proximate nature of price indexes due to problems of product quality, choice of weights, sampling of prices, etc., and of the consequent absolute size of the probable error of the change in price indexes, Richard Ruggles recommends that the official published price indexes should be reported in terms of full percentage points rather than in tenths of percentage points as is now done.

The preferable procedure is to issue preliminary indexes, which would be the basis of contractual and legislative uses. The final indexes can then be issued with the lag dictated by the flow of information. The present practice of misdating the changes in prices should be abandoned.

Two important instances may be given where retroactive revision is essential in the BLS indexes, at least with present procedures. When seasonal commodities disappear for a time, they are sometimes estimated on the basis of similar commodities' prices until they reappear. Once their prices become available, their previous level should be revised to agree with the new price. A more important but parallel problem arises for prices in cities where collections are made quarterly. For the two months in which no price is available it is imputed on the basis of other cities. Any correction on the next reporting date is absorbed in that month rather than prorated over the nonreporting months.

These desirable retroactive revisions, and those based upon the delayed availability of superior information, can best be made by issuing each year a set of revised monthly indexes for the preceding year.

The price collecting agencies generally rely upon their own price reporting programs for their price data, as indeed they should and must. But occasionally important and reliable outside information (e.g., rents or medical data collected by another government agency) become available. We believe that such information should be fully utilized in the revision of previous indexes.

IV

THE CONSUMER PRICE INDEX

1. The Concept and Purpose of the Index

It is often stated that the Consumer Price Index measures the price changes of a fixed standard of living based on a fixed market basket of goods and services. In a society where there are no new products, no changes in the quality of existing products, no changes in consumer tastes, and no changes in relative prices of goods and services, it is indeed true that the price of a fixed market basket of goods and services will reflect the cost of maintaining (for an individual household or an average family) a constant level of utility. But in the presence of the introduction of new products, and changes in product quality, consumer tastes, and relative prices, it is no longer true that the rigidly fixed market basket approach yields a realistic measure of how consumers are affected by prices. If consumers rearrange their budgets to avoid the purchase of those products whose prices have risen and simultaneously obtain access to equally desirable new, low-priced products, it is quite possible that the cost of maintaining a fixed standard of living has fallen despite the fact that the price of a fixed market basket has risen.

In periods of wartime, when specific goods in the fixed market basket are no longer freely available to the consumer, the divergence of such an index from practical reality becomes obvious. In this situation price quotations on the virtually unobtainable commodities may not show much increase, or even be rigidly fixed by price controls. Consumers are driven to available substitutes, which are more expensive relative to desired performance (forced uptrading) or rise rapidly in response to expanding demands. Few economists or consumers come to the defense of the rigidly fixed market basket approach under these circumstances. This suggests strongly that what is in fact being measured is not the cost of a fixed set of consumer goods and services, but rather the cost of maintaining a constant level of utility.

The present logic of revision of weights and the methods of introduction of new products into the index and adjustments for quality change are de facto recognition that at a practical level the index must reflect the impact which prices are having on the consumer's standard of living. At the same time many individuals involved in producing and using the index shy away from recognizing the underlying principles which guide the construction of the index and its application in the major analytic uses. There is often a tendency to try to adhere to the more comforting position of having an index of a fixed market basket of goods since acceptance of such a position avoids the difficult decisions required to approximate a utility-based price index.

A constant-utility index is the appropriate index for the main purposes for which the Consumer Price Index is used. The purpose of wage escalation, for example, is to adjust wage rates in periods of general price change so the wage earner (working a constant number of hours) will be able to maintain his "standard of living." The goal of price stability for monetary and fiscal policy can similarly be viewed as the goal of preventing adventitious transfers of real income between borrowers and lenders, landlords and tenants, etc. The growth of real income of consumers is to be measured by "deflating" an appropriate consumers' income series by the corresponding consumer price index.

The current CPI is avowedly not a constant-utility index in this sense. The BLS refers to it as a price index which measures only changes in average prices of goods and services consumed by the specified population of wage and salary earners' families, but the very fact that the weights by which the prices of these 300-odd goods and services are combined are drawn from family expenditure patterns is enough to indicate that the CPI is designed to approximate a constant-utility index, as it should.

The difference between the present CPI and a true constant-utility index may be illuminated by a brief discussion of some of the major respects in which the former differs from the latter.

Changes in Relative Prices.—Since consumers will substitute those goods whose prices rise less or fall more for those whose prices rise more or fall less—and within limits they can do this without reducing their levels of real consumption—the fixed-weight base CPI overestimates rises in the cost of equivalent market baskets.

The converse bias is displayed by fixed quantity weight indexes which are applied backward in time, and a roughly "correct" index can be constructed by averaging the two indexes. For current purposes this is of course impracticable, but we recommend that when the BLS next revises its index (in 1963), it calculate this latter index for the 1952–1963 period to provide an estimate of the maximum upward bias due to the use of a fixed-weight base. Our recommendation of more frequent weight revisions (III, 1) will, if adopted, reduce this bias considerably.

New Commodities.—In addition to those changes in consumer buying habits induced by relative price changes, a new set of changes arises because of the introduction of new commodities. If these new commodities are additional options open to the consumer, he will adopt them only if he prefers them (at their current prices) to goods previously available. But it requires no formal demonstration that the consumer benefits by the availability of electric light even if kerosene is unchanged in price, or by the availability of penicillin even if potato soup is unchanged in price. Conversely, the forced adoption of new products (which occurred during World War II) when customary products have disappeared can impose a welfare loss on the consumer even in the absence of price changes.

Our recommendations (III, 4) are designed to introduce new products into the consumer indexes at an earlier time, and hence to reduce this source of difference between the indexes and the ideal welfare index. A close approximation to a welfare index can sometimes be obtained if new commodities are introduced into a price index when they first appear in any of the markets patronized by the index population. At such times their prices are likely to be high because of the limited extent of their production and the novelty of the techniques of making them. The fall in the prices of these commodities weighted by their current importance at each date is a minimum estimate of the welfare gain. It fails to include the welfare gain of the portion of the index population that bought the commodity at its high initial price, or would have done so were it not for the limited extent of the initial distribution. It also understates the gain to the extent that the spread of the new commodity is the result of people learning more about it rather than a result of a fall in its relative price.

Quality Changes.—The appearance of truly new products is only an extreme form of the pervasive phenomenon of quality change. More commonly the product undergoes continual (although not continuous) modification: the chicken has more breast; the refrigerator has a freezer unit; the horsepower of the automobile engine rises.

At present the CPI in principle introduces these changes by "linking," that is, by introducing the changed quality in such a way as not to affect the index at the time of introduction. (We say, "in principle" because often the exigencies of price collection demand comparisons of old qualities with what are judged to be equivalent new qualities.) A hypothetical example will pose the problem that is involved here. Suppose that a certain community has been using liquified petroleum gas supplied in tanks, and that piped natural gas is made available, with the expense of installing the pipes to the premises paid by the distributor. Suppose further that the cost of he natural gas per therm is below that of the liquefied petroleum gas. The CPI, because it regards the two commodities as different, would not show any change. A welfare index would note that the two provide the same kind of satisfactions to the user. The drop in a welfare index would, at a minimum, equal the drop in the cost of heat per therm. If the piped natural gas is more convenient to use because one does not have to worry about the tanks getting empty, then the welfare index should fall somewhat more than this. Unfortunately, there are few cases where so easy an approximation of the welfare index is available. Suppose we observe a transition from coal heating to gas heating in which the gas is more expensive per therm, but is cleaner and more convenient. The shift of consumers to gas will show that the cleanliness is worth more than the additional cost, but not how much more.

Although we have suggested lines of research on the measurement of quality change (III, 3), we are cognizant that our present knowledge does not allow the routine, let alone current, treatment of this problem in the price indexes.

Durable Goods.—The welfare of consumers depends upon the flow of services from durable goods, not upon the stocks acquired in a given period. The consumer is better off if he has $1,000 worth of shelter services a year than he is if he buys and lives in a $5,000 house. He may have attractive furniture although he has purchased no furniture for many years.

The CPI presently uses purchases of durable goods in the consumer expenditure survey period in place of the flow of services from such goods enjoyed by the index population. It also prices one component of housing costs, interest on mortgages, on a current basis, although the average interest rate paid is actually the average of rates on all outstanding mortgages.

Our recommendations (III, 7) will diminish the major disparities on this score between the CPI and a welfare index, but a full treatment of the problems posed by durable goods calls for much additional research.

Insurance.—The purpose of the Consumer Price Index is to measure the changing cost of a given level of utility (or, as a substitute, a fixed market basket) for the *average* family in the population covered by the index. This purpose implies that only *net* expenditures of the population should be covered: a transfer of funds from family A to family B is an expenditure for one and a receipt for the other, and hence cancels out of the calculation. This has been recognized in the CPI: used cars were dropped from the index during World War II; trade-in values of used cars are deducted from the purchase of new cars at present (see III, 7).

This principle is recognized in the insurance field by the omission of life insurance from the index, since most of premium income is used to pay benefits to policyholders or their survivors or to accumulate assets. A better solution would be to include life insurance with a weight representing only the expenses and profits of life insurance companies, and we so recommend. For non-life insurance, we have not had time to determine whether there is double counting, though we suspect that there may be. For hospitalization insurance, the gross weight is used, and expenditures covered by insurance are omitted from the direct weight for hospital care. This is a satisfactory procedure, if the benefits of the insurance do not increase over time. Automobile insurance is treated in the same way, except that compensation for injury or loss of life (aside from medical bills) is ignored. We recommend a change to net weights for automobile insurance and a general review of practices in the weighting of other expenditures typically covered by insurance. If possible such a review should be prompt enough to permit the collection of additional data on receipts from insurance claims in the forthcoming survey of consumer expenditures if this is indicated. The pricing problem for insurance is very troublesome because the premiums measure the costs of supplying insurance only if the ratio of benefit to gross income is constant. Nevertheless, if the weights are appropriately reduced to a net basis, the use of premium rates instead of cost of insurance rates should not be a source of large distortion in the indexes.

Government Services and Taxes.—The consumer receives a variety of services from governmental units at all levels. Some are easily identified and can even be measured with perhaps tolerable accuracy—education and hospitals, for example. Others are more difficult to estimate, primarily because they are services to the business sector as well as to consumers.

To the extent that public services are paid for by indirect taxes (sales taxes, excises, etc.) they are already in (or are formally added to) the prices used to construct the CPI. Indeed minor paradoxes are easily created by using the CPI to deflate an inappropriate consumer income concept. Suppose a state reduces its sales tax, and raises the same amount by an income tax, without changing its services to consumers. If consumer incomes are deflated by the CPI, they will show a rise in real income which is spurious, but the error would be avoided if the CPI were used to deflate "disposable income" (income minus direct taxes on the consumer).[1]

Much research will be necessary before a more comprehensive welfare index which includes governmental services can be constructed, and we are not prepared to recommend any changes in the present practices at this time.

Recommendations.—Our recommendation to modify the CPI in the direction of a welfare index is explicit and implicit in the foregoing discussion. In some respects, such as the treatment of durables and mortgage interest, the more frequent revision of weights, and the earlier introduction of new commodities, the modifications can easily be introduced when the revised index is launched in 1963.

But many of the problems in approaching a welfare index are much less easily solved. The Committee recommends that a program of research in prices, price indexes, and the measurement of welfare changes be established. The Committee is impressed with the extent to which the methods and concepts used in the construction of the Consumer Price Index are similar to those that were employed 30 or more years ago. The rapid intellectual and technological changes of the past three decades or more appear to have bypassed the field of price research. The Committee believes that the problems in this area are of sufficient national importance to warrant financial support for research both within the Government and in private research agencies and universities. The funds would undoubtedly be modest compared to those being spent in other areas in which support is being given to the search for new knowledge.

The major objective of the research program would be to establish the knowledge and to develop the techniques necessary to calculate an index that approximates a true cost of living index (i.e., a welfare index) as closely as possible. The final resolution between the need to have an unambiguous index produced on a monthly basis and the need for a conceptually sound index may turn out to involve the production of two indexes, a monthly "Consumer Price Index" and an annual "cost of constant living" index.[2] As knowledge and techniques in the field of welfare measurement develop and win acceptance, the "Consumer Price Index" may be modified continuously in the direction of becoming a welfare index to the extent that it is possible to produce one on a monthly basis.

Among the contributions which the BLS could make to this large project should be the following:

(a) An experimental attempt should be made to compute for publication in a scientific journal or for distribution to a professional audience a set of retroactive consumer price indexes using an end-of-period quantity weighting system. In the absence of experiments of this type, which this Committee is not able to undertake, discussion of weighting "biases" in the CPI must be largely speculative. The experimental indexes need not be continuous; they can be confined to widely separated starting and terminal dates. They should, for some components at least, involve reweighting at the item level.

[1] See Staff Paper No. 12.

[2] The annual revision of the monthly series proposed in III, 8, does not, of course, involve the large expansion of concept envisaged in the "cost of living" index.

(b) Along with the work with various weighting systems, experiments with the early introduction of new commodities, initially with low weights and subsequently with increasing weights, should be carried out.

(c) Experiments should be made with various methods of handling quality changes, including those mentioned in III, 3.

It is not necessary, of course, and perhaps not feasible, that work along all of these lines be carried out by the BLS itself or only within the Government. It might well prove advantageous to contract out some or even much of the developmental work to private research agencies or universities.

2. The Scope of the Index

The coverage of a Consumer Price Index can be broad or narrow in terms of the population group for which it is constructed. The number of indexes for which there is some demand is very large; income, geographical area, occupation, and family composition are examples of the bases that have been used to define the index population. Our discussion will be restricted to the indexes which we believe the Federal Government should produce regularly in the next decade.

i. POPULATION AND INCOME COVERAGES

The Consumer Price Index compiled by the BLS covers families (of two or more persons) of wage earners and lower salaried workers living in cities. The maximum income per *family* was $10,000 in 1950. The consumer price component of the Index of Prices Paid by Farmers covers the entire population of farmers. No portion of the rural nonfarm population is covered by existing indexes.

The wage escalation and farm price uses of these indexes make it inevitable that they be collected at least for a considerable period in the future. Even within this limitation, however, we believe that a movement can and should be made toward a more unified and comprehensive consumer price index program.

The residential scope of the present CPI seems too narrow: the wage and salary earners in rural nonfarm areas should be included. The exclusion of the single-person families who otherwise meet the definition of the index population should be removed, even though their inclusion will widen somewhat the range of prices to be collected. An income limitation on salaried persons must be retained if the group is to have any separate identity, although of course the $10,000 maximum of 1950 is obsolete. The appropriate population for the farm indexes is discussed in section VI.

But these are essentially minor revisions designed to make the Consumer Price Index more comprehensive in coverage of the designated occupational group. From the viewpoint of general public policy and scientific study, our basic need is for a comprehensive Consumer Price Index covering the entire population. This is the index that is appropriate to the measurement of the changes in welfare of the Nation and to the measurement of inflation (and hence the guidance of monetary and fiscal policy). The index for the wage earner and lower salaried workers' families can be continued, although we conjecture that it will parallel that of the comprehensive index sufficiently close so it will eventually be deemed more useful to provide other special group indexes (e.g., by income level), on which Staff Paper No. 7 should be consulted.

The comprehensive United States Consumer Price Index is not only the most important index but also its construction will lay the groundwork for all the other special purpose indexes which will be required from time to time, as well as for the accurate deflation of the national income accounts.

On the one hand, the comprehensive survey of budgets of families and single individuals will provide the weights necessary to construct indexes for special subclasses of the population, whether classified by income, occupation, special welfare status, or some other characteristic. The 1950 and the prospective family expenditure surveys (in 1961 and 1962) are already designed to be comprehensive (except for possible limitations with respect to rural nonfarm and farm areas, which should be included). The main additional information which would be essential is detail on the types and qualities of goods consumed by classes not intended for inclusion in the present CPI.

On the other hand, the price-collecting system would have to be broadened, and this is indeed the main implication of our recommendation.

Only a comprehensive collection of data on prices and price changes can provide the empirical base for studying general price movements and for analyzing the differences in price movements associated with the type of commodity or service, with the geographic location, and with economic subgroups of the population. Only price statistics that represent the entire country can provide the details on price changes suited to the estimation of the aggregate volume of consumer expenditures in constant dollars.

Price indexes designed to represent the purchases of particular population groups reflect the price movements of selected types and qualities of goods and services. Our present knowledge of the behavior of consumer prices is confined to only a portion of the total market because of limitations on types of stores and commodities priced. Not only would a comprehensive program of consumer price statistics allow the calculation of a large variety of special group indexes, but also this program would permit a variety of analytical studies of the structure and behavior of markets.

The survey design for the collection of completely representative price statistics will require a thorough examination of the available information on developments in the retail markets. Classifications will be needed of marketing areas and of types of outlets within marketing areas, and both the significance for price behavior and the stability of the classifications must be explored. Just as the assumption of variation in price behavior between new and old products is warranted by common observation and fragmentary statistical evidence, so the assumption of fundamental differences in the trends of prices charged by new and old types of outlets is founded on ordinary experience and fairly evident economic reasons. The importance of the new outlet may considerably outweigh the importance of new products because the marketing changes have affected virtually all commodities and a considerable number of services.

We therefore recommend the preparation of a sampling frame, showing the distribution of consumer expenditures for particular goods and services by market area and type of retail establishment, as the means for determining the location of the current data within the universe and for determining the feasibility and cost of the collection of price statistics representative of the entire Nation.

We also recommend a study of the practical means for determining the changes in the relative importance of the various types of outlets in various marketing areas at frequent intervals. The chain store and the supermarket were introduced into CPI outlet samples only after they had become overwhelmingly important. Some types of retail establishments and some outlets of growing importance for particular commodities are not adequately represented in any present price collection program—the variety store, the hardware store, the departments in drug stores that stock commodities other than drugs, cosmetics and tobacco products, the mail order outlet, and various kinds of discount houses.

A representative system of price indexes for specific commodities and services classified by market area and type of establishment would provide the basic data not only for a general Consumer Price Index and for the deflators of aggregate consumer expenditures but also for various kinds of special indexes. To the extent that particular population groups are concentrated geographically where certain types of establishments predominate, the price changes affecting such groups may be more accurately estimated through the general indexes than by attempts to make direct observations. Differences in price changes among various localities may be explained partly by lags and leads in the introduction of new types of retail establishments.

We hope that the interest in price behavior awakened in recent years will call forth some analytic studies focused on underlying economic trends. The geographic differences in absolute prices and in price changes over time studied simply in terms of changes in the market structure could contribute substantially to our knowledge of sectors of stability and change. The interaction of changes in production and in marketing on the relative price movements of particular commodities could be made the subject of a number of valuable studies.

ii. CITY INDEXES

The Committee recognizes that there is a continuing demand for published city indexes from labor unions and employers and from economists interested in regional studies, among others. While this demand continues, the Committee recommends the continued publication of separate indexes for large cities. However, we do not believe that the publication of accurate city indexes requires that every item in the CPI be priced in every city, nor that city indexes necessarily be used as the basic building blocks of almost all of the components of the national CPI. On the contrary, we believe that on items for which the dispersion of price changes from city to city is small, fewer cities need be priced than at present. This might be true, for example, for some nationally advertised branded manufactured goods, such as men's dress shirts. On the other hand, on items for which the dispersion of price changes among cities is very large and the costs of data collection are low, the optimum use of resources for the national index suggests that the number of cities priced be substantially increased. This would be true, for example, of transit fares and utility rates.

Under the scheme contemplated here, when an item is not priced in a city for which a separate city index is published, its price movement would be imputed to that city from the national index or from some combination of priced cities. Given the thinness of city outlet samples and the further attrition that occurs in them when some of the outlets priced do not have any varieties of an item that meet specifications, this procedure does not imply any lowering of quality of the published city indexes. In fact, these considerations suggest that for some items the quality of the city indexes could be improved by imputing price movements from the national index or from a group of cities to a particular city even where the prices for the particular city are collected. This might be the case where there was no long-run divergence between the item indexes among cities, but the thinness of the outlet sample produced random or erratic movement in the item indexes for particular cities. In imputing price changes to a city from the national index or from other cities, care would have to be taken to adjust for any relevant changes in taxes that had a differential effect.

The Committee recommends that in order to test the feasibility of these suggestions BLS undertake experiments in the retroactive recomputation of city indexes, using imputed prices for certain items where data collection costs are high and the dispersion of price changes among cities is low.

V

THE WHOLESALE PRICE INDEX

1. Concept and Structure

The Original Concept.—The Wholesale Price Index has been published as a continuous series since 1890. It was originally intended as a measure of price movements taking place in primary markets (i.e., other than at the retail level). At the time it was first constructed economics was very much concerned with the concept of the price level, and it was believed that the Wholesale Price Index more correctly reflected the behavior of the price level—the purchasing power of the dollar—than did the traditionally more sticky retail prices. It was recognized, of course, that the index was only an approximation to price behavior at the wholesale or primary market level, since it was based on a relatively small sample of the many commodities which flow through these markets. Not only were many commodities excluded because price quotations were difficult to obtain, but it was recognized that there were some real price changes which could not be measured—for example, some improvements in quality, hidden discounts, differences in delivery schedules, etc. In spite of these difficulties, it was felt that the Wholesale Price Index did adequately represent the prices of all transactions in commodities taking place at other than the retail level.

Although the major emphasis of the wholesale price work in the early period was on the behavior of the aggregate price index, price series for specific commodity groups were also given, and considerable use was made from the start of the prices of these so-called leading commodities. The leading commodities were grouped into nine categories of a somewhat mixed nature, partly reflecting an industrial classification, partly classes of commodities bought by consumers, and partly goods at various stages of fabrication. These early categories were farm products, foods, cloth and clothing, fuel and lighting, metals and metal products, building materials, chemicals and drugs, house furnishings, and miscellaneous. This classification suggests that the Wholesale Price Index was intended to be a comprehensive, general purpose index reporting the general price behavior of the economy.

The Development of the Index.—Since the initiation of the Wholesale Price Index, many changes have been made both in the content and in the methods of calculating the index. Originally prices of some 250 commodities were collected, but this number has gradually increased until at the present time prices of some 1,900 commodities are included. As new commodities were added, they tended to be commodities with a higher degree of fabrication and generally more stable prices. The increased coverage of the Wholesale Price Index therefore had the effect of making the index, and hence the economy, appear to be more stable than it would have under the previous coverage. Increasing the size of the sample and increasing the proportion of more stable items both contributed to minimizing the fluctuation of the index (see Staff Paper No. 8).

With the development of other kinds of price indexes, e.g., the cost of living indexes, Consumer Price Indexes, and most recently the gross national product deflator, the Wholesale Price Index has ceased to be a general purpose measure used to indicate the basic price behavior of the economy. More effort has been directed toward presenting price indexes by specific sectors of the economy and by stage of processing. For example, indexes of prices of crude materials for further processing are given for the food industry, for manufacturing, and for construction. Prices of intermediate materials, supplies, and components are reported for the same groups. As less emphasis has been placed upon the overall price index, more attention has been directed toward the calculation of subindexes which are useful to those concerned with specific sectors of the economy.

The Present Wholesale Price Index.—The present Wholesale Price Index complex consists of (1) a comprehensive monthly index, (2) a weekly index intended to represent what the monthly index would be if all the prices in the monthly index were collected and tabulated each week, and (3) a daily index based on prices of 22 commodities traded on organized markets or exchanges.

The monthly index, as already indicated, covers some 1,900 items from 2,000 companies who supply about 4,500 individual reports. Additional data are secured from trade sources and other governmental agencies. Mail questionnaires are generally used, and specification pricing is used insofar as possible. In those instances where specifications change or new commodities are introduced, elaborate effort is made to see that only price changes affect the index.

The monthly index still contains the type of subgrouping which was used in the 1890 index, but the number of categories has been increased to 16. There has been some redefinition of categories, e.g., foods have been changed to processed foods, and cloth and clothing to textile products and apparel; and new categories reflecting specific industries have been added, e.g., tobacco and bottled beverages, rubber and rubber products, lumber and wood products, pulp, paper and allied products, machinery and motive products, and nonmetallic minerals (structural). These changes reflect a movement toward a more purely industrial classification system. Behind these subgroup indexes, there are indexes for product classes and individual commodities, with a total of 1,340 item series. As already indicated, the indexes have also been classified by stage of processing. The indexes are further amplified by classifications showing the durability of goods and the economic sector for which the goods are destined, e.g., consumers, producers, etc. Finally, there are a series of special wholesale price indexes which are of special interest: thus fish, soaps, detergents, steel mill products, industrial valves, abrasive grinding wheels, and construction materials are all represented by special indexes.

Weights for the monthly index are based upon value of shipments data from the Industrial Censuses for 1954, but interplant transfers are excluded from these weights where possible. Each commodity price series is considered to be representative of a class of prices, and is assigned the weight proper to the whole class. The class of commodities in turn is usually defined in terms of similarity of manufacturing processes, thus embodying the assumption that prices of commodities produced under similar conditions behave in the same way. The assumption that prices reflect conditions of cost more closely than they do conditions of demand is presumably more accurate over long periods than in the short run.

The Uses of the Wholesale Price Index.—The utilization of the Wholesale Price Index as a general price index has changed with the passage of time, as we have noted. The preference that has developed for the use of the Consumer Price Index and the deflators of the national income accounts to measure changes in the value of the dollar had several causes. One major cause of the shift was the realization that the Wholesale Price Index was not a true sample of prices in the system, and that it was not particularly pertinent to any particular group of consumers or businesses in the economy. In contrast, the Cost of Living Index and later the Consumer Price Index had a more exact frame of reference in terms of the market basket of goods purchased by a given class of consumers.

Just as the development of the Cost of Living and Consumer Price indexes replaced the Wholesale Price Index as a general measure of the value of the dollar from the viewpoint of consumers, so also did the development of the implicit price deflators in the national income accounts replace the wholesale price index as an overall measure of price behavior. The implicit deflator of gross national product has the advantage that it is considerably more comprehensive than the Wholesale Price Index, and the weighting system refers to a definable universe of final goods and services.

The factor of timing has prevented the abandonment of the aggregate Wholesale Price Index, however. The implicit price deflators of the gross national product are available only on a yearly and quarterly basis. The monthly Wholesale Price Index together with the Consumer Price Index is therefore still used as an indicator of how prices in the economy are moving on a current month-to-month basis. The weekly and daily Wholesale Price Indexes are still widely used as economic indicators which may help to show how the economy is moving over shorter periods of time. In this context, however, they are used in the same manner as freight car loadings, stock prices, and other short-term indicators.

Manufacturers and trade associations are interested mainly in the group indexes, product class indexes, and individual commodity indexes. A survey made by the Department of Labor indicated that 75 percent of the users wanted the price indexes by commodity groups, and that half of all users considered the prices for individual commodities essential. One-third of the manufacturers questioned used the index to adjust materials contract prices, and one major industry adjusts all its materials contracts on the basis of changes in the index. There can be little doubt but what the considerable amount of detail provided within the Wholesale Price Index is found to be very valuable by businesses which are concerned with the price behavior that is taking place in those markets in which they are producing goods or buying materials. For these users, the general Wholesale Price Index aggregate is not useful, but the highly detailed and specific information on individual industries, product classes, and commodities is very valuable.

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One of the major uses of wholesale price data is in the production of other basic economic data by government agencies. Thus, the implicit price deflators of the gross national product lean heavily upon the product and commodity price data contained in the Wholesale Price Index. Any improvement in the Wholesale Price Index aimed at more comprehensive coverage and better price reporting would substantially aid the deflation of gross national product by final product. Two examples may be cited. At the present time it is not possible to provide deflations of gross national product by industry of origin; improvement in the Wholesale Price Index coverage would make this extension possible. The price data necessary to value changes in inventories are notably deficient.

The Census Bureau, the Bureau of Labor Statistics, and the Federal Reserve Board use the wholesale price data to estimate output by industry and to analyze productivity on an industry basis. These are, of course, different aspects of the same problem, and are directly related to the implicit price deflators by industry. Adequate wholesale price data are therefore the basic information on industrial activity and commodity output required for a large number of different uses.

Thus the use of the general price index as an aggregate has declined except in those instances where it is used as a short term economic indicator (see below). At the same time, however, there has been a demand by industry, by other parts of the statistical system, and by the academic world for more detailed and comprehensive wholesale price data on industries and commodities.

The Structure of a Wholesale Price Index.—The behavior of the Wholesale Price Index is highly dependent on the universe of transactions it covers. It is somewhat paradoxical, then, that the universe of the WPI has never been clearly defined, and that ease of collection has been a major determinant of which prices to include. In reviewing the requirements for a Wholesale Price Index, therefore, it will be useful to examine (1) what the Wholesale Price Index as an aggregate should measure; (2) what universe of prices should be covered; (3) what the substructure of the index should be; and (4) what kind of weighting system should be employed.

From the viewpoint of economic analysis, the Wholesale Price Index does not appear to be a meaningful economic construct. The transaction coverage is not descriptive of any definable set of producers or purchasers in the economy. Nor does the present WPI universe have a logical structure of subclasses which are appropriate to the analysis of economic developments: for example, indexes of buying and selling prices of industries, which would allow analysis of changes in "value-added." There is no principle to determine how many steps in the fabrication of a raw material should be included.

The Committee believes that the structure of the wholesale price area should be revised to meet several objectives. The basic objective is comprehensiveness: there is need for price information on every important sector of the economy dealing in commodities, and a good structure will reveal gaps in our price information. A second objective is maximum detail in price reporting: the individual prices are the basic need for most business and scientific uses. And a third objective is the development of price indexes for the subgroups of commodity transactions which are most useful in economic analyses.

The framework for the universe should consist of the total sales and purchase of commodities other than at the retail level. Care should be taken to see that no important commodity class is omitted from the coverage. This suggests that commodities should be priced at a number of different points in the distribution system, and to the extent feasible separate indexes constructed for the pricing at these different points. Thus, coal of a type sold to power companies may be different in its price behavior from coal of a type sold to dealers for retail distribution. An attempt should be made to cover pricing of every major body of commodity sales in the economy. It is recognized of course that in some areas price information may be very difficult to obtain, and substitute kinds of pricing may have to be developed in order to represent such areas fully. Other areas may be very much better covered because it is relatively easy and inexpensive to obtain price quotations on even quite minor categories.

From the point of view of completeness of price data, it is important that the Wholesale Price Index coverage be integrated with other price measurements. At the present time, the Wholesale Price Index covers agriculture and mining as well as manufacturing. Although construction materials are covered as a part of manufacturing, construction itself is not included, nor is transportation. As further noted in Appendix A, exports and imports are partly covered by the Wholesale Price Index, but they are not systematically segregated. It should be recognized, of course, that on our comprehensive view of the Wholesale Price Index universe, portions of the universe will lie in areas in which data are now collected by other agencies. This is also true at present; however, the agricultural and mineral prices now in the WPI are collected in part by other agencies. We do not attempt to decide whether all of the price data falling in our proposed universe for the Wholesale Price Index should be compiled or analyzed by the BLS or whether the integrated system of price indexes is achieved through interagency collaboration. Analytically and conceptually the same problems will have to be faced and the same price information will have to be collected.

The purpose of giving the Wholesale Price Index extremely broad coverage is to obtain price data which will be useful for the many purposes for which industry and other government agencies use such price data. To achieve maximum usefulness the system of subclassification should be such that it meshes with other kinds of information available about the economy. Thus it should be possible to integrate information available from the Census of Manufactures, from the OASI, and from the Internal Revenue Service, as well as from other parts of the Bureau of Labor Statistics. For this reason, it seems desirable that the subclassification should aim at fitting into the Standard Industrial Classification. At the present time BLS has joined with the Census Bureau to produce price indexes classified by 5-digit commodity groups and by broader SIC industry categories. This represents a very considerable step forward, and if it can be carried out to its logical conclusion would achieve the general structure of wholesale prices we recommend.

If adequate coverage of the economy at the Census 5-digit commodity level can be obtained, these commodity indexes could be combined in a large number of different ways to produce other meaningful price measurements. Commodities could be grouped according to the industry which produces them, thus forming a price index covering the sales of that industry. Similarly the commodity price indexes could be combined so as to yield price indexes of inputs purchased by industries for use in production. Such input and output price indexes would be highly useful in studying productivity changes and in measuring product (value-added) originating by industry. Combination of commodity groups into economic classes would also be possible. Thus price indexes of goods purchased by the government or of goods purchased by producers as capital goods could be calculated. Price indexes could further be calculated according to the durability of commodities, or according to other characteristics which are desired for economic analysis. In other words, price indexes for a basic commodity classification at the Census 5-digit level could be used as building blocks to create a large number of useful and meaningful price indexes.

The ability to combine the basic commodity indexes into meaningful groups depends upon the availability of adequate weighting schemes. In order to build a price index for the output of a given industry from commodity price indexes, it is necesary to know precisely what commodities an industry produces and how much of each commodity is produced. This information is given in the industrial censuses and presents no very great problem. For the input price indexes, however, it is necessary to know what commodities are used by each industry, and the amount of each commodity used. This information is not readily available at the present time, and would require an additional collection program. What is required is a knowledge of the commodity input and the commodity output of each industry, preferably at the Census 4-digit level. This would involve the creation of a large input-output table to provide the basis for weighting. The input-output table would have to be revised periodically (say, at 5-year intervals) to keep the weighting system up to date. If an input-output table were available, the commodity price indexes could be used for deflating the input-output relations to yield the volumes of inputs and outputs of each industry.

The underlying schemata can be illustrated with the following simple input-output table:

	Sectors Purchasing Commodities				
Sectors Producing Commodities	Agriculture	Mining	Manufacturing	Other, e.g., Retailers Government Export	Total
Agriculture	A → A	A → E	A → M	A → O	A → T
Mining	E → A	E → E	E → M	E → O	E → T
Manufacturing	M → A	M → E	M → M	M → O	M → T
Total	I → A	I → E	I → M	I → O	I → T (WPI)

In this table the sectors producing commodities are shown as rows. Sectors purchasing commodities are shown as columns. The commodities produced by agriculture may be sold either to agriculture itself, to mining, manufacturing, or others such as retailers, government, or exports. The price index of total agricultural goods sold would be an average of these price indexes weighted by the relative amount of goods sold to each purchaser, i.e., A→T. Similarly, the goods which agriculture buys from agriculture, from mining, and from manufacturing constitute the commodity inputs to agriculture, and a price index of these purchases (i.e., I→A) yields the input price index of agriculture. Both the output and the input price indexes referred to above are gross, in that they cover transactions between firms in the same industry. It would be quite possible to compute a net output price index and net input price index by omitting the intraindustry transactions (those enclosed in the boxes in the table). In effect, the present BLS weighting procedure for the 4-digit manufacturing industries yields a net output price index since it excludes the interplant transfers within the industry. Probably both gross output and net output price indexes are needed. For the process of deflation, a gross output price index is often more pertinent, since in collecting data on manufacturers' sales it is often not feasible to collect the additional information required to obtain net sales to purchasers outside the industry.

The general Wholesale Price Index in such a scheme would be constructed with the weights resulting from combining the columns or rows, i.e., the corner of the table, I→T. A Wholesale Price Index so defined would meet the definition of an index of prices of commodities bought and sold other than at the retail level, and the prices of these commodities would be weighted by their relative importance in total sales. Such a definition would give the Wholesale Price Index a definite universe and a specific form of weighting, so that changes in scope and weighting would not be so important in the future in affecting the behavior of the index as they have been in the past. It should be recognized of course that the industrial organization of the economy itself will affect the number of transactions taking place in the various industrial sectors, and this in turn will bring into the index either more or fewer price observations, with proportionally more or less weight being given to each area of the economy. Vertical integration, for example, would transform what previously were purchases and sales of commodities between previously separate companies into transfers between departments within the same company with no price indicator attached. Conversely, increased vertical specialization might result in the sale of intermediate goods which before had entered no distinguishable market. There is no way of insulating the Wholesale Price Index from such changes in industrial organization, as long as it is supposed to be a fairly complete representation of the universe of commodity transactions. Changes in growth and in the industrial structure of the economy will therefore be important determinants which alter the behavior of the Wholesale Price Index.

Implementation of the Proposed Revision of the WPI.—The present BLS program for the expansion of the WPI and its reclassification on a 5-digit commodity basis seems definitely in the correct direction. Priorities for adding new items should probably be determined largely by the needs of other statistical agencies in the government that require wholesale price data to compute deflators and to aid in the measurement of output. This strongly suggests that BLS should continue to work closely with the National Income Division of the Department of Commerce, the Bureau of the Census, and the Federal Reserve Board in making the Wholesale Price Index a better tool for their specific needs.

To implement the proposed weighting system, it will be necessary to utilize the 1958 industrial censuses to construct an input-output table. Experience gained in this effort should be directed toward obtaining better basic information at the time of the next industrial censuses. It may be necessary to approach a detailed input-output table through steps of progressively finer industrial classification.

Since the present Wholesale Price Index can be continued during the transition and in any event is not an important index, considerable flexibility is possible in the timing and sequence of the improvements. As soon as improvements are made they should be included in the index. In terms of analytic importance, it would probably be most useful if a first approximation could be made to the 5-digit commodity classification and the other consequent SIC industrial categories at an early date.

Not all parts of the full system of prices we propose will be available currently for the monthly index of wholesale prices. An abbreviated input-output system, with full industrial detail where the data permit, will suffice for the monthly reports, and a comprehensive report covering the entire system can then be published annually.

i. SENSITIVE PRICE INDEXES

The literature abounds with statements of the need for a sensitive price index which measures the immediately current or prospective movements of wholesale prices, as a guide in policy formation and in predicting business movements. This literature, however, is much less emphatic on the nature of "sensitivity." Often what seems to be implied is that the index number should be based upon prices which change often or by relatively large amounts, but these mechanical criteria have no direct relevance to the measurement of short-run business conditions. Even more often what seems to be sought is an index which will predict the future course of prices or of business.

The ambiguity of the discussions of sensitive price indexes, and the ambiguity of such indexes, is due to the failure to specify exactly what the index is to measure. If the index is to measure the current price situation, then presumably the full, regular Wholesale Price Index is what should be used. It is true that this index contains prices which do not change often (although in good part this is a defect in the price data; see Section V, 2), but to the extent that such prices are valid they are part of the current price situation which is to be measured. (The problem raised by mere delay in reporting prices is discussed below.) Sensitivity in this context means only exaggeration, and it is difficult to see any purpose in exaggerating current price movements.

If the index in question is to measure the impending movements of prices—and no one denies that such a measure would be useful—

mere volatility of prices is of course irrelevant. For this purpose those prices should be included in the index which reflect estimates of the state of the commodity markets (say) three or six months in the future. There are two important sets of prices which do attempt to estimate market conditions in the near future. The first set consists of futures prices on organized exchanges; they are at present excluded from the WPI. The second set consists of prices on goods to be produced and delivered a considerable time after the contract is made. The WPI index now contains a substantial number of such prices: many "built to order" items have fairly distant delivery dates; and a considerable number of prices cover contracts which run for specified periods.

We believe an index of this latter type has enough interest and potential usefulness to justify at least a serious experimental program. The basic data, namely, futures prices and identification of prices covering deliveries well in the future, are not now collected, but certainly could be. The experimental work, and given its success the continuing program, might well be undertaken by the Federal Reserve System in cooperation with the BLS.

So far as the currency of price information is concerned, the present delay is not great: prices as of the middle of one month are published by the second week of the following month. The weekly index of the WPI provides a more current estimate of the entire index. The present weekly index does not perform especially well as a predictor of the monthly index, but this deficiency can probably be remedied by drawing a more appropriate sample.[1]

2. The Quality of the Price Data

Some of the wholesale price quotations are collected from governmental bodies and exchanges, but in much the largest part from individual manufacturers or their trade associations, primarily by mail. The question that must be posed is: How good are these price quotations—how accurately do they measure the terms on which transactions actually take place? The answer is not readily given, for obviously if a comprehensive body of transaction prices were at hand, the BLS would use it. But several types of evidence suggest very strongly that the price quotations obtained from manufacturers do not faithfully measure the movements of prices, quite aside from the usual problems of quality change.

[1] The data for the following comparison of the monthly WPI with the closest corresponding weekly index cover the years 1954 and 1955:

Category	Monthly index		Errors in weekly index			
	January 1954	December 1955	Positive	Less than ±0.1	Negative	Median absolute
All commodities	110.8	111.3	3	7	14	0.1
All except farm and food	114.5	119.7	4	4	16	.1
Farm products	97.9	83.4	13	1	10	.2
Processed foods	106.2	98.2	7	5	12	.2

The median errors are considerably larger than the average monthly change in the monthly index, and in the *three* year period, 1953–55 inclusive, the weekly index reported no change for three declines and three rises in the monthly index, and reported one rise as a fall. Large movements of the monthly index are consistently predicted correctly.

(1) Weighty evidence of a spurious short-run rigidity in the behavior of BLS prices is afforded by Staff Paper No. 9. When frequency of price change is tabulated against number of reporters from whom the prices are collected, it is found that the frequency of price change for intermediate and finished manufactures is twice as great if there are three or more price reporters than if only one price report is collected. Yet more than 400 price indexes in the WPI are based upon single reports.

It is impossible to believe, therefore, that the extreme short-run rigidity of many WPI prices represents the true behavior of even the quoted prices in the market. This rigidity introduces a systematic lag in the index relative to changes in average price quotations.

(2) When average receipts of producers are compared with price quotations, there are important and unexpected differences in trend. Thus the WPI index of steel prices rose 101.5 percent from 1947 to 1957, whereas the index of receipts per ton (calculated from numerous subclasses of steel products, with constant weights), rose only 89.3 percent.[2] One must make allowance for minor differences in coverage but the main source of difference (changes of the product mix within the subclasses of steel) should probably have led to a greater rise of unit values because better qualities of steel were being used. A variety of such examples are reported in Staff Paper No. 8; no one is very convincing but the ensemble sheds doubt on the validity of the price quotations, particularly with respect to their lack of responsiveness to cyclical fluctuations.

(3) There exists one large body of publicly available price data which has not been used on any scale to test the BLS quotations: the bids on government purchase orders. A sample of such prices during the past decade has been compared with BLS quotations, and the comparisons are fairly consistent in showing that the BLS prices are both higher and more rigid than the average of bid prices (Staff Paper No. 9). The following example will illustrate this evidence (dollars per gallon).[3]

Date of bid opening	Bid prices on gasoline			WPI price
	Low	Mean	High	
Nov. 6, 1954	$0.0933	$0.0996	$0.1033	$0.105
May 4, 1955	.0948	.0991	.1075	.105
Aug. 3, 1955	.0992	.1038	.11	.105
Oct. 25, 1955	.0844	.0855	.0875	.105
Apr. 25, 1956	.099	.105	.11	.105
Oct. 9, 1956	.09585	.0997	.10495	.105

(86+ octane gasoline, gulf coast, f.o.b. refinery, for bids; WPI, 87 gulf coast, f.o.b. refinery, minimum of 20,000 barrels.)

In summary, the evidence that the BLS company price quotations are not valid transaction prices is highly persuasive. The quotations now collected are at best the initial base for negotiation in many cases, and often represent only the hopes of sellers or the snares of inexperienced buyers.

[2] Unpublished study by Martin Bailey.

[3] A substantial body of similar material, comparing WPI prices and prices paid by large buyers, is presented in Staff Paper No. 8.

We recommend that a major shift be made to the collection of buyers' prices. Large and continuous buyers of manufactures should be able to supply prices which truly represent the effective terms on which transactions are made. We do not believe that this shift to buyers' prices will be simple or free of new difficulties, but it is the most promising source of comprehensive, continuous, and reliable price quotations.

Where buyers' prices are not available, we recommend extensive use of unit values, at least as benchmarks to which the monthly prices are adjusted. Unit values are inferior to specification *transaction* prices, but when unit values are calculated for fairly homogeneous commodities, they are more realistic than quoted prices in a large number of industrial markets.

VI

THE INDEXES OF PRICES PAID AND RECEIVED BY FARMERS

1. The Indexes and Their Setting

By virtue of their scope and status, the farm series raise an exceedingly wide range of index-number problems. The Index of Prices Received by Farmers reflects changes in the unit value of the output of a defined economic sector, consistent with the sector classification recommended above for the WPI; but the component prices are to be distinguished from the farm-product group in the present WPI, which relates to central market prices for standard grades of individual commodities. The Index of Prices Paid by Farmers for Production is a unique instance in which there already exists the corresponding index on the input side. Its computation involves problems of pricing the changing variety of production goods emerging from the technological transformation of present-day agriculture. The Index of Prices Paid by Farmers for Family Living, on the other hand, is a particular occupational application of a consumer price index and subject to the various difficulties associated therewith. These two separate indexes of prices paid for goods and services, together with measures of changes in mortgage interest, taxes, and farm wage rates, are combined into one overall index, also known as the Parity Index, which is officially employed for purposes of escalation.

Institutional Background and Constraints.—The Indexes of Prices Paid and Received by Farmers accordingly become an integral part of the agricultural stabilization program of the Federal Government. They provide the basis for computing the price parities for the various agricultural products, to which various measures for price support (and some price ceilings) are related. The Congress has passed legislation which fixes the price base period and specifies the addition of three items (farm wage rates, farm taxes, and mortgage interest per acre) to the combined Index of Prices Paid. This represents a degree of statutory specificity without parallel in any other area of American index number construction. Since various price-support policies operate on a close time schedule, there is a premium on speed of computation, the indexes being generally published about two weeks following the 15th of the month to which they apply.

The statutory constraints go still further. Although the parity formula has been "modernized" to reflect the changing relationship among agricultural product prices over a preceding decade, the purchasing power of a unit of farm commodity produced, rather than of net money income, is the official focus of attention. This concentration on agriculture's terms of trade has serious shortcomings as a reflection of farmers' well-being (see Staff Paper No. 10). Be that as it may, prevailing practices tend to become frozen into legislative history, and revisions desirable from the standpoint of technical improvement in the indexes open the conscientious public statistician to sharp Congressional rebuke.

A second set of constraints arises out of the peculiarities of the data-collection system. Much of the basic price information is generated by an Agricultural Estimates Division traditionally organized for the purpose of reporting physical crop data, involving statistical officials of the individual States and a delicate pattern of State-Federal working relations. There is a corresponding interest in price data (particularly average prices received) on an individual-state basis, and often pressure for data also for smaller territorial units. At the same time, the availability of state funds means that agricultural statistics are especially well financed as compared with other price data.

The concurrent availability of corresponding data on physical crop production is useful in various ways. Less attention need be paid to obtaining measures of physical volume by the indirect route of deflating a value series by an appropriate price index. Even if the compilation of state average prices were not employed in the computation of national price indexes, and of course the calculation of reliable state prices compels the collection of many times as many price reports as a national price requires, they would continue to make a useful contribution to the preparation of the state personal income estimates by the Office of Business Economics.

Relevant Peculiarities of the Farm Enterprise.—Just as certain institutional peculiarities of the agricultural price indexes condition their interpretation and restrain their modification, certain economic characteristics of the farm unit complicate the construction of appropriate indexes and the interpretation of index behavior.

(a) The farm household as a consuming unit and the farm enterprise as an agricultural production unit are intermingled in particularly intimate fashion, and allocation of individual expenditure items to the two purposes must be to a degree arbitrary. The distinction between indicators of the well-being of a farm family and the input-output relations of a farm firm cannot be sharply drawn. Production of items for consumption on the farm are of declining significance but remain substantial. The cost of housing, an important item in the urban consumer's budget, cannot be readily distinguished from other elements of farm real estate.

(b) Even if expenditures associated with farm production could be accurately identified, there is the further difficulty of distinguishing current operating expenses and expenditures of the farm firm for capital investment. The purchase of tractors, trucks, and farm machinery follows a less stable time pattern than recurrent outlays. One-time surveys of expenditures, to be adapted for computing weights, may give misleading results in this respect. Similarly, individual proprietorship implies that changes in the asset position of the enterprise (particularly as indicated by land values) are important relative to current prices, income, and expenditures.

(c) Even viewed only as a consuming unit, the farm households vary much more widely in income and type of living than the urban worker families, at least as the latter is now defined by the BLS. The movements of the national parity index can therefore depart rather widely from the corresponding experience of different classes of farmers.

(d) Diversity of enterprise is reflected in matters of income distribution as well as expenditure pattern, as may be illustrated from the results of the AMS-Census Bureau Survey of Farmers' Expenditures in 1955. While the smaller units contributed only moderately less than their proportional share of living expenditures by all farms, the lowest two-fifths (ranked by value of sales) were responsible for only about a tenth of all expenditures attributable to farm production and a still smaller fraction of total sales. If social interest is in the condition of the lower income group, then aggregate expenditures averaged out for all farms can seriously mislead.

(e) Off-farm earnings of the farm population amount to a substantial total, around half as large as operators' net farm income. The expenditure associated with that income cannot be isolated, and yet clearly it ought not to be deflated by measures heavily influenced by farm production expenditures.

The Scope of the Committee's Review.—The Committee does not have a mandate to review the agricultural programs of the Federal Government, nor does it have the expertise or the desire to enter into this difficult area. We therefore accept for the purpose of our review what may be termed the philosophy of the farm price indexes—the measurement of the price component of farmers' welfare by a comparison of indexes of prices paid and received.

We interpret this acceptance of the philosophy of the indexes broadly. We do not enter into such questions as whether separate parity indexes should be calculated for major classes of farmers, even though a single index does not describe realistically the movement of the price component of farmers' welfare for the various farm products and areas (see Staff Paper No. 10). On the other hand, we do not refrain from appraisal of elements of the indexes prescribed by statute, where matters of technical index number practice are involved.

2. The Structure of the Indexes

Three price indexes are involved in the present system: an index of prices received for farm products; an index of prices paid by farmers for production items; and an index of prices paid by farmers as consumers. The present practice is to combine the indexes of production and living costs, and compare them with the index of prices received.

This mixing of production and living costs does not seem desirable. We believe it would be much more logical to separate the activities of the farm as a production unit from its activities as a consumption unit, even though the distinction between the two is not always clear either analytically or statistically. If a comparison were made between the prices received—the receipts component—and the prices paid for production purposes—the production expenditure component—one would obtain a figure for the price component of farmers' net income from farming. This in turn could be compared directly with the index of prices paid for living purposes, to obtain the price component of changes in farmers' welfare. Such a revision of structure need have no implications for the level of the parity index.

The merit of separating the farm as a production enterprise from the farm as a consumption unit is that a clearer measure of the production activities would be obtained, and this sector of the economy is still so important that this measure is desirable. The revision would also pose clearly the problem of whether farmers' expenditures as consumers should be compared directly with their net income as farmers, or whether the price component of large amounts of off-farm earnings should be added to the farmers' net income price index. At present perhaps one-third of farmers' living expenditures are financed by off-farm earnings. One can eliminate the anomaly of comparing an income index with a much more comprehensive living cost index either by basing the living cost index upon expenditures of farmers who receive the majority of their income from farming, or by adding an appropriate index of off-farm earnings to the income index. The choice between these alternatives turns upon whether the price component of welfare changes is to be measured for families obtaining their income chiefly by farming or for families living on farms. Either decision could be implemented in such a way as to leave the current parity index unaffected.

3. Pricing Problems

The analyses of index number problems in Section III of our report are applicable to the indexes of farm prices, whether they are continued on present lines or recast as we propose in the previous section. Our proposals in Section IV to bring consumer price indexes closer to welfare indexes are also applicable to the living cost component of the farm indexes.

We would emphasize in particular our recommendation (III, 2) that the Agricultural Marketing Service move toward specification pricing of the commodities bought and sold by farmers. We believe that such a move will improve the price indexes for the measurement of the price component of changes in farmers' welfare, and also make the price indexes much more useful for all other purposes—the extension of an urban Consumer Price Index to the entire nation, the improvement of the deflation of national income accounts, the measurement of changes in productivity, etc.

Base Period.—While we take as given the philosophy of the farm price indexes, we do not feel compelled to accept the propriety of the specific legislative limitations placed upon their calculation. The prescription of the 1910–14 price base, which is entering its second half-century of life, is so bold a contradiction of good index number practice as to defy rational defense. The objection to this obsolete base, we emphasize, is not that it is unduly favorable to agriculture: that would be a policy judgment, which can be avoided by choosing a recent period such as 1947–56 for the base period, which would yield parity prices only 2 percent less than at present, or by multiplying a modern base parity ratio by an appropriate constant. The reason for choosing a modern comparison base is that the present course of the indexes has essentially no relationship to the commodities bought and sold by farmers in the 1910–14 period.

Taxes and Interest.—The present treatment of taxes and interest does not yield price indexes. The amounts paid by farmers in real estate taxes and interest on farm mortgages, *per acre*, are bizarre indexes of *expenditures*. They are prescribed by statute, but no statute can make an index of expenditures into an index of prices. We recommend that the treatment of taxes and interest be altered, by statute if necessary, to conform to the practice recommended in our discussion of durable goods (Section III, 7). There is an element of expenditures also in the Indexes of Prices Received and Paid by Farmers, by the use of current period weights to combine qualities of a commodity, and by the use of current district weights to calculate the state average of certain commodities (turkey feed, tractors, etc.). The current period weights are unavoidable with unit value pricing; the district averaging by current weights should be replaced by base period weights.

Increased Price Coverage.—The scope of prices received by farmers raises few analytical issues. The inclusion of sales of farmers to farmers, as with hay and feed grains, raises the question whether the index seeks to describe farmers as a group: only transaction costs of inter-farm transactions should be included (in production costs) if the index is to represent farmers as a whole. The present procedure does not eliminate the effects of intra-farming transactions because such sales do not have the same relative weights in the prices paid index as in the prices received index.

The production component of the index of prices paid is based upon a seriously incomplete concept of production costs. Certain components of production costs, notably inventory holding costs, cash balances costs, and return on net investment, are omitted, apparently because they are not explicit cash transactions, although expenditures for farm buildings are based upon indirect valuations rather than cash transactions.

There is inadequate coverage of certain production items, particularly custom and veterinary services, repair and maintenance of automobiles and tractors, and farm construction.

Inadequate coverage, notably of medical services, is also a problem for the index of prices paid for farm family living items. We are not persuaded, however, that independent collection of medical service prices is necessary. Just as the BLS is able to employ for the WPI certain price series collected by AMS, we are of the opinion that AMS can properly explore adaptation, for its own use, of prices compiled for computing the CPI. As consumption patterns and distribution outlets become increasingly similar for the farm and the nonfarm population, this procedure becomes all the more desirable, and prices prevailing in the smaller cities become increasingly indicative of those actually paid by farmers. Imputing a missing item in this manner would certainly seem to involve less serious error in the index than the omission of the item altogether. Substantial economies may be possible also in the food and clothing field. Resources would then be spared for improving collection processes for items whose farm behavior has decided peculiarities.

Price Collection by Field Enumeration.—The Indexes of Prices Paid by Farmers now rely predominantly on the collection of prices by mail; this method yields a large number of price quotations at relatively low cost, but the quotations are for commodities that are specified only very loosely. If the recommendations of the preceding section are carried out, so that AMS no longer needs to collect the basic data for every component of the index of prices paid, we believe that a move should be made toward the collection of prices by field enumeration for the remaining components. AMS has already made very useful experiments in this direction. We believe that the superiority of enumeration lies in the closer control made possible over the nature and comparability through time of the commodities priced. Unless there is a shift to specification pricing, field enumeration is not worth its greater cost. And even if the scope of the AMS price collection program is reduced by partial reliance on BLS data, enumeration cannot be used to collect every price in every state except at prohibitive cost. We recommend, therefore, that collection by enumeration be introduced only for commodities where specification is important and in connection with a shift to specification pricing. Where the dispersion of price changes among states is moderate we recommend the collection of prices in a sample of states, with price changes imputed to the remaining states from this sample (a proposal analagous to our recommendation on city indexes, IV, 2, ii). Or, as a much less attractive possibility, the national prices could be divorced from the state prices and a complete enumeration would then be feasible.

APPENDIX A

EXPORT AND IMPORT PRICE INDEXES

INDEXES CURRENTLY PUBLISHED

Price indexes as such are not currently being prepared either for exports or imports.[1] The closest current approximations to export and import price indexes are the unit value indexes produced by the Bureau of Foreign Commerce. A unit value index differs from a price index in that it measures changes in the average value of imports or exports per physical unit regardless of whether the change in value is due to a change in price per se or to some other circumstance such as a change in the size or quality of the item being exported or imported. Our reasons for insisting on the necessity of prices rather than unit values in price indexes are given in Section III, 2. The Bureau of Foreign Commerce is, of course, aware of the distinction between prices and unit values and, within the limits of the resources that have been made available for work on the indexes, it has endeavored to minimize some of the larger distortions arising from the use of unit values and to limit the deviation of the indexes from the measurement of price changes.

Unit value indexes are calculated for each of five broad commodity categories of U.S. exports and imports—crude materials, crude foodstuffs, manufactured foodstuffs and beverages, semimanufactures, and finished manufactures—and for total exports and imports. The indexes are available annually from 1913, quarterly beginning with 1929, and monthly since July 1933. Special indexes are prepared for trade with the American Republics.

In recent years, items included in the indexes have accounted for 60 to 70 percent of the total value of imports for consumption and 40 to 45 percent of total domestic exports. Since the unit values are computed from the value and quantity figures compiled by the Bureau of the Census from data on export declarations and import entries filed at United States ports, it is not possible to include items for which the Census data contain only value figures rather than both values and quantities. With the expansion in the relative importance of finished manufactures in international trade, the proportions of exports and imports directly represented in the indexes have diminished This has been particularly true in the finished manufactures category, which has been of increasing importance in American trade. In 1957, for example, less than a fourth of finished manufactured imports (which accounted for one-third of total imports for con-

[1] A National Bureau study by Robert E. Lipsey currently in preparation will present indexes employing both prices and unit values for the period 1879 to 1923; it has been of great assistance in preparing this section.

sumption) and less than a fifth of finished manufactured exports (which accounted for 60 percent of the total) were covered in the unit value index calculations. These proportions in themselves would not necessarily represent a serious deficiency if the included items constituted an adequate sample for the category. However there is little ground for believing that the sample is representative of price movements for finished manufactured exports and imports; its deficiencies are especially marked in the machinery category. Weights for commodities whose unit values are unknown are generally assigned to other items selected in the same economic class.

The unit value indexes are constructed by Fisher's ideal formula; that is, each index figure represents the square root of the product of base-year weighted and given-year weighted indexes. The base period weights are taken from the preceding calendar year. The advantage of the use of the Fisher formula lies in the fact that the unit value, quantity, and aggregate value indexes are consistent; that is, the aggregate value index will equal the product of the unit value and quantity index. Because of the rapid change in the composition of exports and of imports, the weights are changed for each year's computation. The indexes for successive years are chained in order to derive a continuous series.

The indexes are produced in the International Economic Analysis Division of the Bureau of Foreign Commerce, using the equivalent of one professional and two clerical man-years. The staff is conscious of the desirability of making the unit value index approximate a price index as closely as possible, but it does not have sufficient resources to subject the data to the degree of professional scrutiny that is necessary to maintain high quality index numbers. Little attention can be given to continuous comparisons with external data such as the movements of domestic prices of commodities similar or identical to those included in the indexes.

Although there is a considerable diversity in the practice of other countries, most of them use a current-weighted unit value index, and in many cases this is derived by dividing a base-weighted quantity index into an aggregate value index. A number of countries employ fixed base weights, and a few follow the U.S. in using the Fisher index.

An abortive attempt to develop price indexes for exports and imports was made in the Bureau of Labor Statistics in 1946 and 1947. The project reached the point where exporters and importers were furnishing prices to the Bureau and some index numbers had been computed, when it was abandoned because of budgetary restrictions. The proposed BLS indexes were to be constructed with fixed weights, some of the early calculations for 1945 having been based on prewar trade patterns. Prices were to be collected for around 340 export commodities and 200 import commodities, either by personal visit or by mail collection. As with other BLS indexes, the prices were collected by specification, and an effort was made to take account of such variables affecting price as the size of the transaction, the port at which delivery was taken, the channel of trade discounts, and the like.

The Technical Problems

The fundamental problem of price index number construction—that of coping with a changing basket of goods—seldom appears in so exacerbated a form as in the case of price indexes for exports and imports. The patterns of consumption and production change but slowly compared to the rapid shifts that may occur in the commodity composition of imports and exports. These changes are sometimes so great that substantial differences in the measurement of price change are obtained according to whether the change is calculated with the weights of one year or another. For example, in an NBER study [2] currently under way, indexes of price change between 1879 and 1923 for 22 major classes of exports and imports yielded changes from 20 to 40 percent higher on one set of weights than on another, with the distribution of the percentage excesses as follows:

Percent excess	Number of indexes	
	Export	Import
0 to 4.9	2	1
5 to 9.9	6	1
10 to 14.9	6	1
15 to 19.9	0	7
20 to 24.9	0	8
25 to 34.9	5	3
35 to 44.9	3	1
Total	22	22

The illustration is extreme in that it involves two points in time nearly a half century apart. For shorter periods the differences produced by alternative weighting systems are likely to be much smaller though not always negligible. In the three years 1956–58, for example, there were three instances in which the ratio of the Paasche to the Laspeyres monthly index of imports for the five economic classes exceeded approximately 102.5 percent. These were all in the crude foods category. In the export indexes, there were 24 such cases (out of a total of 180), the maximum divergence among these being about 9 percent. All of these cases occurred in the economic classes of crude and manufactured foods and crude materials. These classes include the commodities most obviously subject to sharp seasonal changes in volume of trade. Most of the export cases (16) occurred in one year—1956. The crude-foods class seems to be especially subject to recurring divergences in the monthly index. Of the two indexes for total trade, that for exports showed one instance of a divergence of over 2.5 percent in the three-year period—a difference of about 4 percent—in December 1956. The index for total imports showed no such divergence.

Nevertheless, the extent of the changes in the commodity composition in trade and the consequent dependence of the measures of price change upon the method employed have led some to question whether meaningful export-import price indexes can be prepared. The Committee recognizes the difficulties involved, but feels that the demand for such indexes is so great that in the absence of officially prepared

[2] Robert E. Lipsey, "United States Foreign Trade Indexes, 1879–1923", in manuscript.

indexes even less satisfactory ad hoc indexes would be concocted both in government offices and in business firms. In these circumstances it is best to have official indexes that are as good as they can be, taking into account the resources that can reasonably be expected to be made available for their construction.

It is clear, however, that the degree of variation in trade patterns makes frequent weight revision necessary. The system presently employed by the Department of Commerce of computing indexes between pairs of years and linking the results in a chain index thus has much to recommend it.

Another aspect of the export-import price program that distinguishes it from others is that these prices are commonly published side by side with quantum and value indexes of exports and imports. For this reason, there is a somewhat stronger case than usual for the use of an index formula that meets the factor reversal test (i.e., that satisfies the condition that the price index times the quantity index should equal the value index). A number of countries meet this need by using current weights for the unit value series and base weights for the quantum series; a few countries carry out the same idea but reverse the weighting systems for the unit value and quantum indexes. Sweden, New Zealand, Ireland, and a few others, like the United States, satisfy the factor reversal test by using the "ideal" index (i.e., the geometric mean of base-weighted and current-weighted index numbers) for both the unit value and the quantum series. This is not an unreasonable compromise, particularly if both the base and the current-weighted index numbers (which must in any case be produced as intermediate products) are made available to interested persons.

Although the technical methods employed by the Bureau of Foreign Commerce to convert the quantities and average values derived from foreign trade data into quantity and average value index numbers appear to be sound and well suited to the nature of the special problems encountered in this statistical area, serious questions must be raised concerning the nature of the raw materials—that is, the average values and the quantities—to which these methods are applied. Unless changes in average values correspond closely to changes in prices, the changes in value will not be correctly factored into price and quantity components and the analytical utility of the indexes will be impaired.

The average values are derived from the Census Bureau's foreign trade statistics by dividing quantities into values. The classifications in the foreign trade statistics are rarely fine enough to ensure that homogeneous qualities of a product will be reported from one period to another. Consequently, changes in average value usually represent the result of an unknown combination of price change and variation in product mix. In some instances, the change in the nature of the product within a given classification may be quite substantial. For example, all nonmilitary passenger cars and chassis are placed in a single export category regardless of their size or value. Shifts in the composition of exports among various sizes of cars will therefore produce a different average value even though there has been no change in the price of any type of car. Furthermore, owing largely to the increasingly common requirements abroad that vehicles assembled locally must include a certain proportion of components of local origin, there has been a growing tendency to export "knocked-down" vehicles for assembly abroad with more and more components missing; indeed, in some cases what is reported as a vehicle unit in the export declaration may contain as little as 15 to 20 percent by value of a complete vehicle. The Bureau of Foreign Commerce has tried to cope with some of the more serious problems of this type of subclassifying exports by destination according to the importance of the local product mixes. However, the extent to which the problems posed by the foreign trade classifications can be circumvented are limited both by staff and by the inherent nature of the data.

It is not surprising to find, therefore, that comparisons between price relatives from the BLS wholesale price index and unit value relatives from the export-import indexes uniformly reveal greater temporal variability in the latter. In some cases, however, the relative stability of wholesale prices may reflect at least in part deficiencies in the BLS system of relying upon prices reported by sellers (see Section V, 2).

In addition, it may be expected that price data for domestic transactions which refer to dates of sale contracts would display differences in the timing of changes from price data derived from foreign trade statistics since the latter are recorded as of dates of shipment across national boundaries.

Finally, unit values derived from Census import statistics may differ from prices for the same goods collected from domestic sources because the Census data are valued at the foreign port of origin. This means that changes in the source of supply may produce changes in the landed price in the United States which, owing to differences in transportation costs, may diverge from the changes in f.o.b. foreign port values. If the focus of analysis is to be on competition for the American market, it would be preferable to try to make the import price index reflect changes in the cost of foreign goods at American points of entry. (We shall return to this point subsequently.)

How important are these divergences between price relatives and unit value relatives? Since nearly 200 unit value relatives enter each index, may not the upgrading in size and quality within some foreign trade classifications be offset by downgrading in others so that the indexes of export and import unit values may not differ much from indexes of export and import prices? These questions can be answered only for the period 1913–23 for which NBER export and import price indexes have been prepared. The author of the NBER study, which has already been cited, presents comparisons between the Commerce and the NBER indexes for six pairs of years for total exports, total imports, and for each of the five major classes of exports and imports for which indexes are published by the Bureau of Foreign Commerce. The frequency distributions of the ratio of the Commerce to the NBER indexes for these six comparisons are as follows:

Ratio	Total index		5 major commerce classes	
	Exports	Imports	Exports	Imports
90.0 to 94.9	0	0	1	2
95.0 to 99.9	1	2	12	10
100.0 to 104.9	5	4	14	14
105.0 to 109.9	0	0	1	3
110.0 to 114.9	0	0	2	1
Total	6	6	30	30

The agreement between the Commerce and the NBER indexes is good. Commerce's unit value indexes for total imports and total exports fell within 5 percent of NBER's price indexes, and the same was true in a high proportion of the cases for the indexes relating to the major classes.

There is no way of knowing what a similar comparison for a more recent period would show if it could be made. In view of the rise in the importance of finished manufactures in United States trade and in view of the growing deficiencies in the Commerce indexes in this area, it is not unlikely that less favorable results would be obtained. At best, moreover, the inference is that the Commerce indexes provide good approximations to price indexes for total exports and total imports and that the margins of error become wider as the commodity class to which the index numbers refer becomes narrower (compare the distributions for the totals and for the major classes). Even on this optimistic conclusion, the Bureau of Foreign Commerce should be encouraged to continue its present practices with respect to the selection of unit value and quantity data only if emphasis in the uses of the indexes is to be placed on overall price changes in exports and imports. However, an understanding of changes in our trade position requires a knowledge of the relative price changes at home and abroad for particular categories of goods. In recent years, for example, changes in the relative prices of automobiles, oil, coal, and steel have been more relevant than export or import prices as a whole. Thus, it would be useful to have indexes for certain important commodity classifications designed for direct comparison with those of other countries that play an important role in the trade of particular items. Depending upon the usage followed by other countries, these subindexes might be based on the standard international trade classification as the United Nations Statistical Commission has recommended, or upon the Brussels nomenclature which has recently been employed extensively on the European continent. England and Japan have taken some steps toward the use of the standard international trade classification and if other major trading countries were to do likewise, it would be easier to analyze the role of relative price changes in competition for trade in third markets. The Commerce Department currently provides the United Nations with an export unit value index for inclusion in the world unit value index for exports of manufactured goods, and it might be useful to make this public.

It would also be desirable to calculate and publish the indexes of total exports and imports for more narrowly defined geographical areas. There is great interest, for example, in the changes that occur in the terms of trade with underdeveloped countries.

The selection of the appropriate geographical and temporal terms of reference for the price indexes poses problems because of the differences between prices in the country of origin and the country of destination and differences between prices at the time of sale (contract) and at the time of shipment from the port of origin or delivery to the port of destination. If the main purpose of the price indexes is to serve as deflators for data on the value of foreign trade so as to produce quantum indexes of trade, the overriding consideration is to make the geographical reference and the timing of the price indexes consistent with those of the value data. Thus prices would be those prevailing at ports of export, the domestic port in the case of exports and the foreign port in the case of imports, and as of the time of contract. Linking contract prices with actual times of the departure of exports from and of the arrival of imports at American ports creates obvious difficulties for any scheme of price collection relying upon sources external to the foreign trade statistics. On the other hand, current rather than past contract prices and domestic rather than foreign prices are relevant to the analysis of competitive conditions in a particular market. This conjures up the possibility of whole congeries of export and import price indexes, an export price index for each destination and an import price index for each source of supply. While we recognize that for various purposes we would desire differently defined indexes, we suspect that the differences will not be so great as to warrant the calculation of more than one index number of export prices and one index number of import prices. We are of the opinion that it would be best to make their geographical and temporal terms of reference consistent with those of the foreign trade value series. Even for some of the purposes for which other terms of reference would be preferable, information on quantity and value as well as price changes is useful or necessary, and something is gained in having all three on a consistent basis.

If the current indexes are to have greater utility, steps must be taken to exercise more extensive surveillance over the unit values that are derived from Census trade data. The minimum changes that should be made in the data collection procedures are (1) the institution of systematic comparisons with domestic price movements as revealed by BLS and other sources and with appropriate foreign export or import price series, and (2) the substitution, where appropriate, of price changes as revealed by these external sources for Census unit values. Substantial improvement along these lines would be possible with only a modest addition to the professional staff of the group responsible for the indexes. The BFC staff's proposals for mechanization of the computations by taking advantage of the Bureau of the Census electronic computing equipment should be adopted, and if adopted, the staff would be somewhat freer to carry on the policing of the Census figures that is necessary, though the need for additional staff would not be obviated.

It would, in addition, be highly desirable to do some specification pricing in the field, particularly in the finished manufactures area. Much of this pricing might be experimental, especially in the early stages, with the purpose of determining to what extent unit value data from Census statistics and price data from the Wholesale Price Index were satisfactory for export and import price indexes. In the long run, therefore, the indexes would be based upon a variety of sources chosen in accordance with criteria of validity and cost.

The byproducts of this work could be of benefit to the Wholesale Price Index. The total transactions information of the BFC data can provide a useful external check to some of the wholesale price series, since they include discounts and premiums which the latter series often does not detect. The same may be said of the information that would be obtained from field visits to exporters and importers made primarily for the foreign trade indexes.

For this and other reasons, the export-import index work should be brought into closer association with other price index activities, either through closer interagency cooperation or through the transfer of responsibility from an operating to a statistical agency. The latter suggestion is not made in a spirit of criticism of the manner in which the Bureau of Foreign Commerce staff has discharged its responsibilities. There is every indication that the resources available to it have been used intelligently and with great professional skill. But the available resources are inadequate to the magnitude and importance of the task, and it may be desirable to place this work in an administrative setting in which it is a major assignment rather than an incidental byproduct.

APPENDIX B

CONSTRUCTION PRICE INDEXES

The Present Indexes

The Department of Commerce "composite" construction cost index, now compiled by the Bureau of the Census, is the closest substitute for a comprehensive construction price index now available. It is a very distant substitute, being defective in almost every possible way. This is the inevitable result of the fact that the skimpiest of resources have been devoted to it. It depends entirely on secondary sources (no original data have ever been collected for it), and these are more than ordinarily defective.

Persons working in this field distinguish between construction "prices" and construction "costs." In force-account construction performed by the prospective user the two are synonymous—both represent the amount paid by (or costs to) the buyer or user. A difference arises in the case of houses, stores, and occasionally other structures that are built for sale by speculative builders, and in contract construction. Here, "price" means the price paid by, or cost to, the ultimate buyer, while "cost" means the cost to the speculative builder or prime contractor, exclusive of his profit (but including the profits of subcontractors). In practice there may also be other differences (such as in the treatment of commissions), but these are not differences of principle. Measurement of either "price" or "cost," but especially "price," involves a difficult problem of distinguishing land value from the price (or cost) of structures.

This Committee believes that the objective here, as elsewhere, should be to measure prices rather than costs. If (as some argue) "cost" indexes are also needed, they should be provided as supplementary information. The difference between an index of prices and an index of costs as just defined is minor, however, as compared to the difference between either of the two and the composite index presently available.

The Department of Commerce "composite" is the quotient of total construction activity valued at current costs, seasonally adjusted, and total construction activity valued at 1947–49 cost, seasonally adjusted. Total construction activity at 1947–49 cost is obtained by deflating each type of construction at current cost by a so-called "cost index" for that type of construction, and summing the deflated components.

The gravest deficiency of the index originates in the character of the individual cost indexes used for deflation. With the exception of the Bureau of Public Roads for a "composite mile of highway," and Interstate Commerce Commission series for railways and pipelines, these cost indexes do not approximate cost as defined above. For the most part they are, instead, indexes of wage rates and building material prices weighted together in accordance with their importance in the cost of a unit of construction of some specified type in a base period. As such, when used to measure price (or "cost" as earlier defined) they assume that there is no change in productivity in construction. Over any considerable period of time this tends to impart a strong upward bias to the cost indexes. The only reason for any doubt that such an upward bias exists in the "composite" index arises from the many other deficiencies of the component indexes which impart other biases of unknown direction.[1]

These other deficiencies are extremely serious. We merely list what seem to be the more important ones. (1) Most of these indexes are compiled by private firms as a byproduct of other activities viewed as far more important. They are not reviewed by any central agency for adequacy of statistical procedures nor for consistency. Information in sufficient detail to permit adequate review, the Committee is informed (although it has not itself attempted to contact the compilers directly), is not generally available. (2) The indexes are not prepared in order to provide appropriate coverage for the categories of construction they are used to deflate. Instead, these categories are deflated by whichever of the available indexes seems to fit most closely (or least distantly) each category of construction activity. In some cases no relevant index is available. (3) The bill of materials priced and included in the indexes is usually incomplete, and in some cases grossly so. (4) Weights by which various indexes of wage rates and materials are combined are usually based on periods in the remarkably remote past, and their accuracy even for the period to which they relate is dubious. (5) It appears that the wage rates and prices used frequently do not represent actual transaction prices but rather some type of quoted or "normal" price. (6) The geographic coverage and weighting of the indexes are rarely suitable and comprehensive. (7) The timing of the cost indexes is not, in general, appropriate for deflation of the construction activity estimates, which represent an allocation over time of contracts or other valuations established at an earlier date.

Two additional general comments should be made: (1) The "composite" index is an "implicit price deflator" and, as such, measures the combined result of cost changes and of changes in the weights of different types of construction in the current-dollar construction activity aggregate. This is appropriate for deflation but not for the compilation of a price index. When and if the major deficiencies in the index are corrected, a change should be made to a fixed-weight index. We do not recommend this change now lest it contribute to the illusion that a true construction price or construction cost index exists. (2) The present definition of construction with respect to the inclusion or exclusion of various types of equipment, landscaping, commissions, and other items is, to say the least, imprecise. An interagency committee of the Federal Government has recently examined the definition from the standpoint of the construction activity estimates, and has recommended definitions with which the construction activity estimates should be brought into conformity. The present Committee has not reviewed this report, but does wish to stress that

[1] A supplementary note to this appendix contains a listing and brief description of the construction cost indexes used to deflate each category of construction activity, and the value of construction in that category in 1959.

the definition of construction in the compilation of price indexes should be consistent with that adopted for value estimates.

Suggestions for New Work

Construction is a particularly difficult field to price because the units built are constantly changing, and the "quality change" problem is acute. At present there evidently is no way to allow for quality change in the form of changes in convenience, efficiency, attractiveness resulting from better (or worse) design, or improvements in building materials. Once this limitation is accepted it appears possible to construct a reasonably adequate price index if the necessary effort is devoted to devise methods of measurement and if funds can be provided for collection of data. The techniques that can be followed to obtain better data are not the same for all categories of construction, but major improvements are possible in nearly all categories.

Whenever possible, the series ought to be based on actual transaction prices. By price we mean the price paid by the buyer in the case of speculative builders, the contract price in the case of contract construction, and the total expenditure in the case of force-account construction. This approach is, in principle, available for all types of buildings, which comprise the great bulk of construction. It seems almost certainly practical for residential and commercial structures, which represent about half the total value of new construction.

In the case of residences, for example, the approach requires the classification of new houses in sample localities by certain broad characteristics which dominate the determination of price per square foot, and the computation for each category of a price per square foot. The characteristics by which houses are classified may include size (by number of dwelling units and floor area), development or nondevelopment, general building material, number of floor levels, and some specification as to equipment, but the classes should be kept as few as possible in order to minimize collection problems. Basement and attic areas can be converted to equivalent square feet on the basis of relative cost in the base period. The index of price per square foot in each category is then treated as a price index, and these can be weighted together by the value of the different categories in the base period. As already noted, the procedure requires the elimination of land values from houses speculatively built. This is an important limitation on the method but it does not loom large in comparison with the difficulties of other approaches.

In a rudimentary way the index of house prices computed by the Bureau of Labor Statistics as a component of the Consumer Price Index (but not separately published) is a start toward the use of this approach. It is based on price per square foot for FHA-insured housing. However, in its present form it is not suitable for use as a construction price index. Cells are too broad (specifications are only for new vs. used, over or under 1,000 square feet, and site value below the FHA median for the city or not); land is not eliminated; and the series is not (and is not intended to be) representative of all housing. As the BLS index is presently compiled, separate indexes for new and used houses do not emerge. The Federal Housing Administration has been trying to develop an improved price index carrying this approach further by standardizing FHA-insured houses in additional respects. It may also be noted that the Bureau of the Census, in connection with its building permit survey, is now collecting data on cost and expected selling price of new houses. These data have not yet been tabulated, but soon will be. Since the coverage of this sample is not restricted by the method of financing, it may have potential value as a primary source of data for a price index, although there appear to be fairly serious difficulties to be faced. Asking prices (rather than actual prices) are collected and information on important characteristics of the units is not obtained.

For types of construction that vary so much as to preclude direct pricing of complete projects and conversion to a square foot or similar basis, pricing of separate operations entering into them appears to be the best alternative. The Bureau of Public Roads series corresponds broadly to this approach. It is based on average contract unit bid prices for various road-building operations, such as a cubic yard of excavation or a square yard of paving. The bid prices are obtained from actual contract information. The Interstate Commerce Commission follows an essentially similar approach in compiling series for railroad and pipeline construction.

Other approaches, which do not use actual contract prices, should be used only as a last resort. One is to specify a particular type of structure and obtain estimates from builders of their contract price to build it. If used, the specifications should be changed frequently so that they always correspond as nearly as is practicable to structures that are in fact being commonly built. (The new indexes would, of course, be introduced by linking, not by assuming the new specifications to be equivalent to the old.) This procedure has the distinct disadvantage, especially for short-term price comparisons, that it is not based on actual transactions. This appears especially serious because actual bids on actual projects are known to vary widely and the same contractors are not consistently high or low, and because a hypothetical quotation may well differ from what the same contractor would bid on an actual contract under competitive conditions. However, the long-term bias in most of the existing indexes arising from productivity change would be reduced or eliminated by this procedure.

Another approach is to continue the existing procedures but adjust periodically to benchmark data for changes in direct labor requirements in construction so as to correct for changing productivity. The Bureau of Labor Statistics, for example, is currently studying direct and indirect labor requirements for hospitals and schools. If repeated periodically, such surveys would provide information needed for such an adjustment. However, reliance on contract prices for these types of structures would be much preferred.

DEPARTMENT OF COMMERCE

BUREAU OF THE CENSUS

CONSTRUCTION STATISTICS OFFICE

September 9, 1960.

CONSTRUCTION COST INDEXES CURRENTLY USED FOR DEFLATION OF VALUE OF CONSTRUCTION PUT IN PLACE

The following statement relates to the individual construction cost indexes which are now being used to convert the monthly values of new construction to 1947–49 prices, and to the so-called Commerce Composite Construction Cost Index.

INDIVIDUAL COST INDEXES USED FOR DEFLATION

The selection of the cost indexes which are now being used to deflate the current value of construction activity, by major types of construction as indicated in the attached table, was made about 1946. The object of the study which resulted in this selection was to obtain construction cost indexes for each of the primary categories of construction for which activity estimates were computed.

With the exception of the Bureau of Public Roads Composite Mile index, which was designed to measure changes in construction costs for highways, none of the available indexes was found to be completely representative of any one specific primary classification of construction. For example, the Boeckh residential index (item 1 on the attached table) does not include apartment buildings or non-housekeeping residential facilities. Nevertheless, a number of single indexes or combinations of indexes were found, each of which was judged to be reasonably representative of one specific primary category. However, for several of the primary categories—those included in items 4 and 14 on the attached table—no index was found to be applicable to only one specific category. For each of these groups a single index was selected as being reasonably representative of all of the primary categories in the group.

In addition to the question whether any particular index is designed to measure changes in construction corresponding to our system of project classification, the indexes pose several other problems. Among these are:

(*a*) Some of the indexes measure cost changes for fixed quantities of material and labor which were typical of structures or facilities constructed 25–30 years ago but which are no longer representative.

(*b*) Few of the indexes make any allowance for changes in productivity.

(*c*) At least one of the indexes excludes major items of construction cost, such as: plumbing, heating, electrical work, air conditioning and elevators.

(*d*) Very little detailed information is available concerning the sources of data for these indexes or the methods used in their construction.

COMMERCE COMPOSITE COST INDEX

The composite index is a variably weighted, seasonally adjusted index which is computed monthly. The cost indexes are weighted by the seasonally adjusted values of the categories to which they apply; these categories are listed in the attached table. The seasonally adjusted values are used to minimize the influence of the differential seasonal fluctuations of activity for the individual types of construction.

Construction Cost Indexes Used To Adjust the Value of New Construction to 1947–49 Prices

Item No.	Type of construction	Value of new construction in 1959 (millions of dollars)	Name of cost index used [1]	Comments on indexes
1	Residential (nonfarm)	25,431	E. H. Boeckh & Associates—Residential	A national average construction cost index prepared monthly by E .H. Boeckh & Associates covering residences in 20 major pricing areas.
2	Industrial	2,474	Turner Construction Co.	A construction cost index prepared quarterly by the Turner Construction Co., representing the cost experience of that firm, primarily in eastern cities.
3	Office buildings and warehouses	1,954	George A. Fuller Co.	A national construction cost index prepared quarterly by the George A. Fuller Construction Co., representing a composite of 3 types of buildings—factories, hotels, lofts.
4	Stores, restaurants, and garages Educational buildings Hospital and institutional buildings Other nonresidential buildings	1,976 3,181 998 2,790	American Appraisal Co.	A national average construction cost index prepared monthly by the American Appraisal Co., covering "4 representative types of frame, brick, concrete and steel buildings" in 22 cities. This index covers only the structural portion of the building and does not cover such items as plumbing, heating, lighting, sprinklers, or elevators.
5	Farm operators, dwellings	425	Agricultural Marketing Service—Operators' dwellings.	A national construction cost index prepared annually by the Agricultural Marketing Service of the U.S. Department of Agriculture based on a weighted average of prices paid by farmers for building materials (73 percent) and farm wage rates (27 percent).
6	Farm service buildings	836	Agricultural Marketing Service—Service buildings.	Same as above except weights of 78 percent and 22 percent are used.
7	Railroad Local transit (private)	251 25	Interstate Commerce Commission—Railroad	A national average construction cost index prepared annually by the Interstate Commerce Commission representing a weighted average of 45 expenditure acccounts covering capital improvements, other than equipment, by class I railroads.
8	Telephone and telegraph	952	Interstate Commerce Commission—Telephone and telegraph.	A national average construction cost index prepared annually by the Interstate Commerce Commission representing expenditures by class I railroads for communication systems.
9	Highways	5,916	Bureau of Public Roads—Composite mile	A national construction cost index prepared quarterly by the Bureau of Public Roads measuring cost changes for furnishing and installing fixed quantities of excavation, concrete paving, structural concrete, reinforcing steel and structural steel as represented in a 1925–29 composite mile.

10	Electric light and power	2,072	Weighted average of:	
			Handy-Whitman—Electric plant (weight 9).	An unweighted average of construction cost indexes compiled semiannually by Whitman, Requardt & Associates for 6 geographical regions representing the cost of constructing and equipping steam electric light and power plants.
			Handy-Whitman—Utility buildings (weight 1).	An unweighted average of construction cost indexes compiled semiannually by Whitman, Requardt & Associates for 6 geographical regions representing, separately, the cost of constructing reinforced concrete buildings and brick buildings.
11	Gas	1,657	Weighted average of:	
	Public service enterprises	551	Handy-Whitman—Gas plant (weight 9)	An unweighted average of construction cost indexes compiled semiannually by Whitman, Requardt & Associates for 6 geographical regions representing the cost of constructing and equipping gas manufacturing plants.
			Handy-Whitman—Utility building (weight 1).	See item 10.
12	Military facilities	1,488	Unweighted average of:	
			American Appraisal Co	See item 4.
			Bureau of Public Roads—Composite mile	See item 9.
			Turner Construction Co	See item 2.
			George A. Fuller Co	See item 3.
13	Petroleum pipelines	95	Unweighted average of:	
			Handy-Whitman—Electric plant	See item 10.
			Handy-Whitman—Gas plant	See item 11.
			Handy-Whitman—Utility building	See item 10.
			Interstate Commerce Commission—Railroad.	See item 7.
14	Sewer	906	Unweighted average of:	
	Water	561	Associated General Contractors	A national average construction cost index prepared monthly by the Associated General Contractors of America based on data reported from 12 geographical areas covering wage rates and construction materials prices (weighted 40 and 60).
	Conservation and development	1,130		
	All other private	207		
	All other public	229		
			Engineering News-Record—Construction	A national average construction cost index prepared monthly by Engineering News-Record based on a weighted average of prices for fixed units of construction materials and common labor in 20 cities.

[1] Where the applicable deflating index is not available on a monthly basis, an appropriate monthly index is used, by linking to the deflating index, to estimate the current monthly values of the deflator.

Source: Bureau of the Census, Department of Commerce, Washington, D.C., Sept. 9, 1960.

APPENDIX C

PRICES OF TANGIBLE ASSETS

Prices of tangible assets, of which real estate is the most important example, are needed in several important fields of economic analysis.

Asset price indexes are an essential element in the derivation of estimates of national wealth and national balance sheets. For many types of tangible wealth, current estimates are dependent upon an extrapolation of benchmarks which in turn utilize asset price indexes: an example is the estimate of real estate values in the Balance Sheet of Agriculture.[1] Where the current value of reproducible tangible assets is derived by the perpetual inventory method, which utilizes construction cost and similar indexes to adjust for price changes,[2] indices of the prices of existing tangible assets are necessary to make independent checks of the estimates.

Asset price indexes are also needed in flow-of-funds analyses (including the "equation of exchange" of the quantity theory of money), if it is desired to separate movements in the volume of transactions in existing assets and movements in their prices. Related uses of the asset price data are involved in the deflation of various items in the national income accounts.

In addition to these uses of asset prices in constructing basic economic data systems, a variety of analytical uses could be cited. To study the effects of inflation upon the economic position of various debtor and creditor classes one must have information on the movements of asset prices. To study the locus and causes of economic progress, one must have information on the deflated stocks of capital. Asset prices are playing an increasingly important role in all branches of economic analysis.

Indexes of asset prices encounter the usual problem of quality change. One cannot compare directly the price of a 1956 automobile in 1959 and in 1960, for the price relative one wishes is that for a three-year-old car, not one which has aged another year. The comparison of a 1956 automobile's price in 1959 with a 1957 automobile's price in 1960 raises the same problems as the pricing of new goods, and our discussion (III, 3) is applicable here.

There are four practicable approaches to price indexes of existing tangible assets:

The first approach compares the prices registered in actual transfers of identical or similar properties at different points in time. Either all transactions or a systematic or unsystematic sample of them may be utilized in the construction of the index.

The second approach is based on estimates of price changes of comparable assets made by experts, either for the purpose of con-

[1] See *Land Values and Farm Finance* (Agricultural Handbook No. 118), U.S. Department of Agriculture, 1957, p. 7.
[2] See, e.g., R. W. Goldsmith, *A Study of Saving in the United States*, Vol. III, p. 31.

structing a price index or as a byproduct of lending, taxing, or other administrative activities. These estimates will in practice be tied to an unsystematic sample of actual transaction or of bid and ask prices.

The third approach makes use of prices listed in publications (often known as "Red Books," or by a similar name) guiding dealers in secondhand assets, particularly automobiles and farm equipment. These prices in principle approach those realized in actual transactions, at least in those transactions in which the trade-in of an old asset is involved in the purchase of a new one.

The fourth approach resorts to the reproduction cost of an asset specified as to type and age; i.e., it is essentially a weighted average of cost elements at current prices. This method therefore does not, strictly speaking, yield an index of the price movements of existing assets, although allowance for depreciation will bring it close to the latter.

At the present time, hardly any current and reasonably reliable information exists on the prices of tangible assets. The only exceptions are the annual index of farm real estate prices compiled by the Department of Agriculture and the monthly index of selling prices of single-family residences put together by Roy Wenzlick & Co. The information on the average annual prices of existing one-family houses, on which loans have been guaranteed during the year by the Federal Home Loan Banks and the Veterans' Administration, although not price indexes in the strict sense, may be regarded as pertinent.

The index of farm real estate prices [3] is based on estimates of the changes in the current price of farm properties which are made semiannually by about 16,000 farm crop reporters cooperating with the Department of Agriculture. These estimates are first combined (without weights) to obtain averages for each of the several hundred crop-reporting districts. These unweighted district averages are then combined by the Department of Agriculture into state averages with weights generally corresponding to the acreage of farm land in the district. Finally, the state averages are combined into weighted averages for regions and for the entire United States. The state and United States estimates may be adjusted on the basis of replies to a mail questionnaire received twice a year from 6,000 to 7,000 "farm real estate dealers, lawyers, local bankers, county officials, and others in contact with the local farm real estate market." In most districts the exact type of property to which the estimates refer is not specified, nor are separate estimates required for different types of properties. In the western states, however, separate estimates are required for irrigated and nonirrigated and grazing land.

The basis and method of the Wenzlick index on selling prices of single farm structures are not known precisely. It is supposed to refer to well-maintained family residences to which no major additions have been made.[4]

In this situation, we must start virtually from scratch in the construction of a reasonably comprehensive system of price indexes of tangible assets, and we can hope for only slow progress. Even modest

[3] *Land Values and Farm Finance*, pp. 3–7.
[4] See, e.g., "Factors Affecting the Outlook for Real Estate in 1959" (chart).

progress will require continuous pressure for experimentation with asset prices in neglected fields and steady improvement in the few indexes that we have. Tentative recommendations for development or improvement of indexes for the main types of privately owned tangible assets are presented in summary form in the following pages.

1. Farm Real Estate

The index of farm real estate prices of the Department of Agriculture should be improved by distinguishing the main types of farm properties so that separate indexes may be derived for each type, by giving more definite instructions regarding the estimates to be made by farm crop reporters and by checking the information received from farm crop reporters and from real estate dealers and others against a systematic sample of actual transactions. The data on value of farmland should be distinguished from, and given priority to, that on farm homes and service buildings.

2. Single Family Homes

Since single family homes is the category of tangible assets in which the volume of transactions is largest, and since homes are very important as a basis for credit, the area deserves immediate and concentrated attention. Two main approaches to deriving indexes of the prices of existing single family homes appear feasible.

The first is the utilization of the existing statistics of the average appraised value of homes on which FHA and VA loans have been made (see also App. B). These statistics should be brought closer to true price indexes by classifying homes by age, size, type of construction, location, and possibly some other characteristics, so that the average prices will refer to groups of structures which are reasonably homogeneous from an economic point of view. Such a relatively fine classification is possible because of the large number (several hundred thousand) of units which are appraised each year. It would also be desirable to shift the data from an annual to a quarterly basis. A good deal can be accomplished simply by tabulation of data already being collected as part of the lending activities of FHA and VA.

Since FHA and VA loans account for only about one-third to one-half of all homes on which loans are made, it would be advisable to enlarge the basis of the index by a sample of the homes on which conventional mortgage loans are made by private lenders, particularly savings and loan associations and mutual savings banks.

The second approach utilizes the price of homes realized in actual sales. These statistics might be obtained as part of a project, on which preparatory work has already been done, particularly at the School of Business of the University of California in Los Angeles, of selecting a systematic sample of all real estate transfers throughout the country, a sample that would serve as a basis for statistics on many aspects of residential real estate and mortgages.

The first approach permits separation of the value of the land from that of the structures, since appraisals usually distinguish between these two elements of the total value of the property. The second approach obviously does not permit such a separation.

Assessed valuations do not constitute a usable independent source for indexes of real estate prices since assessments usually deviate considerably from market values and, what is more serious, there is no method of estimating the relation of assessed to market values and the changes in that ratio unless there is an independent ascertainment of market values.

3. Multifamily Structures

At the present time, we are entirely without information of changes in prices of multifamily structures. As in the case of single family homes, two approaches are open, appraisals by lenders and sampling of actual transactions. In this case, the most important lender groups are life insurance companies and mutual savings banks, followed at substantial distance by commercial banks and saving and loan associations.

In principle, the problems are the same as those encountered in calculating an index of prices of single family homes, but the practical difficulties are likely to be greater because of the smaller number of properties which change hands or become the subject of institutional loans. It will, therefore, be considerably more difficult to select an adequate sample of properties to obtain reliable information on multifamily structures of different age, size, and other characteristics defining economically homogeneous groups.

4. Commercial Structures

The two basic approaches, appraisals by lenders and sampling actual transactions, are available here too, but the practical difficulties are still greater because of the greater variety of types, the greater influence of location, and the lower rate of turnover. It may therefore be well to start with a few fairly standardized types of commercial structures, particularly office buildings. In this case, the main lender groups whose records are needed are life insurance companies, commercial banks, and mutual savings banks.

5. Vacant Lots

Vacant lots are important enough to merit a special index. This will probably have to be based on a systematic sample of either transactions or appraisals; the latter approach is less promising in this instance. It will undoubtedly be difficult to maintain a reasonable degree of homogeneity with respect to "ripeness" of lots, i.e., the status of improvements such as streets, sewers, and utilities.

6. Cars and Trucks

In some respects price indexes for used cars and trucks are relatively easy to calculate—the number of transactions is very large, the subject of transactions is relatively homogeneous, and there exist trade publications listing the prices of used cars and trucks of different age and type as a guide to dealers. There are, however, considerable conceptual problems. The true allowance made for used cars or trucks traded in connection with the purchase of a new vehicle is disguised by the practice of using the trade-in value to give a discount from the list price of a new car or truck. It will therefore be preferable to base the index on the sales price realized by used car and truck dealers. These prices are probably best ascertained by systematic sampling of dealers, requiring reports on a limited number of representative types and age groups.

7. Other Consumer Durables

It would be very difficult to ascertain the prices for the remaining consumer durables because they are heterogeneous in character and the markets are unorganized. In view of the limited volume of transactions, it is doubtful if price information on these other used consumer durables is worth the cost at this time.

8. Producer Durables

Hardly anything is known in quantitative terms about the size of the market and the price movements of used producer durables other than trucks and farm equipment. In the latter case, it is possible to proceed in the same way as for cars and trucks, using dealers' catalogues or actual prices for representative types of farm equipment obtained by a systematic sample from dealers. The other types of used producer durables pose probably the most difficult of all cases of constructing an index of prices for existing assets, both conceptually and practically. Such an index, however, is particularly important because among the major components of reproducible wealth the value of the stock of producer durables is outranked only by residential and nonresidential structures. Two special conceptual difficulties are the apparently very low ratio of sales of secondhand equipment to the stock, which makes it very difficult to find prices of transactions that do not represent distress sales, and the multiplicity and rapidity of change in models.

9. Forest Land

While timberland is one of the smaller components of national wealth, movements of its price are of considerable economic interest. It would therefore be desirable to have an index of timberland (stumpage) prices. The construction of the index should probably be based upon the collection of prices of actual sales of timberlands of different species in the main forest regions of the United States. Information should be relatively easy to obtain for Federal and State forest, but transaction prices of privately owned timberlands would be much more difficult to secure.

10. Oil Lands

The price movements of oil lands (i.e., land with proven or suspected but not yet developed oil reserves) is of great economic importance for some parts of the country, particularly the Southwest, and is of considerable interest for an analysis of the oil industry. The number of transactions in oil acreage is sufficiently large to yield useful average prices per barrel of oil under ground. It is doubtful, however, whether an overall average for the United States would be meaningful, and it might well be necessary to prepare separate averages for major fields, areas of different degrees of exploration, and areas differing in other economically relevant respects.

STAFF PAPERS

These staff papers have been exempted from the rules governing submission of manuscripts to, and critical review by, the Board of Directors of the National Bureau. They have, however, been reviewed and accepted for publication by the Director of Research.

STAFF PAPER 1

AN INDEX OF MOTOR FREIGHT RATES

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I. INTRODUCTION [1]

In this study, the index number problem is concerned with the estimation of changes over time in the costs of transporting commodities. Although the relative importance of the transportation industry, as measured by share of national income generated, has been declining over time, it still remains one of the important industries in our economy.[2]

A substantial part of the industry is regulated by various governmental agencies, notably the Interstate Commerce Commission. A large volume of data has been gathered and published by these agencies in conjunction with their regulatory activities. Regulation of freight rates is one of the major functions of these agencies. However, attention has largely been focused on specific rate cases, with very little effort made to estimate changes in the general level of rates. Some indexes for rail shipments of specific commodities and for all Class I rail carload freight have been generated by the I.C.C. and the Agricultural Marketing Service.[3] However, important segments of the industry, such as highways, have been wholly neglected.

The primary objective of this study was to propose a method for constructing an overall freight rate index for the United States. The index formula which was felt to be the most appropriate for this purpose was the familiar Laspeyres formula, used in constructing the Consumer Price Index. Given this formula, the theoretical discussion in Section II also develops an optimal sampling scheme for collection of the rate data. We firmly feel that this method is both conceptually sound and economically feasible.

To demonstrate this latter point, data were collected to generate a motor freight rate index for common carrier truckload freight in the Central States territory. Our method relies on a knowledge of the market organization for the particular kind of transport service;

[1] The authors wish to acknowledge the kind cooperation extended to the Transportation Center by members of the trucking industry. Particularly helpful on this study were Mr. Earl Mizenbach of the Central States Motor Freight Bureau; Mr. Frank Kahovec of the Rogers Cartage Company; and Mr. W. E. Mitchell of the Arco Auto Carriers.

[2] The share of national income, generated by the transportation industry, (as reported in *The Survey of Current Business*) has declined from 7.6 percent in 1929 to 4.7 percent in 1957. These figures exclude the privately produced transportation services provided by vertically integrated firms outside the transportation industry. Hence, the relative decline is overstated by these figures.

[3] Brief descriptions of these freight rate indexes are presented in Appendix B to this study.

in this respect, it is similar to the Wholesale Price Index. A description of the market for highway transportation and the mechanics of rate determination is included in Section III. The next three sections describe the procedures employed in obtaining the weights, price relatives, and final index numbers. The published data, from which weights were estimated, forced us to make some restrictive assumptions. In addition, the number of freight rates sampled was limited by our limited resources. Despite these qualifications, which are explicitly stated in Section VI, we believe that our motor freight rate index is representative of the changes over time in the level of rates for truckload freight in the Central States territory.

Finally, in Section VII, recommendations are made for additional data compilations to implement the method outlined in Section II. These recommendations were made in the light of the available statistics and the urgency of the problems currently facing the transportation industry.

II. Theoretical Framework for the Construction of a Freight Rate Index

The first step in the construction of an index number is to define the set of commodities or services covered by that index. In this study the freight rate index shall refer to the set of all "for hire" transport services; namely, it is an index of the prices paid for the spatial movement of goods excluding all self-produced transport services.

Ordinarily, the set of all commodities covered by an index is classified into subsets or groups such that the commodities in each subset possess certain common characteristics. This step serves two functions. First, it permits the estimation of indexes for various combinations of the subsets. Second, it facilitates the sampling problem encountered in every index number. The characteristics which distinguish various kinds of transport services can be subsumed under four variables of classification.

1. Mode of transportation: e.g., rail, motor, water, air, pipeline
2. Commodity transported
3. Distance transported
4. Geographic region

The stratification by mode of transportation isolates differences in the method of providing transportation as well as certain "service" or quality characteristics such as speed, batch size of individual shipments, portal to portal service, etc. Commodity characteristics such as perishability, density, packaging, etc., also influence the kind of transport service provided. Distance must be explicitly considered since the use of a single measure, such as ton-miles, conceals very real differences in the mix of transport services. The transport service includes both the movement of the goods and the loading and unloading activities. Hence, the relation between distance and either costs or rates is not linear; furthermore, it may differ between different modes. Finally, the classification by geographic region isolates differences in freight rates due to the area of operation.

The basic purpose of a freight rate index is to measure the average change in the prices paid for transporting goods. Initially, assume that the individual price relatives or average price changes[4] can be accurately estimated for each subset of transport services. The appropriate method of combining these individual price relatives to obtain a single representative average price change constitutes the index number problem. The alternative methods of constructing an index number have been discussed in the literature and, hence, are omitted in the present study.[5] The three formulas which have survived through time and are still employed today are (1) the Laspeyres index, (2) the Paasche index, and (3) the chain link index. All three are weighted averages of the individual price relatives.

Two compelling reasons which favor the Laspeyres index over the other two are (1) minimal data requirements, and (2) ease of interpretation. In the Laspeyres index, quantity data are only required for the base period; in subsequent periods, only price data need be collected. If both price and quantity data are required in each period, as is the case for the other two indexes, publication of the current month's index may be delayed by as much as 2 years.[6] Furthermore, a Laspeyres freight rate index for the current period tells us the cost at current prices of purchasing the same bundle of transport services as that purchased during the base period. Although the Paasche index has an equally succinct meaning, this is not the case for a chain link index.

Where the composition of the bundle of transport services changes drastically over time, the Laspeyres index may yield an erroneous estimate of the true average price change. This fact has been clearly demonstrated in the case of the Consumer Price Index. Under these circumstances, the best alternative appears to be a chain link index. Between any two successive periods, the composition of the bundle cannot change too drastically. Hence, the chain link method estimates the average percent change between two adjacent periods, then cumulates these over time. One disadvantage of the chain link index is that it cumulates errors of measurement. Thus, if there is a serial correlation in the errors of measurement, this index will yield a biased estimate of the true average price change.

Over the past two decades, substantial shifts have been observed in the composition of the transport services consumed by our economy. During this period, the relative importance of highway transportation has increased steadily. Consequently, a fixed weight index would provide an accurate estimate for only a relatively short time span. However, given the mass of quantity data currently collected by the regulatory authorities, revisions could be made in the base period weights at frequent intervals, say each 5 years.

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[4] The terms "freight rate," "rate" and "price" shall be used interchangeably through the remainder of this study.

[5] Irving Fisher, *The Making and Using of Index Numbers*, New York: Houghton Mifflin Co., 1923. Wesley Clair Mitchell, *The Making and Use of Index Numbers*, U.S. Bureau of Labor Statistics, Bull. No. 284. Bruce D. Mudgett, *Index Numbers*, New York: John Wiley & Sons, Inc., 1951.

[6] For example, the rail carload freight rate index is usually published approximately 2 years after the date for which it applies.

Of the three indexes, the Laspeyres index was selected as the appropriate one for constructing a freight rate index. The freight rate index in period t, relative to the base period, 0, is denoted by I_t.

$$I_t = \frac{\sum_j W_j X_{jt}}{\sum_j W_j} \qquad (2.1)$$

where W_j denotes the weight assigned to the j-th type of transport service [7] and X_{jt} the price relative in period t relative to the base period, 0.

The appropriate weight for each type of transport service or traffic category is the share of total freight revenues generated by shipments in that traffic category during the base period. For rail carload freight, the ICC collects a 1 percent waybill sample from which freight revenues, classified by the kinds of traffic categories described in this study, could be estimated. Currently, class I motor common carriers are only required to report aggregate freight revenue and weight data for truckload shipments, classified by commodity type and territory of origin and destination. For the other sectors of the transportation industry, comparable data are not available. There is some reason to expect that the short-run fluctuations would be greater than the long-run fluctuations in freight revenue.[8] This would suggest the estimation of weights from revenue data for several years rather than for a single year. This was the procedure employed in section IV below.

We turn next to the estimation of the individual price relatives, X_{jt}. The two methods of estimating the price relative are (1) specification, or (2) aggregate value. Under specification value, one would observe the freight rates for particular transport services; e.g., the freight rate for the movement of shingles between two specified points via common carrier trucks in shipments of less than 2,000 pounds. Under this method, a sample of specific transport services would be selected and held fixed, if at all possible,[9] in subsequent periods.

The aggregate value method is currently used in the rail carload freight rate index. Under this method, an aggregate value or average freight rate is estimated for all shipments reported in a given traffic category. For example, a single rate per ton-mile is estimated for all "roofing materials" shipped in carload lots in the southern territory for a particular mileage block. For the rail carload index, the pertinent data can be lifted directly from the 1 percent waybill sample collected by the ICC. Where the variance in freight rates within any traffic category is large, aggregate value can lead to errors of measurement. For example, suppose there was no change in the structure of freight rates between years 0 and 1. However, the sample selected in year 0, by chance, included only those shipments with low freight rates. Use of the aggregate value method would reveal an increase

[7] The type of transport service corresponds to a specific subset or traffic category designating (1) mode of transportation, (2) commodity, (3) distance, and (4) geographic region.

[8] Variations in the spatial distribution of product demands could be satisfied through variations in either the demand for transportation or in the location of firms. Ordinarily, the short-run adjustments would be expected to take place through variations in the demand for transportation. The relocation of firms is usually a long-run phenomenon.

[9] The sample would necessarily change if certain freight services are discontinued in later periods.

in the average freight rate for this traffic category, although no change did in fact occur.

In constructing a motor freight rate index, specification value was employed in estimating the individual price relatives in section V. However, aggregate value may be preferable under other circumstances; specifically, if the data are in a form which makes it difficult, if not impossible, to employ specification value. In addition, differences in the costs of sampling under the two methods may encourage the use of aggregate value.

In the index number literature, relatively little attention is accorded the statistical properties of index numbers. An index number may be viewed as a point estimate of the average price change over a specified time period. Since it is neither possible nor feasible to observe all prices, the index must be based on a sample of prices. Furthermore, the sample size is limited by the costs of sampling and budget considerations.

Given a sample size, an optimal index number should satisfy two conditions. (1) The index is an unbiased estimate of the true average price change. (2) The index is a *best* estimate; namely, the variance of the estimate is a minimum.

In this formulation of the index number problem, prices are treated as if they were stochastic variables. The problem is to find the best unbiased estimate of the true average price change.

In the context of a Laspeyres index, this formulation prescribes an optimal sampling procedure. If the Laspeyres index is strictly applicable, then each price in period t has a corresponding counterpart in the base period. By redefining units of measurement, it is always possible to make the prices of all commodities equal in the base period. Using these redefined prices, there exists a probability distribution of price relatives in period t. Given the sample size, an optimal index number should provide the best unbiased estimate for the mean of this probability distribution.

Suppose the sample size is limited to n observations of individual price relatives. Two unbiased estimates are available: (1) the average of a random sample selected from the entire population of all commodity prices, and (2) a weighted average of the sample means for price relatives stratified into groups. The latter estimate will always possess a smaller variance than the former if the classification of commodities into groups results in either or both of the following conditions:

a. The true average price change for the j-th group, denoted by m_j, is not the same for all groups. That is, $m_j = m$, for some j.
b. The variance of price relatives within the j-th group, σ_j^2, is not the same for all groups.

Under these conditions, the optimal sampling procedure is to stratify the sample.

In this stratified sample, the number of price relatives sampled from the j-th group is determined by (1) the probability of observing a price relative in the j-th group, and (2) the variance of price relatives within the j-th group. The probability that a single price relative, drawn at random, will come from the j-th group is equal to the weight, W_j, for that group. Let σ_j denote the standard deviation of price relatives within the j-th group. The optimal number of price relatives sampled from the j-th group, n_j, is then given by:[10]

$$\frac{n_j}{W_j\sigma_j}=\frac{n}{\Sigma W_j\sigma_j} \tag{2.2}$$

where $n=\Sigma n_j$. The fixed sample size, n, should be apportioned to the j groups so that the ratio of the sample size, n_j, to the product of the weight times the standard deviation, $W_j\sigma_j$, is the same for all groups. Given that the weights are estimated accurately, this procedure will yield the best unbiased estimate of the true average price relative for the set of all prices.[11]

The sampling procedure outlined in the preceding paragraphs may appear impractical. However, the method employed in collecting the price relatives for the Wholesale Price Index (WPI), resemble this precise procedure. The Bureau of Labor Statistics relies on industry opinions to determine the number and specific prices included in the WPI. In a sense, a priori estimates of the weights and variances by knowledgeable persons are substituted for empirical estimates for these magnitudes.

The procedure is particularly promising for constructing a freight rate index. For example, virtually all less-than-carload and less-than-truckload traffic moves on class rates. The variance of price relatives sampled from class tariffs is extremely small; indeed, a sample of a single rate would probably suffice. At present, a vast amount of rate data are available in the tariffs filed by all common carriers. Preliminary investigations on the variance in price relatives for various traffic categories might indicate rather modest sample size requirements. In this case, a fairly small continuing sample could provide a fairly accurate freight rate index for all common carriers. In this study, the number of rates sampled was determined solely by the weight assigned to each traffic category. Limitations of time and resources prohibited estimation of the variances.

III. The Market for Highway Transportation

A. ROLE OF THE COMMON CARRIER IN HIGHWAY TRANSPORTATION

The market for highway transportation is divided into two broad sectors—regulated and nonregulated. In the past 11 years, the exempt segment of the motor carrier industry generated over 60 percent of the total intercity ton-miles of freight. The exempt or nonregulated carriers are principally those operating under the agricultural exemption to the Interstate Commerce Act plus the proprietary operations of many individual shippers. Little published data are available on the commodities handled or the rates at which such services are provided. These exempt and private operations are conducted under essentially free market conditions, including competitive rates and freedom of entry.

In a study published by the ICC, utilizing data derived in a 1955 Bureau of Public Roads survey, two interesting facts were revealed

[10] G. U. Yule and M. G. Kendall, *An Introduction to the Theory of Statistics*, New York: Hafner Publishing Co., 1950, p. 533. Paul G. Hoel, *An Introduction to Mathematical Statistics*, New York: John Wiley & Sons, Inc., 1947, p. 226.

[11] An optimal sampling procedure could also be developed by imposing a budget constraint together with different costs of sampling for each of the j groups.

about the North Central Region.[12] First, the East North Central Census Region[13] comprised only 14.1 percent of main rural road mileage, yet this region generated 20.9 percent of the total intercity motor carrier ton-miles. Second, this region accounted for 28.6 percent of the authorized (regulated) ICC intercity ton-miles of freight. For the States of Illinois, Indiana, Ohio, Michigan, and Wisconsin, the percent of exempt to total ton-miles was less than 47 percent as opposed to over 60 percent in all other regions except one. These facts point to a higher utilization of highway transportation in the Central States and an even greater use of the regulated carriers.

Although regulated freight service is provided by both common and contract carriers, an increasing proportion of common carriers is operating in a manner formally attributable to the contract carrier. These include increased use of specialized commodity and equipment service, restriction of service to truckload volume, and devotion to the needs of a limited number of shippers. For our purposes, a distinction should be made between the general commodity and specialized commodity carriers. The latter camp includes both the contract and specialized common carrier.

A brief discussion of the characteristics associated with a special commodity carrier may help to explain their relative growth.

These carriers have (1) minimal terminal facilities, at best parking and servicing facility for the rolling stock, (2) a modest office for billing, and (3) a telephone through which the shipping public makes its contact. In many instances, whole fleets operate without these facilities; equipment is parked on the shipper's property or at the owner-operator's residence. Widely varying loading practices exist, with shippers in some cases performing the loading operation. Although several stops or deliveries might be made to complete unloading, the unit tendered the carrier is a full load, and the charges are based thereon. Labor and other expenses are directly allocable to the line haul movement, with little overhead expense. Often drivers have been specially trained in both the handling of the product and the shipper's or consignee's methods and operation; carrier's personnel may be given keys to enter customer's premises and to load or unload at all hours of the day or night. Higher state size and weight limits, together with technological improvements, have led to greater revenue producing capacity by increasing loads on truckload shipments. Durability and service life of the equipment have also increased over time, tending to offset the secular increase in unit factor costs. For example, the labor input (as measured by man-hours) per ton-mile has declined over time; however, this has been offset by an increase in the wage rate.[14]

The general commodity common carrier is characterized by (1) scheduled service on regular routes, (2) acceptance of all shipments from the public, and (3) wide territorial coverage, either through single line service or joint service with other common carriers. The

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[12] Bureau of Transport Economics and Statistics, ICC, *Truck Traffic on Main Rural Roads, 1955, ICC Authorized, Other for Hire and Private Carriers,* Statement No. 5710, (Washington, D.C.) July 1957, pp. 22, 23, 24–28.

[13] This region includes Illinois, Indiana, Michigan, Ohio, and Wisconsin.

[14] See American Trucking Associations, Inc., *American Trucking Trends,* 1959, Washington 6, D.C., p. 30. Also earlier years for regional series of operating costs on vehicle-mile basis, beginning with *Trends*, 1950. See also mileage and hourly scales in *Central States Area Over-the-Road Motor Freight Agreement,* Central States Drivers Council, Nov. 16, 1945, to the present. I.B.T.C.W. and H., A.F. of L. Local 710, Chicago, Ill.

general commodity spectrum for the motor common carrier is narrower than that for the rail due to the exceptions written into every general commodity authorization granted by the regulatory agency. These exceptions read as follows: "General Commodities except those of unusual value, Class A and B explosives, Household Goods as defined by the Commission, Commodities in bulk, and those requiring special equipment." Finally, the physical dimensions of the equipment prohibit the shipment of outsized or extremely heavy pieces of freight via motor carriers.

The equipment roster of the general commodity carrier is substantially larger than the specialized carrier because of the assembly and distribution of small lot freight in the city terminal area. In turn, the small lot freight results in higher terminal and administrative costs. For example, the general commodity carrier requires greater floor space for sorting and assembly, additional freight handling equipment, larger clerical staffs to process more numerous billings, etc.

Many general commodity operators also engage in some activities which closely resemble those of a specialized operator. Thus, where volumes of traffic are particularly heavy, some operators may concentrate on specific commodities which fall within the general commodity description. In some instances, operators have added special rosters of equipment or organized special divisions to service these particular commodities. This is frequently observed in the handling of "Iron and Steel Products," "Packing House Products," "Roofing and Building Materials," etc. In these instances, service and rates tend to be competitive with any completely specialized carriers in the territory.

Frequently, a general commodity carrier may enter into rate competition with other general commodity carriers, private fleets,[15] or contract and specialized carriers. Such competition typically occurs where the movement constitutes the backhaul, coincident with excess capacity. Again, if traffic is available and equipment idle, these carriers can and do handle exempt agricultural items—often at unpublished rates.

Although technological advances in rolling stock accrue to all motor carriers, these cost savings for a general commodity carrier are offset by certain developments in the terminal zone coverage. The increased congestion at rush hours and at shipper facilities, as well as the greater geographic dispersion of shippers in the terminal zone, results in higher costs for the general commodity operator. Furthermore, during the postwar period, labor costs have increased at a faster rate than any of the other cost items. Since the terminal and assembly operations require fairly intensive use of labor, the cost disadvantage of the general commodity carrier is even further intensified. In 1957, total compensation of all employees, expressed as a percent of total revenues for 94 general commodity common carriers, 40 special commodity common carriers, and 9 contract carriers, were respectively 47.8, 23.3, and 35.8 percent.[16] Part of the lower relative labor cost for the specialized carriers is attributable to a larger portion of equipment leased with drivers. A liberal adjustment to re-

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[15] Some shippers choose to operate private fleets, thereby satisfying their transportation requirements rather than purchasing them from common carriers.

[16] Bureau of Transport Economics and Statistics, Interstate Commerce Commission, *Transport Statistics, U.S., 1957, Part 7, Motor Carriers*, Washington, D.C., 1958, tables 30, 31, and 32.

flect the same leasing portions as the other two groups results in a relative labor cost between 35 and 36 percent of total revenues for the specialized carriers. Finally, the average revenue per vehicle mile for these three groups—general, special, and contract—were found to be 71.7, 41.7, and 34.8 cents, respectively.

Thus, various types of motor carriers provide substantially different services; part of these differences are reflected in cost differentials. Furthermore, the cost differentials between types of motor carriers are widening for three reasons: (1) differences in relative labor costs, (2) increases over time in the relative employment of labor by the general commodity carriers, and (3) increases over time in the unit cost of labor.

Up to now, the discussion has dealt with the characteristics of various sectors of the highway transportation industry. As measured by ton-miles, in 1957 the nonregulated (exempt) sector was twice the size of the regulated (common and contract) sector; in 1943 the nonregulated sector was slightly smaller than the regulated. Between 1943 and 1957, highway transportation increased by 361 percent as compared to an overall increase in all transportation of only 31 percent.[17] Furthermore, over the same period, substantially different growth rates were observed for various sectors within the motor carrier industry. The exempt or nonregulated carriers experienced the highest annual growth rate of 14.1 percent. Common carriers had an annual growth rate of 7.8 percent, while contract (specialized) carriers showed an intermediate annual growth rate of 9.2 percent.[18] It should be pointed out that these annual growth rates were obtained from the ton-mile data for the initial (1943) and terminal (1957) periods.

The preliminary 1958 data indicate that the growth in common carrier ton-miles has virtually ceased despite two opposing factors: (1) an increase in the number of special bulk commodity authorizations granted by the ICC, and (2) the conversion of many contract carriers to common carrier certificates as a result of 1957 legislation which redefined contract carriers. In its last four annual reports, the ICC has commented at length on the increasing number of specialized commodity applications to serve particular commodities; notably frozen foods, bulk liquids, and bulk cement.

This trend in the relative decline of general commodity traffic is also mentioned in the annual reports of many general commodity carriers. Indeed, those firms which have experienced growth in recent years have done so through either mergers or expansion into the special commodity field. Although there has been substantial growth in all highway transportation, the traffic available to the general commodity carrier has declined for two reasons. First, when the volume of shipments becomes sufficiently large, a shipper may find it profitable to employ his own private fleet. Second, heavy traffic in a specific commodity encourages the formation of specialized carriers, even though this traffic is generated by a large number of shippers. Both reasons point toward an even narrower field in the future for the gen-

[17] U.S., Congress, Senate, Subcommittee of the Committee on Interstate and Foreign Commerce, Hearings, *Problems of the Railroads, Part I*, 85th Congress, 2d Session, 1958, p. 60. *72d Annual Report*, Interstate Commerce Commission, Washington, 1958, p. 12.

[18] Bureau of Transport Economics and Statistics, Interstate Commerce Commission, *Statistics of Class I, II and III Motor Carriers 1939–1956*, Statement No. 589, July 1958, p. 17.

eral commodity carrier. However, the small shipments (less than truckload) still remain in the domain of the general commodity carrier.

Thus, a motor freight rate index confined to common carrier truckload freight applies to, at most, one-third of the market for highway transportation. In addition, if historic trends continue, the common carrier share of the market will decline. These considerations should be kept in mind, both in interpreting the motor freight rate index presented in this study and in any future attempt to estimate a motor freight rate index for all highway transportation.

B. MECHANICS OF RATE DETERMINATION

Each motor carrier certificated as a common carrier must file a tariff with the Interstate Commerce Commission which requires strict adherence to the rates published in this tariff. For both rail and motor common carriers, the majority of these tariffs are prepared by ratemaking bureaus. In the Central States territory, approximately 800 carriers are joined together in a single rate-publishing bureau, the Central States Motor Freight Bureau. The dominant role played by these ratemaking bureaus warranted further investigation. What is the actual procedure followed in effecting a rate change?

The typical motor freight bureau is too large to permit active participation by all member firms on each decision taken by the bureau. Thus, the bureau's bylaws and procedures specify a method of selecting a board of directors from its member firms. In turn, a manager and a staff, answerable only to the bureau, are then employed by the board of directors. All rate decisions are then channeled through two committees: (1) a standing rate committee consisting of employees of the bureau, and (2) an appellate committee, ordinarily selected from the board of directors.

A proposed rate change is initially submitted to the standing rate committee, together with the supporting justification and background data. The proposal is then issued a docket number and publicized in a regularly issued docket bulletin distributed to all member firms. At least fifteen days' notice must be given prior to the scheduled hearing on the proposal; such hearings are scheduled at regular intervals, usually monthly. At the hearing the standing rate committee receives any opposition or additional support for the proposal. Once the matter has been thoroughly investigated and considered, the committee arrives at a disposition. The recommended disposition is then publicized and a reasonable time allowed for member firms to raise objections. Within thirty days of the disposition's publication, all objections must be supported by written statements supplying the reasons for the objection.

After these objections are published, a hearing is scheduled by the appellate committee. If they so choose, the committee may defer action for as long as a year following the first hearing. After due consideration, the committee arrives at a final recommended disposition; however, the committee retains the option to reconsider this "final disposition" at any time within a year. If no additional objections are raised within fifteen days following the final disposition's publication, then the recommendation is incorporated into the organization's tariff. A proposed rate change must pass through these stages before it is filed with the ICC. Furthermore, it must be filed at least thirty days before the effective date of the proposed change.

An emergency procedure is accorded members for a limited number of reasons; principally (1) to correct errors in the tariff, (2) to satisfy national defense needs, and (3) to meet the competitive practices of other common carriers. Under this procedure, a carrier must file his proposal together with evidence supporting the emergency nature of this proposal. Even then, the standing rate committee has up to fifteen days to pass judgment on the matter; indeed, they can deny emergency action, thereby requiring adherence to the regular procedure. However, if the emergency nature of the proposal is granted, action is usually quite prompt.

Through this entire procedure, the one spur to prompt action is a provision which guarantees independent action by any member firm. A carrier may have a proposed rate change published on his own account either initially or at any stage during the regular procedure. Such action is also publicized and fifteen days allowed to receive requests from any competitors who wish to join in this action. Under the rules of the Commission, the bureau or any of its members may protest the publication and request an investigation by the Commission. If the proposed rate change results in a noncompensatory rate,[19] then the publication may be suspended by the Commission. Such independent action is not encouraged by the bureau and is rarely undertaken by member firms. Where it does occur, protests are frequently filed by either the bureau or member firms with the result, in many cases, of delaying the effective date of the proposed rate change.

In summary, two major features emerge from an investigation of the procedures employed by ratemaking bureaus in effecting rate changes. First, wide publicity is accorded every proposed rate change. Second, a vast amount of time and resources are consumed in making any rate change. Under these circumstances, one would not expect rates to reflect minor fluctuations in the demand and supply of motor carrier services. Indeed, a persistent or substantial change in market conditions must prevail before it elicits an adjustment in freight rates. Consequently, it was not surprising to find that the frequency of rate change in the four years covered by this study was quite small.

IV. The Weights: Commodity Composition of Common Carrier Truckload Freight in the Central States Territory

As discussed in Section II, any index number must refer to some set or universe of commodities or services. In this study the motor freight rate index refers to a subset of all highway transportation services; specifically, the set of all common carrier truckload freight in the Central States territory. All truckload shipments were classified into individual commodity groups; the definition of the groups was dictated by the data.[20]

[19] A noncompensatory freight rate is one which is less than the "out-of-pocket costs" for that particular service. The "out-of-pocket costs" may be estimated by use of a cost formula such as, "Simplified Procedure for Determining Costs of Handling Freight by Motor Carriers," prepared by the Cost Finding Section of the ICC, Bureau of Accounts, Cost Finding and Valuation, August 1959.

[20] *Motor Carrier Commodity Freight Statistics, Class I Common and Contract Carriers of Property for the Years Ending 1956, 1957, and 1958.* Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Statement Nos. 596, 5815, and 5718.

The appropriate weight for each commodity according to the method outlined in Section II is the share of total revenue generated by that commodity.[21] To minimize the year-to-year fluctuations, revenues were averaged for the three years, 1956 to 1958. By eliminating all commodities which generated less than 0.007 percent of total revenues, the list of commodities was reduced to 170. These weights, based on the 1956–58 average revenues, ranged from a low of 0.007 percent for sulfur to a high of 26.662 percent for motor vehicles.

The frequency distribution of the 170 commodities classified by weight reveals a sharply skewed distribution as can be seen in Table 1. The 20 commodities, each of which generated over 1 percent of total revenue, comprise only 12.8 percent of the total number of commodities transported; yet they account for 70.6 percent of total revenues from all commodities. On the other hand, 41.9 percent of the commodities fell into the smallest weight class (0–0.099 percent) and accounted for only 3.3 percent of total revenues. As a result, the motor freight rate index will be dominated by the rate movements for a relatively small number of commodities.

TABLE 1.—*Frequency Distribution of Commodities by Number and Weight for the Central States Territory, 1956–58*

Weight class	Number of commodities	Percent of—	
		Total number	Total weight
0 to 0.099	72	41.9	3.3
0.100 to 0.199	31	18.0	4.4
0.200 to 0.299	16	9.3	4.0
0.300 to 0.399	9	5.2	3.1
0.400 to 0.499	4	2.3	1.8
0.500 to 0.599	5	2.9	2.7
0.600 to 0.699	4	2.3	2.7
0.700 to 0.799	4	2.3	3.0
0.800 to 0.899	3	1.7	2.6
0.900 to 0.999	2	1.3	1.8
1.000 and over	20	12.8	70.6
Total	170	100.0	100.0

SOURCE.—*Motor Carrier Freight Commodity Statistics*, years ending 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, statement Nos. 596, 5815, and 5718.

Thus far, the year-to-year fluctuations in the commodity composition of total revenues for the Central States have been neglected. For the major commodity groups and for selected individual commodities,[22] revenue and tonnage data are presented in Table 2 for each of the 3 years included in the average. Although the revenue shares by commodity group fluctuate from year to year, the order of magnitude for each commodity remains fairly stable. The effect of using a single year's weights, rather than the 3-year average weights is demonstrated in Table 11 below. The discrepancy between revenues and tonnages are due to both differences in freight rates per hundredweight and differences in the distance profile of shipments.

[21] Freight revenue and weight data for truckload freight are classified by territory according to the domicile of the reporting carriers. To the extent that a proportionally larger number of interterritorial carriers are domiciled in the Central States Territory, a bias is introduced, overstating revenues for this territory.

[22] The commodities with the highest weights were selected.

TABLE 2.—*Commodity Composition of Common Carrier Truckload Traffic for the Central States Territory, 1956–58*

Commodity class	1956				1957				1958			
	Revenue		Short tons		Revenue		Short tons		Revenue		Short tons	
	Dollars (000)	Percent	(000)	Percent	Dollars (000)	Percent	(000)	Percent	Dollars (000)	Percent	(000)	Percent
Products of agriculture	3,712	0.74	243	0.54	2,921	0.57	182	0.42	3,316	0.67	222	0.55
Animals and products	24,616	4.91	1,215	2.69	21,082	4.14	1,029	2.39	23,479	4.77	1,098	2.71
Meats, fresh, NOS	11,884	2.37	533	1.18	10,143	1.99	459	1.07	12,227	2.49	494	1.22
Products of mines	3,275	.65	766	1.70	3,989	.78	891	2.07	3,406	.69	855	2.11
Products of forests	1,615	.32	158	.35	1,489	.29	117	.27	1,401	.28	104	.26
Manufactures and miscellaneous	465,579	92.84	42,465	94.09	473,271	92.84	40,282	93.70	453,529	92.21	37,832	93.24
Gasoline	9,978	1.99	4,492	9.95	11,144	2.19	5,083	11.80	10,778	2.19	4,818	11.87
Fuel (residual oils)	9,196	1.83	4,224	9.36	8,304	1.63	3,771	8.77	9,079	1.85	4,094	10.09
Chemicals, NOS	13,072	2.61	1,254	2.78	15,287	3.00	1,311	3.05	15,675	3.19	1,442	3.55
Paint, paint material, putty	6,515	1.30	455	1.01	6,558	1.29	446	1.04	6,983	1.42	448	1.10
Plastics	7,763	1.55	466	1.03	7,878	1.55	463	1.08	8,470	1.72	477	1.18
Aluminum	5,426	1.08	365	.81	4,890	.96	315	.73	4,871	.99	206	.73
Copper, brass, bronze	8,123	1.62	573	1.27	7,854	1.54	470	1.09	7,318	1.49	441	1.09
Iron and steel, bar rod slab	8,448	1.68	1,162	2.57	6,064	1.19	857	1.99	4,642	.94	630	1.55
Iron and steel, NOS	25,923	5.17	3,638	8.06	17,654	3.46	2,621	6.10	16,640	3.38	2,351	5.79
Manufacturing iron and steel	27,527	5.49	3,001	6.65	28,261	5.54	2,750	6.40	24,464	4.97	2,530	6.24
Machinery and machines	13,157	2.62	717	1.59	13,665	2.68	664	1.54	11,845	2.41	557	1.37
Machinery parts	6,828	1.36	508	1.13	6,805	1.33	452	1.05	5,561	1.13	308	.76
Autos, passenger	72,809	14.52	2,699	5.98	104,328	20.47	3,673	8.54	97,140	19.75	3,156	7.78
Autos, freight	9,064	1.81	267	.59	8,546	1.68	283	.66	7,626	1.55	227	.56
Vehicles, motor, NOS	7,305	1.47	370	.82	6,427	1.26	305	.71	6,479	1.32	205	.51
Vehicle parts, NOS	39,301	7.84	3,009	6.67	27,224	5.34	2,199	5.11	25,722	5.27	1,899	4.68
Electrical equipment and parts, NOS	13,013	2.59	752	1.67	12,603	2.47	669	1.56	11,697	2.38	612	1.51
Liquors, alcoholic, NOS	8,624	1.72	553	1.23	7,595	1.47	437	1.02	7,421	1.51	413	1.02
Food products, NOS, not frozen	11,915	2.38	890	1.97	10,554	2.07	790	1.84	11,422	2.32	839	2.07
Soap, cleaning and washing compounds	6,443	1.28	495	1.10	6,139	1.20	475	1.10	6,645	1.35	523	1.29
Manufactures and miscellaneous, NOS	22,231	4.43	1,323	2.93	22,645	4.44	1,243	2.89	24,905	5.06	1,302	3.21
All commodities	501,498	100.00	45,133	100.00	509,772	100.00	42,994	100.00	491,836	100.00	40,576	100.00

SOURCE: *Motor Carrier Freight Commodity Statistics*, years ending 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, statement Nos. 596, 5815, and 5718.

Finally, a comparison of the commodity composition of common carrier freight was made between the Central States territory and the rest of the United States. The revenue data, classified by major commodity group, are presented in Table 3. Some differences in the commodity composition of freight are evident from an inspection of

TABLE 3.—*Commodity Composition of Common Carrier Truckload Traffic by Revenue for Selected Commodities, Central States, and United States, 1956–58*

	1956			1957			1958		
	United States	Central States	Rest of U.S.	United States	Central States	Rest of U.S.	United States	Central States	Rest of U.S.
Revenue (millions of dollars):									
All commodities	1,454.1	501.5	952.6	1,575.3	509.8	1,065.5	1,526.5	491.8	1,034.7
Agriculture	39.7	3.7	36.0	44.8	2.9	41.9	47.3	3.3	44.0
Animals and products	87.4	24.6	62.8	91.5	21.1	70.4	92.2	23.5	68.7
Mining	26.2	3.3	22.9	28.5	4.0	24.5	26.8	3.4	23.4
Forests	8.6	1.6	7.0	9.1	1.5	7.6	9.5	1.4	8.1
Manufacturing and misc	1,286.3	465.6	820.7	1,390.1	473.3	916.8	1,340.0	453.5	886.5
Percent distribution: [1]									
All commodities	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture	2.7	.7	3.8	2.8	.6	3.9	3.1	.7	4.3
Animals and products	6.0	4.9	6.6	5.8	4.1	6.6	6.0	4.8	6.6
Mining	1.8	.7	2.4	1.8	.8	2.3	1.8	.7	2.3
Forests	.6	.3	.7	.6	.3	.7	.6	.3	.8
Manufacturing and misc	88.5	92.8	86.2	88.2	92.8	86.0	87.8	92.2	85.7

[1] Percents do not add to 100 due to exclusion of freight forwarder traffic.

SOURCE: *Motor Carrier Freight Commodity Statistics*, years ending 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, statement Nos. 596, 5815, and 5718.

this table. The most important major commodity group, "Manufactures," accounts for a slightly higher percentage of total revenues in the Central States than in the rest of the United States. Finally, freight revenues in the Central States comprise roughly one-third of the total freight revenues of all common and contract carriers. Thus, an index for the Central States territory applies to a substantial portion of the entire common carrier motor freight industry.

V. THE PRICE RELATIVES

An individual freight rate or price corresponds to the movement of a given commodity between two specified points. In this study, the universe of all common carrier truckload freight rates for the Central States territory was stratified by commodity into 170 individual commodity groups. Within each commodity group there are a large number of rates representing different point-to-point movements or slightly different commodities within the same commodity group.[23] For each commodity, a sample of freight rates was collected; for many commodities, this sample consisted of a single freight rate.[24] An attempt was made to collect more rates for those commodities with larger weights, as would be indicated by the theory of stratified

[23] For example, within the major group, "Motor Vehicles," different rates are quoted for automobiles, tractors, trucks, etc.

[24] The list of commodities, together with the number of rates sampled, is presented in Appendix A.

sampling. However, a random sample within each commodity group is inappropriate, since some rates have higher probabilities of being observed than other rates. A brief résumé of the institutional framework of the market for highway transportation provides the rationale for the sampling procedure employed in the study.

In the Central States territory, the majority of the general commodity carriers belong to the Central States Motor Freight Bureau.[25] The Bureau assumes the function of publishing and revising the tariffs for all its member firms. Although some carriers may publish independent tariffs, the bulk of the general commodity traffic comes under the jurisdiction of the CSMFB.

The multitude of tariffs published by the CSMFB are of three basic types: (1) the class tariff, (2) the general commodity tariff, and (3) the special commodity tariff. The class tariff has the widest territorial coverage and the lowest priority. If the freight rate for a particular shipment cannot be found in either of the other two kinds of tariffs, then a class rate shall apply. This tariff, for truckload shipments, gives freight rates as a function of the distance shipped for thirteen classes of commodities.[26]

Unlike the class tariff, the general commodity tariff specifies a freight rate per hundredweight for a given point-to-point shipment of a particular commodity. In December 1959, six general commodity tariffs were published by the CSMFB. Each tariff designates different geographic subregions by either points of origin and/or points of destination. For example, Commodity Tariff No. 555 applies to shipments with origins in Chicago-Gary and points along the Mississippi in Illinois, Iowa, and Missouri, to virtually all destinations in the Central States Territory. In some instances, coverage by a commodity tariff is quite narrow; for example, there is a tariff for shipments between Chicago and Milwaukee.

Finally, the special commodity tariffs are published for specific commodity groups. In general, such "special tariffs" occur where volumes of shipments are highest. For example, "special commodity tariffs" are published for "packinghouse products," "flavoring syrups," "iron and steel products," etc.

For general commodity traffic, the price relatives were taken from (1) General Commodity Tariff No. 555, and (2) the class tariff. A specific "commodity point to point" freight rate (or rates where more than one was taken) was attached to each of the 170 individual commodity groups. The starting point was the "555" tariff which was in effect on December 31, 1959. If the commodities included in a commodity group could not be found in the 555 tariff, then they were assumed to move on class rates. As a result, 76 commodities, comprising 15.95 percent of total freight revenues, were assumed to move entirely on class rates.[27]

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[25] The Central States Motor Freight Bureau will hereafter be denoted by its initials, CSMFB.

[26] For a commodity moving on a class rate, the first step is the classification of that commodity into one of the 13 classes. The distance of the point-to-point movement then determines the rate per hundredweight.

[27] To the extent that some of these 76 commodities move on other than class rates, this assumption tends to understate the frequency of rate changes and overstates the increase over the 4 years covered by the present study. The magnitude of this error cannot be estimated without additional data on the proportion of these commodities moving on other than class rates. It has also been implicitly assumed that the remaining 80 commodities move entirely on commodity rates. Insofar as some of these 80 commodities are moved on class rates, an offsetting error is introduced.

From January 1956, to December 1959, three increases were effected in the class tariff. In all three, the same percentage increase was applied to all class ratings. The practice of an "across the board" percentage increase was altered in the rate increase which became effective in June 1960. In this last change, all class rates were increased by the same nominal amount of 2 cents per hundredweight. The percentage increases in the entire class tariff were used to generate the price relatives for all 76 commodities moving on class rates. The price relative for each month represented the ratio of the rate in effect at the end of the month relative to the average rate for the year, 1957. This procedure concealed any rate changes resulting from revisions in the commodity classification, included in the "Exceptions" to the class tariff. Lower class ratings correspond to lower freight rates. Hence, a change in the commodity classification, moving commodities to different class ratings, means a change in the freight rates for these commodities. These rate changes were neglected in the present study, since additional waybill statistics would be required to make the appropriate adjustments.

For the remaining 80 commodities, the freight rate for a specific "commodity point to point" movement is found in the General Commodity Tariff by first finding its appropriate "item number." This item number then defines the rate. Thus, the same item number may correspond to different commodities or different point-to-point movements. Between 1956 and 1959, four general percentage increases were found for the 555 tariff. However, individual freight rates may have experienced more or less than four rate changes during this period due to either changes included in the numerous supplements or "flagouts" to the general rate change.[28] The influence of both of these latter two factors is caught by our procedure of tracing the rate histories for each of the 194 individual freight rates. Thus, if our sample of 194 rates is truly random, then the probability of changes included in the supplements or through "flagouts" is the same for both our sample and the universe of all commodity rates.

A major criticism of our sampling procedure is that all of the rates were taken from the 555 tariff, although six general commodity tariffs are published by the CSMFB. A casual inspection indicated that the timing and magnitude of the general rate changes were similar for all six tariffs. To verify this fact, a sample of freight rates for comparable commodities was collected from General Commodity Tariff No. 558. A comparison of the rate histories, obtained from the 555 and 558 tariffs, is presented in table 4. Although some minor discrepancies are revealed, a close similarity is observed in the behavior over time for the rates sampled from these two tariffs. Thus, no systematic error appears to have been introduced by confining the sample to the 555 tariff.

Although "Iron and Steel Products" are nominally included within the general commodity description, a sufficient volume of freight is generated within the Central States to warrant the publication of a special commodity tariff by the CSMFB. Freight rates for steel products may be found in other tariffs; however, relatively few ship-

[28] A "flagout" is a term employed in the trucking industry to designate an exception to a general rate increase.

TABLE 4.—*Comparison of Price Relatives From 2 General Commodity Tariffs*

Commodity	Tariff 555		Tariff 558	
	Date of rate change	Price relative	Date of rate change	Price relative
1. Furniture	May 1956	96.0	May 1956	94.1
	December 1956	95.0	August 1956	100.0
	March 1957	101.6	September 1958	107.3
	September 1958	108.7		
2. Chemicals	May 1956	94.9	May 1956	95.5
	March 1957	101.7	March 1957	101.5
	September 1958	108.4	September 1958	108.6
3. Food products, canned	May 1956	97.2	May 1956	95.9
	August 1956	95.0	March 1957	101.4
	March 1957	101.6	September 1958	109.6
	September 1958	108.2		
4. Packing house products	September 1956	95.1	May 1956	96.4
	March 1957	101.6	July 1956	95.0
	September 1958	109.0	March 1957	101.6
			September 1958	108.2
5. Pulpboard, paperboard	March 1956	95.7	March 1957	101.6
	March 1957	101.4		
	September 1958	109.0		

ments are made at these rates. Consequently, the price relatives for "Iron and Steel Products" were taken from this special tariff.[29]

The transportation of motor vehicles and bulk liquids accounts for 29.113 percent of the total revenue generated by common carrier truckload freight in the Central States territory. These commodities are transported by specialized common carriers who remain outside of the conference of general commodity carriers. The limited number of commodities transported by these carriers permits the publication of independent tariffs. However, a large number of vehicle carriers are joined together in a national ratemaking bureau, the National Automobile Transporters Association.

Freight rate histories for bulk liquid commodities (notably gasoline, fuel oil, asphalt, acids) were obtained from the Rogers Cartage Company—one of the leading bulk liquid carriers in the Central States territory. Freight rates for auto shipments were obtained from the Arco Company for shipments out of Detroit, South Bend, and Kenosha. Vehicle rates were particularly interesting, since they were quoted on either a "per hundredweight" or a "per vehicle" base. Differences resulting from the use of the two bases are discussed in Section VI below. Again, one might criticize the use of a single tariff in the case of bulk liquid commodities. However, industry opinion as reflected by conversations with several truckers indicates a high correlation between rates charged by different firms.

Finally, one might criticize the extremely small sample employed in this study. In any index number, the appropriate sample size depends on the degree of accuracy desired and the variance of price relatives within each commodity group. Indeed, if the variance in price relatives is small, then a sample of as few as one observation may suffice. An experiment was undertaken to ascertain the magnitude of the error introduced through small sample sizes. For some commodities with large weights, several individual freight rates were sampled. The price relative for that commodity was the arithmetic

[29] In the 4 years covered by the index, only one percentage increase was applied to all rates in this tariff. Hence, in Appendix A, the number of rates sampled is not entered The same procedure was employed here as in the case of the class tariff.

average of the price relatives for these individual rates. Random samples of one and two rates were selected and their price relatives computed. The results are summarized in Table 5.

TABLE 5.—*Sampling Variability of the Price Relatives*

Commodity	All rates, average		Sample of 1 rate		Sample of 2 rates	
	Date of rate change	Price relative	Date of rate change	Price relative	Date of rate change	Price relative
1. Autos (hundred-weight rates) (19 rates).	October 1956	100.0	October 1956	100.0	October 1956	100.0
	April 1958	104.8	April 1958	104.8	April 1958	104.8
2. Gasoline (7 rates)	May 1958	101.7	May 1958	101.9	May 1958	97.6
	February 1959	111.8	February 1959	118.9	February 1959	109.7
	March 1959	117.1	March 1959	123.8	March 1959	111.5
3. Electrical equipment, parts, NOS (5 rates).	May 1956	95.0	May 1956	95.7	May 1956	95.4
	August 1956	97.0	March 1957	101.4	August 1956	98.0
	March 1957	101.0	September 1958	108.9	March 1957	100.6
	September 1958	107.9			September 1958	107.6
4. Soap and cleaning compounds (4 rates).	May 1956	92.2	August 1956	94.6	May 1956	90.4
	August 1956	94.6	March 1957	101.7	August 1956	94.5
	March 1957	101.8	September 1958	108.8	March 1957	101.8
	September 1958	107.5			September 1958	109.2
5. Machinery and machines (8 rates).	May 1956	90.6	June 1956	95.4	June 1956	94.7
	June 1956	93.4	August 1956	94.9	July 1956	96.3
	July 1956	94.5	March 1957	101.6	August 1956	95.9
	August 1956	95.1	September 1958	108.8	March 1957	101.2
	March 1957	101.6			September 1958	106.1
	September 1958	107.7				
	June 1959	108.1				

In the four years 1956 to 1959 the number of rate changes for a single freight rate was typically quite small; for our sample, the maximum number of rate changes was seven. This is evident for the price relatives of the five commodities selected for Table 5. In addition, the rate changes tend to cluster at certain points in time. Both findings are not surprising in light of the costs and delays involved in effecting rate changes.

The maximum discrepancy between the price relative for "all rates" and the price relative for the sample of either one or two rates was found for "Gasoline." The variance in price relatives indicated by this discrepancy is quite large. The interesting feature of the gasoline rates is that prior to the change in May 1958, the rates had remained fixed for over four years. The observed variance in the price relatives for automobiles is virtually zero; a sample of one rate would have sufficed here. Finally, some of the minor discrepancies in the price relatives are attributable to the rounding of rates to the nearest penny in any general percentage increase.[30]

In summary, an adequate sample size depends on the desired degree of accuracy and the variance in individual price relatives. If the price relative for each commodity is to be estimated to the nearest percentage point, then the actual sample sizes used in this study are clearly inadequate for some commodities. This is obvious in the case of "Gasoline." In retrospect, the sample sizes for commodities such as "Gasoline" and "Soap and Cleaning Compounds" should have been increased, whereas the number of rates sampled for "Automobiles" is clearly too large.

[30] A 6-percent increase applied to a tariff leads to the same 2-cent increase for all freight rates between 25 and 41 cents. In this case, the same 6-percent increase resulted in effective percentage increases of 8 and 5 percent, respectively.

Before turning to the final index numbers, two additional points should be mentioned. First, are the tariff rates truly representative of actual prices paid by shippers, or are they like the list prices for new automobiles? Second, have there been any significant changes in the quality of service provided by motor common carriers?

Actual rates may differ from published tariff rates through either a misclassification of commodities or outright chiseling. The latter method is rarely practiced, since, if it can be proven, both operator and shipper may be held criminally liable.[31] Penalties for chiseling include forfeiture of licenses, as well as fines or imprisonment. Due to the sizable rate differentials by commodities, misclassification of goods can result in significant rate reductions. To guard against such practices, many ratemaking bureaus establish policing staffs, whose sole function is to inspect shipments and waybills for misclassifications. In the absence of data from these policing departments, it is impossible to estimate the extent of such informal rate cutting.

The term "quality," as applied to transport services, connotes various things including reliability, speed, safety, loading and unloading of cargos, and frequency of departures. The two elements which are most readily identifiable are speed and the loading services. In the last decade, improvements in highways have resulted in slightly higher over-the-road speeds for trucks. However, the reduction in transit time, resulting from these improvements, has been offset in many instances by increasing congestion in cities and by geographic constraints.[32]

The loading service is a far more significant item in the quality of transportation provided by an operator. This fact was demonstrated by a recent case in the Midwest. A fairly large shipper negotiated a lower rate with the Bureau by agreeing to perform the loading and stowing functions. In some cases, shippers have been offered an option whereby they could enjoy lower freight rates by performing the loading or turn this function over to the trucker. A similar phenomenon is observed in the allowances granted shippers for pickup and delivery, sometimes called cartage allowances.[33] In cases where rates are negotiated without these services, some adjustments should be made to reflect the deterioration in the service. In summary, for the last ten years no substantial changes are discernible in the quality of the transport services provided by motor common carriers, with the possible exception of the long haul, transcontinental traffic.

[31] Informal rate reductions may be profitable for both shipper and operator. Where the reductions are informal, a given rate reduction is more likely to attract a greater increase in the volume of traffic for an individual operator.

[32] Speed is of value to a shipper only insofar as it affects transit time. The value of reduced transit time to a shipper is not a continuous function of time. For many point-to-point movements, all that is desired by shippers is overnight service. Thus, for routes under 350 miles, time saving from greater truck speeds is of no value to the shipper since earlier arrival of goods must await opening of warehouses and shops in the morning. These short hauls greatly diminish the value of greater truck speeds through improvements in highways or technological advances in rolling stock.

[33] The allowance is granted the shipper if he delivers his goods directly to the terminal rather than have the truck operator perform this function.

VI. An Index of Motor Freight Rates, 1956 to 1959

The motor freight rate index constructed in this study refers to the set of all common carrier truckload freight shipments in the Central States territory. The methods used in estimating the weights and price relatives for the individual commodity groups were described in Sections IV and V above. The price relatives were combined into a single motor freight rate index by substituting the estimated weights, W_j, and the price relatives, X_{jt}, into the Laspeyres formula defined in equation (2.1). The index was benchmarked to a base period of 1957, even though the weights apply to the average quantities shipped during the three years, 1956–58.

Table 6.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Major Commodity Class*

[1957=100]

Year and month	Products of agriculture	Animals and products	Products of mines	Products of forests	Manufactures and miscellaneous	All products
1956—January	90.4	89.8	89.1	89.1	90.8	90.7
February	90.4	89.8	89.1	89.1	91.5	91.4
March	90.4	89.8	89.1	89.1	91.5	91.4
April	90.4	89.8	89.1	89.1	91.5	91.4
May	90.4	90.5	91.8	89.1	93.3	93.1
June	91.2	91.9	93.7	94.4	95.3	95.1
July	91.2	92.3	93.7	94.4	95.4	95.2
August	91.1	93.7	93.7	94.4	95.8	95.6
September	91.1	93.8	93.7	94.4	95.8	95.7
October	91.1	93.8	93.7	94.4	96.6	96.4
November	91.1	93.8	93.7	94.4	96.6	96.4
December	91.2	94.4	94.5	94.4	96.6	96.5
Average	90.8	91.9	92.1	92.2	94.2	94.1
1957—January	91.2	94.4	94.5	94.4	96.6	96.5
February	91.2	94.4	94.5	94.4	96.7	96.5
March	100.4	101.1	101.1	101.1	100.4	100.4
April	101.9	101.1	101.1	101.1	100.4	100.4
May	101.9	101.1	101.1	101.1	100.6	100.6
June	101.9	101.1	101.1	101.1	100.6	100.6
July	101.9	101.1	101.1	101.1	100.6	100.6
August	101.9	101.1	101.1	101.1	100.6	100.6
September	101.9	101.1	101.1	101.1	100.9	100.9
October	101.9	101.1	101.1	101.1	100.9	100.9
November	101.9	101.1	101.1	101.1	100.9	100.9
December	101.9	101.1	101.1	101.1	100.9	101.0
Average	100.0	100.0	100.0	100.0	100.0	100.0
1958—January	101.9	101.1	101.1	101.1	100.9	101.0
February	101.9	101.1	101.1	101.1	100.9	100.9
March	101.9	101.1	101.1	101.1	100.9	100.9
April	101.9	101.1	101.1	101.1	101.3	101.3
May	101.9	101.1	101.1	101.1	101.6	101.5
June	101.9	101.1	101.1	101.1	101.6	101.6
July	101.9	101.0	101.1	101.1	101.6	101.5
August	100.6	101.0	101.1	101.1	101.6	101.5
September	107.2	106.6	107.6	108.2	105.5	105.6
October	107.2	106.6	107.6	108.2	105.5	105.6
November	107.2	106.6	107.6	108.2	105.6	105.4
December	107.2	106.6	107.6	108.2	105.6	105.7
Average	103.6	102.9	103.3	103.5	102.7	102.7
1959—January	107.2	106.6	107.6	108.2	105.6	105.7
February	107.2	106.6	107.6	108.2	106.1	106.2
March	107.2	106.8	107.6	108.2	107.1	107.1
April	107.2	106.8	107.6	108.2	107.1	107.1
May	107.2	106.8	107.6	108.2	107.1	107.1
June	107.2	106.8	107.6	108.2	107.1	107.1
July	107.2	106.8	107.6	108.2	107.1	107.1
August	107.2	106.8	107.6	108.2	107.1	107.1
September	107.2	106.8	107.6	108.2	107.2	107.2
October	107.2	106.8	107.6	108.2	107.2	107.2
November	107.2	106.8	107.6	108.2	107.2	107.2
December	107.2	106.8	107.6	108.2	107.2	107.2
Average	107.2	106.8	107.6	108.2	106.9	106.9

The index for "All Commodities" is presented in column 6 of Table 6. Next, the set of all 170 individual commodities was classified into five major commodity groups. As a result, freight rate indexes could be constructed for each major commodity group. Since over 92 percent of total freight revenues are generated by "Manufactures," movements in the "Manufactures" index dominates the "All Commodities" index. A finer breakdown was obtained by using the commodity classification employed by the Wholesale Price Index. Freight rate indexes by this latter classification are shown in Table 7.

TABLE 7.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Major Wholesale Commodity Group*

[1957=100]

Year and month	Farm products	Processed foods	Textile products and apparel	Hides, skins, and leather products	Fuel, power, and lighting materials	Chemicals and allied products	Rubber and rubber products	Lumber and wood products
1956—January	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
February	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
March	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
April	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
May	89.4	92.3	90.5	89.1	99.4	94.0	95.6	89.1
June	91.1	93.3	94.4	94.4	99.4	94.5	95.6	94.4
July	91.1	93.5	94.4	94.4	99.4	94.5	95.6	94.4
August	92.3	94.2	96.0	94.4	99.3	94.9	95.6	94.4
September	92.3	94.3	96.0	94.4	99.3	94.9	95.6	94.4
October	92.3	94.3	96.0	94.4	99.3	94.9	95.6	94.4
November	92.3	94.4	96.0	94.4	99.3	94.9	95.6	94.4
December	92.4	94.7	96.0	94.4	99.3	94.9	95.6	94.4
Average	90.9	92.4	92.9	92.2	99.1	92.9	93.4	92.2
1957—January	92.4	94.7	96.0	94.4	99.3	94.9	95.6	94.4
February	92.4	94.7	96.0	94.4	99.3	95.5	95.6	94.4
March	101.5	101.0	100.8	101.1	100.1	101.0	100.2	101.1
April	101.5	101.1	100.8	101.1	100.1	101.0	100.2	101.1
May	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
June	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
July	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
August	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
September	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
October	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
November	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
December	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
Average	100.0	100.0	100.0	100.0	100.0	100 0	100.0	100.0
1958—January	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
February	101.5	101.1	100.8	101.1	99.9	101.0	101.1	101.1
March	101.5	101.1	100.8	101.1	99.9	101.0	101.1	101.1
April	101.5	101.1	100.8	101.1	99.9	101.0	101.1	101.1
May	101.5	101.1	100.8	101.1	101.9	101.0	101.1	101.1
June	101.5	101.1	100.8	101.1	101.9	101.0	101.1	101.1
July	101.5	101.0	100.8	101.1	101.9	101.0	101.1	101.1
August	100.5	101.0	100.8	101.1	101.9	101.0	101.1	101.1
September	108.0	106.4	108.2	108.2	102.7	107.1	105.1	108.2
October	108.0	106.6	108.2	108.2	102.7	107.1	105.1	108.2
November	108.0	106.6	108.2	108.2	102.7	107.1	108.0	108.2
December	108.0	106.6	108.2	108.2	102.7	107.1	108.0	108.2
Average	103.6	102.9	103.3	103.5	101.5	103.0	102.9	103.5
1959—January	108.0	106.6	108.2	108.2	102.7	107.1	108.0	108.2
February	108.0	106.6	108.2	108.2	111.5	107.1	108.0	108.2
March	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
April	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
May	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
June	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
July	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
August	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
September	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
October	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
November	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
December	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
Average	108.0	106.7	108.2	108.2	114.5	107.6	108.0	108.2

TABLE 7.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Major Wholesale Commodity Group*—Continued

[1957=100]

Year and month	Pulp paper and allied products	Metals and metal products	Machinery and motive products	Furniture and other household durables	Nonmetallic minerals—structural	Tobacco manufactures and bottled beverages	Miscellaneous products	All commodities
1956—January	88.9	92.8	89.9	89.1	88.7	89.6	89.0	90.7
February	88.9	92.8	91.6	89.1	88.7	89.6	89.0	91.4
March	88.9	92.8	91.6	89.1	88.7	89.6	89.0	91.4
April	88.9	92.8	91.6	89.1	88.7	89.6	89.0	91.4
May	91.1	93.0	92.9	91.0	93.2	90.3	89.6	93.1
June	93.6	98.2	94.0	94.6	94.4	94.8	94.5	95.1
July	93.7	98.2	94.1	94.6	94.4	94.8	94.5	95.2
August	96.0	98.3	94.4	94.9	95.5	95.0	94.9	95.6
September	96.0	98.5	94.4	94.9	95.5	95.0	94.9	95.7
October	96.0	98.5	96.4	94.9	95.5	95.0	94.9	96.4
November	96.0	98.5	96.4	94.9	95.5	95.0	94.9	96.4
December	96.3	98.5	96.4	94.8	95.6	95.0	94.9	96.5
Average	92.8	96.1	93.6	92.6	92.9	92.8	92.4	94.1
1957—January	96.3	98.5	96.4	94.8	95.6	94.9	94.9	96.5
February	96.3	98.5	96.4	94.8	95.6	94.9	94.9	96.5
March	100.7	100.4	100.1	101.0	100.7	101.3	101.0	100.4
April	100.7	100.3	100.1	101.0	100.7	101.3	101.0	100.4
May	100.7	100.3	100.5	101.0	100.7	101.3	101.0	100.6
June	100.7	100.3	100.5	101.0	100.7	101.3	101.0	100.6
July	100.7	100.3	100.5	101.0	100.7	100.8	101.0	100.6
August	100.7	100.3	100.5	101.0	100.7	100.8	101.0	100.6
September	100.7	100.3	101.3	101.0	100.7	100.8	101.0	100.9
October	100.7	100.3	101.3	101.0	100.7	100.8	101.0	100.9
November	100.7	100.3	101.3	101.0	100.7	100.8	101.0	100.9
December	100.7	100.3	101.3	101.0	102.2	100.8	101.0	101.0
Average	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1958—January	100.7	100.3	101.3	101.0	102.2	100.8	101.0	101.0
February	100.7	100.3	101.3	101.0	102.2	100.8	101.0	100.9
March	100.7	100.3	101.3	101.0	102.2	100.8	101.0	100.9
April	100.7	100.3	102.2	101.0	102.2	100.8	101.0	101.3
May	100.7	100.3	102.5	101.0	102.2	100.8	101.0	101.5
June	101.7	100.3	102.5	101.0	103.2	100.8	101.0	101.6
July	100.7	100.3	102.5	101.0	102.1	100.8	101.0	101.5
August	100.7	100.3	102.5	101.0	103.0	100.8	101.0	101.5
September	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.6
October	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.6
November	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.4
December	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.7
Average	103.3	101.2	103.2	103.7	104.0	103.5	103.9	102.7
1959—January	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.7
February	108.4	102.9	105.6	109.1	107.2	108.5	109.7	106.2
March	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
April	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
May	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
June	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
July	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
August	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
September	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
October	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
November	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
December	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
Average	108.4	103.0	106.9	109.1	107.2	108.5	109.7	106.9

As mentioned in Section V, freight rates were sampled from three kinds of tariffs: (1) class, (2) general commodity, and (3) special. Separate freight rate indexes were constructed for each kind of tariff and presented in Table 8. During the four-year period, the class tariff was increased three times, in June 1956, March 1957, and September 1958. The cumulative increase over the entire period was 21.4 percent. Although more frequent changes are observed for the General Commodity rates, the major increases again occur at three points in time. The cumulative increase of 21.7 percent from January 1956, to December 1959, is roughly comparable to the class tariff. Even though the revisions to the General Commodity Tariff are more

TABLE 8.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Type of Tariff*

[1957=100]

Year and month	Class rates	Commodity rates	Special rates
1956:			
January	89.1	88.5	93.6
February	89.1	88.5	95.1
March	89.1	88.5	95.1
April	89.1	88.5	95.1
May	89.1	92.7	95.1
June	94.4	93.8	96.9
July	94.4	93.9	96.8
August	94.4	94.9	96.8
September	94.4	94.9	96.8
October	94.4	94.9	98.7
November	94.4	94.9	98.8
December	94.4	95.1	98.8
Average	92.2	92.4	96.5
1957:			
January	94.4	95.1	98.8
February	94.4	95.1	98.9
March	101.1	101.0	99.7
April	101.1	100.9	99.7
May	101.1	101.0	100.0
June	101.1	101.0	100.0
July	101.1	101.0	100.0
August	101.1	101.0	100.0
September	101.1	101.0	100.7
October	101.1	101.0	100.7
November	101.1	101.0	100.7
December	101.1	101.1	100.7
Average	100.0	100.0	100.0
1958:			
January	101.1	101.1	100.7
February	101.1	101.1	100.7
March	101.1	101.1	100.7
April	101.1	101.1	101.6
May	101.1	101.3	101.9
June	101.1	101.4	101.9
July	101.1	101.3	101.9
August	101.1	101.4	101.9
September	108.2	107.5	101.9
October	108.2	107.5	102.0
November	108.2	107.1	102.0
December	108.2	107.7	102.0
Average	103.5	103.3	101.6
1959:			
January	108.2	107.7	102.0
February	108.2	107.7	103.2
March	108.2	107.7	105.3
April	108.2	107.7	105.3
May	108.2	107.7	105.3
June	108.2	107.7	105.3
July	108.2	107.7	105.3
August	108.2	107.7	105.3
September	108.2	107.7	105.6
October	108.2	107.7	105.6
November	108.2	107.7	105.6
December	108.2	107.7	105.6
Average	108.2	107.7	104.9

frequent, in the main the two tariffs, both published by the CSMFB, move together through time. Finally, the special tariffs which apply for the specialized carriers of vehicles, bulk liquids, and steel do not exhibit the same sharp jumps which characterized the other two tariffs. In addition, the cumulative increase over the four years was only 12.8 percent compared to an approximate 21 percent increase for the other two tariffs.

The modest increase in the index of special freight rates can be partially explained by the behavior of vehicle freight rates which accounts for over half of this index. For all makes of autos, other than Fords, rates are quoted on a "per hundredweight" (per cwt.) base, while rates on Fords are quoted on a "per vehicle" base. For these operators, costs are related to the carrying capacity of the equipment as measured by number of vehicles; indeed, if the number of autos which can be loaded onto a single vehicle carrier remains fixed, variations in the aggregate weight of the autos by as much as 20 percent will have little influence on costs. The secular increase in the average weight of an auto has led to an automatic escalation in revenues for those operators who quote a per cwt. rate. Consequently, the per cwt. rate has increased at a slower rate than the per vehicle rate. This is shown in Table 9 by the first two rows which show

TABLE 9.—*Actual and Implied Freight Rates for Automobiles*

	Average annual index			
	1956	1957	1958	1959
Actual hundredweight rate	95.4	100.0	103.3	104.3
Actual vehicle rate (Ford)	93.0	100.0	110.0	113.0
Implied vehicle rate (all makes)	94.7	100.0	100.0	107.8
Implied vehicle rate (Ford)	93.8	100.0	102.6	107.5

the rate relatives for the two alternative freight rates. An implied per vehicle rate for "all makes other than Fords" was constructed by multiplying the per cwt. rate by the average vehicle weight for the corresponding model year.[34] Finally, an implied per vehicle rate was constructed for Fords in the same manner. This last rate relative, the fourth row of Table 9, tells us the relative freight rate which would have been paid by Ford shippers if they had shipped on a per cwt. base. The two implied per vehicle rates correspond quite closely to the actual per vehicle rate for Fords. Clearly, if all freight rates for auto shipments had been quoted on a per vehicle base, the secular increase in the index of special freight rates would have been substantially greater. In this study, a weighted average of the per cwt. and per vehicle rates was used to obtain the price relative for all "Motor Vehicles."

The behavior of the freight rate indexes, classified by commodity groups (Table 7), is influenced by the relative importance of class rates. Some or all of the commodities included in each commodity group were assumed to move solely on class rates. Hence, the 15 commodity groups differ substantially in the relative weight given to the class tariff. Where the relative importance of the class tariff is greatest, one would expect to find the greatest percentage increases in the freight rate index.[35] For the 15 commodity groups, the rank correlation between these two variables was found to be 0.591.[36]

Finally, the motor freight rate index for the Central States was compared to the rail carload freight rate index for the 3 years for which data were available. This comparison is shown in Table 10. For "All Commodities," the increase in the motor freight rate index was slightly higher than the rail index. The motor freight rate index showed a slightly smaller increase than the rail for only one com-

[34] The implied rate relative was adjusted to make the average for 1957 equal to 100.

[35] Over the 4-year period, the percentage increase in the commodity tariff was slightly higher than that for the class tariff. However, the individual commodity rates ranged from increases of 7.2 to 34.5 percent over the entire period.

[36] Against the null hypothesis of zero correlation, the critical value of the rank correlation coefficient at a 5-percent level of significance is 0.440.

TABLE 10.—*Comparison Between Motor Freight Rate Index and the Railroad Carload Freight Index, by Major Commodity Groups*

[1957=100]

	1956		1958	
	Railroad carload	Motor freight	Railroad carload [1]	Motor freight
All commodities	94.9	94.1	102.5	102.7
Products of agriculture	95.7	90.8	101.7	103.6
Animals and products	94.3	91.9	99.2	102.9
Products of mines	95.6	92.1	102.6	103.3
Products of forests	94.3	92.2	102.4	108.2
Manufactures and miscellaneous	94.1	94.2	103.4	102.7

[1] Preliminary estimates.

modity group, "Manufactures." However, this group accounted for over 92 percent of all truckload freight revenues in the Central States territory.

TABLE 11.—*Indexes of Motor Freight Rates for 21 Important Commodities Using Single-Year and Three-Year Average Weights*

[1957=100]

Month and year	1956–58 average weights	1957 weights	Difference
January 1956	91.34	91.39	0.05
July 1956	95.59	95.59	.00
January 1957	97.03	97.46	.43
March 1957	100.54	100.48	−.06
May 1957	100.76	100.73	−.03
July 1957	100.76	100.73	−.03
September 1957	101.19	101.21	.02
November 1957	101.19	101.21	.02
January 1958	101.19	101.21	.02
July 1958	102.11	102.17	.06
January 1959	105.33	105.19	−.14
July 1959	107.09	107.02	−.07
December 1959	107.09	107.02	−.07

Thus far, the discussion has focused on the estimation of the price relatives and their impact on various motor freight rates. The accuracy of the index also depends on the accuracy with which the weights are estimated. In Section IV, an inspection of the data in Table 2 suggested that the share of revenue generated by each commodity remained fairly stable—at least for the 3 years for which data were available. For all 170 commodities, the average share of total revenue, for the 3 years 1956 to 1958, was correlated with the share of total revenue for a single year, 1957.[37] The correlation coefficient was 0.9894. Since the weights varied widely, from 0.007 to 26.662, one would expect an extremely high correlation. The sensitivity of the index to variations in the weights is more clearly demonstrated in Table 11. Here the motor freight rate indexes for the 21 most important commodities[38] were constructed by using (1) the 3-year average weights, 1956–58, and (2) the single-year weights, 1957. The indexes were computed to two decimal points to demon-

[37] Since the first variable includes the second, some positive correlation will be induced.
[38] Each commodity included in this index generated over 1 percent of total freight revenues.

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strate the differences. The maximum deviation was 0.43 points. Thus, use of single-year weights would have generated roughly the same index as that obtained by using the 3-year average weights.

In conclusion, the primary purpose of this study was to propose a method for the construction of a freight rate index. The proposed method was applied in the construction of a motor freight rate index for common carrier truckload freight in the Central States territory. The validity of the index has not been checked.[39] The shortcomings of the motor freight rate index presented in this study are evident to the authors. These include:

1. In obtaining the freight rate data, it was often necessary to exercise personal judgment in assigning commodities to tariffs. Logically, the tariff from which the rates are sampled should apply for the majority of the shipments of that commodity. This element of judgment could be avoided by an analysis of waybills, classified by commodity and type of tariff.

2. The waybill statistics from which the weights were estimated are only applicable to truckload shipments. In the Central States Motor Freight Bureau, approximately 60 percent of all freight revenues are generated by less than truckload shipments. This omission makes it impossible to extend the index to all common carrier traffic. However, since virtually all L.T.L. shipments are moved on class rates, the estimation of the price relatives should be relatively simple.

3. The effect of distance on the behavior of freight rates was completely neglected in the present study. For those commodities moving on class rates, this omission is not serious, since the same percentage increase was applied to all rates. If all rates are increased by the same nominal amount, as was done in June 1960, then the distance variable must be explicitly considered. The importance of distance is further emphasized by the changes over time of the differentials in the costs per ton-mile as a function of the distance of shipments.

4. The rates published by the Central States Motor Freight Bureau were assumed to be representative for all general commodity common carriers. This assumption would be appropriate if either (1) the independent carriers as a whole are extremely small relative to all common carriers in the territory, or (2) the rate changes by the independents mirror the rate changes by the Bureau.

5. The index was based on a sample of 240 individual freight rates, together with the overall increases in the class tariff and the special commodity tariff for "Iron and Steel Products." Perhaps too little attention was given to the other special commodity tariffs. However, in the absence of waybill data of the kind suggested in point (1) above, this question cannot be resolved. The dangers from the small sample size as well as use of Tariff 555 were described in Section V.

Despite these shortcomings, we feel that the index is representative of the movements in motor freight rates for the Central States ter-

[39] The index could be checked against a sample of waybills. A random sample of waybills at one point in time could be coupled with the waybills for identical shipments at a second point in time. The average rate change, estimated from the waybills, could then be compared to the index.

ritory. If these shortcomings could be corrected, then we believe the method employed in estimating this index is the appropriate method for the construction of a freight rate index.

VII. Recommendations for the Compilation of Freight Rate Indexes

In Section II of this study, a conceptual framework was developed for the construction of a freight rate index of all "For Hire" transport services. The implementation of this method would involve the following steps:

1. The set of all "For Hire" transport services must be classified into traffic categories where each category designates (1) mode of transportation, (2) commodity, (3) distance transported, and (4) geographic region.
2. According to this method, the weight for each traffic category is equal to the share of total freight revenues generated by shipments in that traffic category. These weights must be estimated from a waybill sample for all "For Hire" carriers.
3. The average rate change or price relative for each traffic category must be estimated from a sample of freight rates. The proposed method also outlined an optimal sampling scheme. This sampling scheme requires one additional piece of information, the variance of price relatives within each traffic category. An intimate knowledge of the market for transportation services may provide fairly accurate a priori estimates of these variances.

If the method were adopted, it would be possible to construct a number of freight rate indexes by taking different combinations of the individual traffic categories. For example, indexes, by each mode of transportation, could be constructed for "short-haul" and "long-haul" traffic by classifying the traffic categories by distance and mode.

The proposed method would require the collection of a substantial volume of additional data which are not currently collected by the regulatory authorities. At present, two acceptable freight rate indexes are published. The rail carload freight rate index, published by the ICC, provides separate freight rate indexes for (1) commodity groups, (2) territories, and (3) interstate versus intrastate movements. Second, the Agricultural Marketing Service publishes freight rate indexes for the rail shipments of various agricultural commodities. The other so-called freight rate indexes are simply indexes of the average revenue per ton-mile.

The problems currently facing the transportation industry place higher demands on certain subindexes of an all-inclusive freight rate index. The specific problems which we have in mind are (1) the decline of the railroads, and (2) the rapid growth of private carriage in highway transportation. An analysis of these problems would be aided by the following additional freight rate indexes.

1. Rail Carload Freight Rate Index by Mileage Blocks: Given the present ICC rail carload freight rate index, all the data required to construct this index are available. The traffic categories need only be classified by mileage blocks and the indexes computed. These in-

dexes would reveal the relative changes in "short-haul rates" versus "long-haul rates."

2. Motor Freight Rate Indexes for all Common and Contract Carriers by (a) Commodity, (b) Mileage Block, and (c) Territory: If the method outlined in Section II is followed, waybill statistics would be required at only periodic intervals—say each 5 years. The waybill sample would first be classified by commodity, mileage block, and territory to estimate the weights for the index. Second, within each traffic category, the waybills can be classified by the type of tariff from which the freight rate was taken. This second step reveals the source from which subsequent freight rates should be sampled. Although the number of operators in highway transportation is substantially greater than in rail, the presence of the ratemaking bureaus greatly reduces the number of pertinent tariffs. This procedure eliminates the necessity for a continuing waybill sample. Furthermore, if the weights are adjusted at periodic intervals, the index can be adjusted to reflect shifts in the composition of highway transport services.

3. An Implicit Index of Self-Produced Truck Transport Services: For those shippers who choose to produce their own transport services with private fleets, the relevant freight rate is some measure of user costs. Specifically, it is the cost per ton-mile of operating the private fleet.

The cost studies for common and contract carriers can be extended to private carriers. Some modifications would be required to account for differences in utilization or load factors, possible use of nonunion drivers, commodities transported, etc.

Additional freight rate indexes would be desirable for other current problems in transportation. For example, an index of airfreight rates, together with an index of railway express rates, would be useful in analyzing the rapid growth of air cargo. Also, relatively little work has been done in the area of freight rates for waterborne transportation. However, rail and highway transportation still account for the bulk of the transportation industry. Hence, we feel that priority should be given to the highway area, where data are presently meager.

APPENDIX A

COMMODITY COMPOSITION FOR THE INDEX OF MOTOR FREIGHT RATES

Commodity	Weight [1] (1956–58 average)	Weight [1] 1957	Percent rate change, January 1956 to December 1959	Number of rates sampled	Tariff classification
CLASS TARIFF					
Products of agriculture, seeds	0.029	0.039	21.4	(2)	1
Animals and products:					
Dairy products NOS	.089	.111	21.4	(2)	1
Wool and mohair in grease	.068	.012	21.4	(2)	1
Wool and mohair NOS	.011	.007	21.4	(2)	
Hides, skins and pelts	.060	.077	21.4	(2)	1
Leather NOS	.086	.086	21.4	(2)	1
Poultry, dressed and frozen	.166	.148	21.4	(2)	1
Poultry, live	.010	.002	21.4	(2)	1
Margarine NOS	.251	.222	21.4	(2)	1
Products of mines:					
Stone, rough NOS	.034	.062	21.4	(2)	1
Stone and rock, crushed	.019	.021	21.4	(2)	1
Stone, finished NOS	.058	.082	21.4	(2)	1
Aluminum ore and concentrate	.011	.012	21.4	(2)	1
Ores and concentrates	.038	.042	21.4	(2)	1
Clay and bentonite	.049	.049	21.4	(2)	1
Sand, industrial	.021	.027	21.4	(2)	1
Products of forests:					
Rosin and turpentine	.014	.019	21.4	(2)	1
Lumber shingles and lath	.102	.116	21.4	(2)	1
Box crate	.028	.027	21.4	(2)	1
Veneer plywood	.092	.069	21.4	(2)	1
Manufacturing and miscellaneous:					
Sewer pipe and drain tile	.127	.116	21.4	(2)	1
Artificial stone	.023	.030	21.4	(2)	1
Brick, NOS and building tile	.181	.165	21.4	(2)	1
Brick, common	.042	.508	21.4	(2)	1
Cement, NOS	.164	.167	21.4	(2)	1
Cement, natural and portland	.091	.119	21.4	(2)	1
Manufacturing tobacco NOS	.049	.056	21.4	(2)	1
Building, houses fabricated, portable	.244	.194	21.4	(2)	1
Guns, small arms NOS	.039	.023	21.4	(2)	1
Airplanes, craft and parts	.077	.068	21.4	(2)	1
Ammunition and explosives	.332	.262	21.4	(2)	1
Refractories	.178	.211	21.4	(2)	1
Newsprint paper	.032	.015	21.4	(2)	1
Printed matter	1.013	.944	21.4	(2)	1
Insulating materials	.282	.272	21.4	(2)	1
Building woodwork and millwork	.071	.083	21.4	(2)	1
Building materials	.539	.272	21.4	(2)	1
Asbestos articles	.084	.110	21.4	(2)	1
Furnaces, heaters, parts	.562	.510	21.4	(2)	1
Bathroom, lavatory fixtures	.360	.387	21.4	(2)	1
Floor covering	.662	.676	21.4	(2)	1
Woodenware	.030	.034	21.4	(2)	1
Chinaware, crockery	.113	.126	21.4	(2)	1
Household utensils	.067	.063	21.4	(2)	1
Refrigerators, freezers, parts	.281	.260	21.4	(2)	1
Stoves, ranges and parts	.091	.083	21.4	(2)	1
Laundry equipment	.182	.159	21.4	(2)	1
Copper, ingot, matte, pig	.044	.039	21.4	(2)	1
Copper, brass, bronze NOS	1.641	1.642	21.4	(2)	1
Aluminum NOS	1.069	1.022	21.4	(2)	1
Aluminum, bar, slab	.323	0.305	21.4	(2)	1
Magnesium metal and alloys	.060	.056	21.4	(2)	1
Alloys for steel manufacturing	.080	.069	21.4	(2)	1
Containers, wooden	.040	.035	21.4	(2)	1
Containers, NOS	.366	.356	21.4	(2)	1
Containers, fiberboard, K.D	.749	.750	21.4	(2)	1
Waste materials NOS	.097	.103	21.4	(2)	1
Waste materials for remelting NOS	.234	.236	21.4	(2)	1
Agricultural parts	.268	.261	21.4	(2)	1
Agricultural implements NOS	.127	.125	21.4	(2)	1
Food products, frozen NOS	.472	.395	21.4	(2)	1
Syrup and molasses, refined	.124	.082	21.4	(2)	1
Wallboard	.093	.088	21.4	(2)	1
Cloth and fabrics NOS	.167	.194	21.4	(2)	1
Rope cordage and binder twine	.028	.031	21.4	(2)	1
Boots, shoes and findings	.144	.119	21.4	(2)	1
Athletic, gym, NOS	.144	.143	21.4	(2)	1

See footnotes at end of table, p. 133.

Commodity Composition for the Index of Motor Freight Rates—Continued

Commodity	Weight [1] (1956–58 average)	Weight [1] 1957	Percent rate change, January 1956 to December 1959	Number of rates sampled	Tariff classification
CLASS TARIFF—continued					
Manufacturing and miscellaneous—continued					
Games and toys	.051	.044	21.4	(2)	1
Liquor, alcoholic NOS	1.665	1.581	21.4	(2)	1
Wine	.055	.052	21.4	(2)	1
Tools and parts NOS	.122	.117	21.4	(2)	1
Cotton factory products	.069	.072	21.4	(2)	1
Blacks, NOS	.309	.366	21.4	(2)	1
Synthetic fiber and yarns	.068	.070	21.4	(2)	1
Tanning materials	.028	.028	21.4	(2)	1
Food animals and poultry NOS	.164	.115	21.4	(2)	1
COMMODITY TARIFF					
Products of agriculture:					
Fruits, dried NOS	.010	.007	13.0	1	2
Rice	.020	.014	20.0	1	2
Peanuts	.008	.006	20.0	1	2
Vegetables, fresh frozen	.059	.061	7.2	1	2
Beans and peas, dried	.013	.007	21.9	1	2
Vegetables, fresh, not frozen	.012	.010	22.2	1	2
Potatoes, not sweet	.011	.005	22.2	1	2
Coffee	.126	.107	20.1	3	2
Fruits and berries, fresh	.043	.029	21.6	1	2
Cereal food preparations NOS	.030	.033	20.0	1	2
Flour, edible NOS	.113	.100	20.0	3	2
Flour, wheat	.022	.020	20.0	1	2
Vegetable and nut oil	.026	.026	14.0	1	2
Animals and products:					
Meats, cooked, cured	.347	.357	13.0	3	2
Fish and animal oil	.031	.007	22.2	1	2
Sea food NOS	.072	.051	14.0	1	2
Butter	.455	.475	11.6	2	2
Eggs	.146	.152	23.3	2	2
Packing house products, edible NOS	.333	.214	16.6	3	2
Cheese	.288	.251	16.0	3	2
Meats, fresh NOS	2.361	2.120	20.6	8	2
Products of mines:					
Salt	.115	.128	13.0	2	2
Asphalt	.281	.284	21.8	3	2
Sulphur	.007	.008	20.7	1	2
Petroleum, crude	.017	.016	21.3	1	2
Manufactures and miscellaneous:					
Fertilizers	.104	.144	23.4	1	2
Oils NOS	.058	.056	21.3	1	2
Food products NOS (cans, not frozen)	2.387	2.205	21.3	6	2
Cigarettes	.253	.256	12.3	3	2
Starch	.056	.053	15.9	1	2
Gases, other than petroleum	.107	.142	21.4	2	2
Cotton cloth and cotton fabric NOS	.157	.172	17.3	2	2
Bagging, burlap NOS	.028	.034	13.0	1	2
Chemicals NOS	2.435	3.197	20.8	7	2
Drugs, medicines and toilet preparations	.810	.756	20.8	3	2
Liquors, malt	.085	.079	20.0	1	2
Beverages	.046	.037	14.7	1	2
Sugar	.215	.148	13.6	1	2
Candy and confectionery	.754	.711	13.4	1	2
Lead, zinc, bar ingot, pig	.096	.108	21.2	1	2
Lead and zinc NOS	.120	.124	20.8	1	2
Metals and alloys NOS	.287	.268	18.3	3	2
Paper bags	.158	.169	13.0	2	2
Scrap paper and rags	.046	.043	22.2	1	2
Printing paper NOS	.432	.388	18.5	3	2
Wrapping paper	.289	.275	22.2	1	2
Paper and paper articles	.686	.597	34.5	2	2
Glass	.705	.706	14.0	4	2
Plastics	1.696	1.647	20.8	4	2
Lubricating oils and greases	.560	.551	19.3	4	2
Insecticides and fungicides	.129	.129	22.0	1	2
Paint varnish and putty	1.412	1.370	18.8	5	2
Tar pitch and creosote	.140	.180	20.3	2	2
Cellulose articles	.181	.099	16.7	2	2
Sodium (Soda) products	.455	.511	15.1	3	2
Rubber, crude, natural, synthetic	.793	.833	21.5	4	2
Soap, cleaning and washing compounds	1.354	1.283	20.9	4	2

See footnotes at end of table, p. 133.

Commodity Composition for the Index of Motor Freight Rates—Continued

Commodity	Weight [1] (1956–58 average)	Weight [1] 1957	Percent rate change, January 1956 to December 1959	Number of rates sampled	Tariff classification
COMMODITY TARIFF—continued					
Manufacturers and Miscelaneous—Continued					
Abrasives, not crude	.168	.169	23.0	1	2
Furniture and parts	.097	.100	21.4	1	2
Furniture, NOS	.260	.231	21.6	3	2
Containers, metal	.221	.200	21.6	3	2
Containers, returned empty	.125	.137	21.7	2	2
Matches	.062	.065	13.9	1	2
Rubber goods NOS	.350	.392	19.7	3	2
Tires, tubes, rubber	.852	.850	21.6	1	2
Paperboard, fiberboard, pulpboard	.502	.487	16.1	4	2
Building paper, NOS	.665	.609	16.1	4	2
Electrical equipment, parts NOS	2.628	2.633	21.2	5	2
Hardware NOS	.248	.236	19.5	2	2
Glass bottles and glassware	.989	.753	24.4	6	2
Cast iron and pipe fittings	.160	.159	13.8	2	2
Iron and steel pipe and fittings NOS	.891	.965	7.6	4	2
Machinery and machines	2.723	2.855	21.5	8	2
Machinery parts	1.352	1.422	21.3	4	2
Vehicle parts	6.497	5.690	22.3	9	2
Railroad equipment, parts	.023	.023	15.8	1	2
Plaster, stucco	.018	.018	21.6	1	2
Vehicles, not motor	.328	.262	20.9	3	2
Tanks, NOS	.079	.080	21.3	1	2
Oil foot sediment	.013	.001	21.7	1	2
SPECIAL TARIFFS					
Manufacturing iron and steel	5.865	5.902	6.0	(3)	3
Iron and steel NOS	4.241	3.689	6.0	(3)	3
Iron, pig	.026	.027	6.0	(3)	3
Iron, steel, billot, bloom ingot	.221	.223	6.0	(3)	3
Iron and steel, bar rod slab	1.349	1.357	6.0	(3)	3
Scrap iron and steel	.056	.050	6.0	(3)	3
Iron and steel borings and turnings	.050	.040	6.0	(3)	3
Iron and steel nails and wire NOS	.697	.668	6.0	(3)	3
Petroleum products, refined NOS	.915	.919	15.0	4	3
Fuel, petroleum, residual oils NOS	1.874	1.736	18.5	6	3
Gasoline	2.350	2.329	17.1	7	3
Acids	.580	.544	34.6	3	3
Oils, vegetable	.165	.146	25.6	2	3
Motor vehicles	7.743	8.874	14.9	8	3

[1] Weights denote percent of total revenues as taken from *Motor Carrier Freight Commodity Statistics; Class I Common and Contract Carriers of Property.* Years ended 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics.
[2] Class rates.
[3] Iron and steel tariff.

Appendix B

Published Freight Rate Indexes

A search of the available statistics revealed that two acceptable freight rate indexes are currently published. Brief descriptions of these indexes are included below. The other so-called freight rate indexes uncovered in this search were found to be indexes of the average revenue per ton mile. These average revenue indexes are presented in Table B-1. In addition, the Consumers' Price Index includes a component for the transportation of household goods as well as components for the movement of persons. These CPI indexes were neglected in the present study since they do not directly relate to the movement of goods. Finally, several studies concerned with freight rate indexes are listed in the bibliography to this Appendix.

TABLE B-1.—*Indexes of the Average Revenue Per Ton-Mile by Mode of Transportation*

(1949=100)

Year	Class I rail	Class I motor carriers			Pipelines	Domestic water [1]
		Weighted average	Common carriers	Contract carriers		
1946	73.0	82.1	81.8	90.5	X	X
1947	80.4	92.5	92.5	90.4	X	X
1948	93.4	97.5	98.3	88.4	X	X
1949	100.0	100.0	100.0	100.0	100.0	100.0
1950	99.2	96.1	95.6	99.5	92.2	104.6
1951	99.7	98.8	98.8	96.9	100.5	X
1952	106.8	106.7	107.2	103.7	102.8	106.2
1953	110.4	109.7	109.4	113.8	100.9	105.9
1954	106.1	111.2	111.2	111.5	100.3	112.4
1955	102.4	110.7	110.7	115.2	101.7	116.5
1956	103.3	113.8	113.9	117.7	98.8	112.2
1957	107.9	118.4	117.1	137.0	97.0	118.5
1958	109.3	118.8	118.1	129.3	96.9	120.8

[1] This index is confined to domestic inland and coastal water transport. It is simply a revenue per ton of freight transported. The data did not permit estimation of ton-miles or other comparable output measure.

SOURCE: ICC Transport Statistics. Statistics of Class I motor freight carriers, statement 589.

A. THE RAIL CARLOAD FREIGHT RATE INDEX [40]

The rail carload freight rate index published by the ICC refers to all carload freight movements on Class I railroads. Separate freight rate indexes are available by (1) major commodity groups, (2) territory, and (3) interstate v. intrastate movements.

The index is an annual chain link index based on the 1 percent waybill sample collected from all Class I rail carriers. The waybill sample is classified into approximately 30,000 individual traffic categories where each traffic category designates (1) commodity, (2) mileage block, and (3) territory. From the waybills included in each traffic category, two quantities are computed: the total ton-miles of freight, q_0, and the average revenue per ton-mile, p_0. [41]

The index is a chain link index using the method of "constructive revenues." Thus, the index in year 1, relative to year 0, is given by:

$$I_{10}=\frac{\Sigma p_1(q_1+q_0)}{\Sigma p_0(q_1+q_0)}. \qquad \text{(B-1)}$$

The numerator gives the "constructive revenue" in year 1 or the total revenues which would have been realized by Class I railroads if the average quantities shipped in years 1 and 0 (q_1+q_0) were shipped at year 1 prices, p_1. Similarly, the denominator gives the "constructive revenue" for year 0.[42] The formula, given by equation B-1, is employed in estimating the percent increase in freight rates between any two adjacent years. For example, the index in year 2, relative to year 1, I_{21}, is given by:

$$I_{21}=\frac{\Sigma p_2(q_2+q_1)}{\Sigma p_1(q_2+q_1)}. \qquad \text{(B-2)}$$

[40] *Indexes of Average Freight Rates on Railroad Carload Traffic, 1948–56.* Interstate Commerce Commission, Bureau of Transport Economics and Statistics, March 1958, Washington, D.C. Statement RI–1.

[41] The subscript 0 denotes the base year 0. For the waybill sample in the i-th year, the quantities would be designated by q_i and p_i.

[42] Equation B–1 could be rewritten as the product of two terms. The first term is simply a Laspeyres price index using year 0 quantities, q_0, as weights. The second term is the ratio of (a) one plus a quantity index using year 1 prices as weights to (b) one plus a quantity index using year 0 prices as weights.

The index in year 2 relative to the base year, 0, is obtained by linking the two percentage changes.

(B-3) $I_{20}=I_{21}I_{10}$.

Using this method, the ICC has constructed annual rail carload freight rate indexes for the postwar period. These indexes for the major commodity groups are presented in Table B-2.

TABLE B-2.—*Rail Carload Freight Rate Indexes by Major Commodity Groups (1950=100)*

Item	Index										
	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958[1]
All commodities	93	99	100	102	109	111	109	108	112	118	121
Group I—Products of agriculture	93	98	100	102	108	110	110	109	112	117	119
Group II—Animals and products	93	99	100	102	110	113	112	112	116	123	122
Group III—Products of mines	91	98	100	102	108	109	108	107	110	115	118
Group IV—Products of forests	93	98	100	102	110	113	113	113	117	124	127
Group V—Manufacturers and miscellaneous	94	101	100	102	110	112	110	108	112	119	123
Group VI—Forwarder traffic	101	106	100	103	113	114	112	112	115	124	130

[1] Preliminary estimates.

SOURCE: *Indexes of Average Freight Rates on Railroad Carload Traffic, 1948–56,* Bureau of Transport Economics and Statistics, Interstate Commerce Commission, statement RI–1, Washington, March 1958, pp. 5–6.

The rationale for classifying the waybills into 30,000 traffic categories is to minimize the variation in freight rates between waybills in the same traffic category. However, some variance remains and is particularly large in the various "NOS" commodity groups. The ICC recognizes these residual variances by estimating a standard error of estimate for the index number. By this method, it is impossible to trace the freight rate for a specific "commodity-point-to-point" shipment through time since the waybill samples in each year are random samples.

The primary advantage of the chain link method is that it adjusts for the changing composition of rail carload traffic. The weight assigned to each traffic category is determined by the ton-miles reported on those waybills which fall into that traffic category. Variations in the weights can result from either the sampling variability inherent in the 1 percent waybill sample or actual shifts in the composition of rail carload traffic.

The danger in the use of a chain link index is that errors of measurement are locked into the index and carried in subsequent periods. If the errors of measurement are serially correlated, the index will yield a biased estimate. For any two adjacent years, the index provides an unbiased estimate of the true percentage change in freight rates; however, this need not be the case for two separated years.

In summary, the rail carload freight rate index provides a measure of the change in freight rates independent of the changes in the composition of rail carload traffic. A comparison of this index with the index of the average revenue per ton-mile reveals that the decline in the latter index is largely attributable to the loss of "high revenue" freight rather than a reduction in freight rates.

B. RAIL FREIGHT RATE INDEXES FOR FARM PRODUCTS [43]

Since 1913 the Agricultural Marketing Service has published an annual rail freight rate index for farm products as well as separate indexes for (1) wheat, (2) cotton, (3) fresh fruits and vegetables, (4) meats, and (5) livestock. The index in year t relative to the base year 0 is given by the formula:

$$I_{t0}=\frac{\Sigma AR_t W_0}{\Sigma AR_0 W_0} \qquad (B\text{-}4)$$

where AR_t and AR_0 denote the annual average freight rates [44] in years t and 0, and W_0 the weight assigned to each traffic category in the base year. Again, each traffic category designates a "commodity-point-to-point" movement. The weights are adjusted at periodic intervals to reflect shifts in the composition of rail freight movements. In the latest revision, the weights represented the average ton-mile shipments between 1947 and 1949.

The basic Laspeyres formula employed in this index was also used in our proposed method outlined in Section II of this study. Between 1948 and 1952 the movements in this fixed weight index were almost coincident with the movement of the chain link rail carload freight rate index for "Products of Agriculture." Finally, the index for farm products is the only continuous freight rate index extending over forty years.

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[43] U.S. Department of Agriculture, Agricultural Marketing Service, *Methods Used in Computing Rail Freight Rate Indexes for Farm Products*, AMS–209, Oct. 1953, pp. 3–7 (by Robert B. Reese).

[44] In estimating the annual average freight rate, adjustments are made for the seasonal variations in both shipments and rates.

Staff Paper 2

ALTERNATIVE RETAIL PRICE INDEXES FOR SELECTED NONDURABLE GOODS, 1947–59[1]

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I. Purposes and Methods

The construction of a price index involves an extremely large number of decisions in the selection and processing of the data to be used. Different investigators, even when working within the same basic framework of concepts, will inevitably make some of these decisions differently. Each can defend his decisions as reasonable, and few ever explore the consequences of making different decisions. In evaluating the movement of a price index, it is important to know which of these decisions have large effects on the behavior of the final index and which do not. This knowledge cannot be deduced in the abstract. It depends in large part on the variances in price movements among places, outlets, commodities, and varieties of commodities.

Information about the effects of some important decisions can be obtained by reviewing the choices made in processing the data collected for an established price index and inquiring into the consequences of altering these choices. Some valuable studies following this approach as applied to the Consumer Price Index have been made available to the Price Statistics Review Committee by the Bureau of Labor Statistics. Many of the crucial decisions, however, are made in the selection of items to be included in the index, in the setting up of specifications for these items, and in the collection of data. The effects of such decisions can be tested only by the collection of additional data not already incorporated in the index in any way.

This paper presents comparisons between components of the established retail indexes and new item indexes based on prices collected from mail-order catalogs. The comparisons are designed to test the effects of decisions made in selecting particular varieties of a commodity from among the large number of varieties on the market, and the effects of decisions on when to introduce new commodities or new varieties of a commodity into an index. In general the paper will not contend that the indexes based on mail-order data are superior

[1] The work underlying this paper was done while I was a Fellow of the Center for Advanced Study in the Behavioral Sciences, Stanford, California. I am heavily indebted to Don A. Proudfoot, Jr., and Edward Murphy, of Stanford University, who collected and processed the data. D. M. Tooker, of the Los Angeles branch of Sears, Roebuck, and Company and the staff of the Oakland Branch of Montgomery Ward and Company were of great help in enabling us to complete our collection of mail-order catalogs. The Division of Prices and Cost of Living of the Bureau of Labor Statistics made available unpublished histories of specifications for a number of items in the Consumer Price Index, and the Agricultural Price Statistics Branch, Agricultural Estimates Division, Agricultural Marketing Service, made available unpublished tabulations of prices paid by farmers for particular items. In this connection, we are especially indebted to Sidney A. Jaffe of BLS and B. R. Stauber of AMS. The members of the Research Group in Labor Economics and Industrial Relations at the University of Chicago made helpful comments on an earlier draft.

to the corresponding components of the official indexes; it is clear in many cases that they are not. Rather the paper suggests that where the differences among alternative indexes are large, it will pay to concentrate attention and research on the improvement of the indexes, and where the differences among alternative indexes are small, problems in methodology that seem important in the abstract can safely be neglected in practice. For such a suggestion to be helpful, it is of course necessary to be able to generalize about the kinds of situations in which large differences among alternative indexes can be expected to occur.

The new indexes for particular commodities presented here were constructed from Sears Roebuck and Montgomery Ward catalogs for the years 1947–59. Since the work was done in California, the catalogs we were able to assemble were Los Angeles catalogs for Sears and Oakland catalogs for Ward. Indexes based on these data will be compared with national item indexes that are components of the Consumer Price Index and the Index of Prices Paid by Farmers for Family Living (hereafter called simply the BLS and AMS indexes). The absolute level of prices in California is higher for some items, especially bulky items such as mattresses, than it is for the country as a whole. However, we do not believe that there are appreciable differences in the movement of prices on this account; at any rate we have not been able to detect any.

Mail-order catalogs have several advantages for the inexpensive collection of large bodies of historical price data. Price quotations are accompanied by reasonably full descriptions of the items and by photographs or drawings in most cases. These usually provide the information, at least for major features of the item, called for in BLS specifications. The continuity of catalog numbers from one catalog to the next is often helpful in following a particular item. Most important, the prices given in the catalogs are those at which many transactions actually take place, and are not the starting point for bargaining or discounts.[2]

There is a problem in the determination of the period during which catalog prices are in effect. Special sales and in some cases price increases may be announced shortly after the catalogs are issued, and we have no collection of such announcements. Changes in the proportion of all sales made through special sales catalogs and changes in the difference between general catalog and sales catalog prices could introduce bias into our indexes The general catalogs themselves do not show an exact date of issue. We compare the Spring catalog prices with the March indexes of BLS and AMS and the Fall and Winter catalog prices with the September official indexes. There is considerable internal evidence in the study, especially during the period of the Korean war, that this dates the catalog prices too late, for the official indexes lead at a number of turns. However, the alternative of comparing Spring catalogs with December indexes and Fall catalogs with June would have produced opposite discrepancies and would have made it impossible to include some seasonal items.

[2] For other recent uses of mail-order catalogs to construct price indexes, see Meyer L. Burstein, "The Demand for Household Refrigeration in the United States," in A. C. Harberger, ed., *The Demand for Durable Goods* (Chicago, 1960), and Albert Rees with the assistance of Donald P. Jacobs, *Real Wages in Manufacturing, 1890–1914* (Princeton University Press for NBER, in press).

Our collection of catalogs was missing one catalog from each mail-order house, fortunately not for the same date. Because of the differences in price levels between Chicago and California, we did not use Chicago catalogs to fill the gaps. Rather we have interpolated the data for the missing periods.[3]

The items considered in the study are confined to nondurable goods because the problems of pricing durable goods are discussed in several other staff papers.[4] The selection of nondurable goods for study was a judgment selection, and not in any sense a random sampling operation. The following considerations influenced the selection: (1) We wanted to study a wide variety of nondurable goods, including clothing, house furnishings, and other items, and including products of the textile, leather, and rubber industries. (Food and tobacco, of course, cannot be priced from mail-order catalogs.) (2) We wanted to include items that were in both the AMS and BLS indexes, insofar as possible. (3) We wanted some items that were little affected by innovation or technological change during the period of the study, and others that were greatly affected. (4) We wanted to omit items with radical year-to-year changes in style, such as women's street dresses, since these are almost impossible to follow in the catalogs (and, it might be added, extremely difficult to follow by any other procedure as well). Of the list originally selected on these criteria, all the items have been studied except men's dress shoes, the only item made of leather. The very large number of varieties of this item in the catalogs and the great complexity of the BLS specifications for it caused us to leave it until last, and we did not get to it because of limitations of time and budget.

The three sets of indexes compared in the study are constructed on three quite different principles. The BLS indexes are based on the selection of one or sometimes two narrowly specified varieties of an item, which are priced at several outlets in each of 19 cities. For furniture and apparel items, an average of about 4 quotations per item is obtained in the larger cities.[5] Since the average for smaller cities may be lower, 76 quotations per item is probably close to the maximum for most of the item indexes. BLS prices are, of course, collected in the field by agents of the Bureau. Data for clothing and furniture items are obtained both from department stores and from specialized clothing and furniture stores.

In contrast to the BLS indexes, the AMS data refer to a much broader range of specifications. For example, in Axminster rugs

[3] The missing catalogs are Spring 1948 for Sears, and Spring 1953 for Ward. After considerable experimentation, we evolved the following rule for interpolation: Where in the house with the missing catalog the price change for a full year (Fall to Fall) is in the same direction as in the house with all catalogs present, and where, in addition, in the latter house the price change is in the same direction in both subperiods (Fall to Spring and Spring to the following Fall), we divide the price change in the first house among the subperiods in the same proportions as that in the second house. In all other cases, the price change in the first house was distributed equally between the two subperiods. The experimentation referred to above consisted of assuming that data were missing which in fact we had, and seeing what interpolation rule reproduced them most closely.

[4] Strictly speaking, we stray outside the area of nondurable goods by including mattresses, a product of the furniture industry. However, mattresses have certain characteristics of nondurable goods and have not been studied in any of the studies of durable goods.

[5] There are 46 cities in all in the CPI. However, the published item indexes are based only on the 19 cities priced in the months of March, June, September, and December. The average number of observations per item reported above is as of 1955 from BLS Bulletin 1182, p. 15. The average refers to cities in size classes A1, A2, and B (cities of over 240,000 population), of which there are 11 among the 19 cities included in the item indexes. The number of observations per city may be lower for the other 8 cities. My impression is that about four outlets are visited in such cities for these items, and not all of these will always have an item in stock to meet specifications.

AMS specifies only the size (9′×12′) and that the rug be seamless. BLS specifies in addition the fiber content, the number of rows to the inch, the number of ply, the backing, and that the pattern be current. AMS quotations are collected by mail from a large number of outlets in each of the States. These quotations are weighted together to produce a national average price. As of September 1949 there were 2,428 reports for one of the items considered in this study, men's work socks.[6]

The average prices reported by AMS are in effect unit values rather than specification prices. Such unit values are subject to upward or downward drift relative to a specification price index if there is a change in the average quality of the item bought by farmers or change in the composition of the outlet sample. This of course does not mean that all the AMS indexes are affected by such a drift or that they are all inferior to the corresponding BLS indexes. Detailed discussion of this issue will be reserved for the following sections.

The AMS data as we received them consisted of quarterly average prices paid for particular items, based on samples of independent stores for 1947–53 and of independent and chain stores combined for 1953–59. We have used the data for March and September of each year. These have been converted into indexes on the base 1947–49=100; the data for 1954–59 have been changed in level to that of the first segment of the data by use of the one year overlap in 1953.[7]

Our own indexes based on mail-order catalogs differ in several respects from both of the other sets. Obviously, we have a much smaller number of outlets—that is, two. Our data are confined to one state, California. Our procedure on specifications differs from that of both government agencies. Every price comparison we make refers to a detailed specification at a level of detail similar to that of BLS; we compare a Fall 1947 price with a Spring 1947 price for an identical specified-in-detail item sold by the same outlet. However, we make such comparisons for as many different varieties of the item as possible, within a broad over-all definition of the item not unlike that of AMS. In some cases, this gives us a very large number of price comparisons between two adjacent dates. The largest number of such observations in any of our indexes is 89 (women's rayon and nylon panties, Fall 1954 to Spring 1955), a number probably not appreciably different from the average number of observations behind a given BLS item index for a similar item. The period-to-period change in the price of an item is estimated as the average of the changes for all the detailed varieties of the item, and these average changes are multiplied together to form a chain index. Our final item indexes can thus be described as unweighted specification chain indexes covering a broad range of specifications. If the weighting process is viewed as applying to the major varieties of an item, rather than to the most detailed varieties, then there is a kind of weighting implicit in our procedure. The weight assigned to any major variety of an item will be equal to the number of detialed varieties for which we can make comparisons, which in turn will depend in large part on the number of such varieties present in the catalogs. It seems rea-

[6] See *Major Statistical Series of the U.S. Department of Agriculture,* Agriculture Handbook No. 118, vol. I, p. 36.

[7] This is the same procedure used by AMS in constructing the index of prices paid by farmers, except that AMS uses an overlap of one observation only—that of March 1953. See *Major Statistical Series of the U.S.D.A.,* p. 38.

sonable to assume that the number of different detailed varieties in the catalog will be greatest where the volume of sales is greatest, so that we probably weight the major varieties of an item in rough proportion to their importance.

In constructing the indexes shown in the paper, we have combined the data from the two houses, Sears and Ward, by pooling them; that is, we have averaged together all price changes regardless of which house they came from. The same specified-in-detail item will be counted twice if we have observations for it from both houses. Our worksheets and work charts also contain separate item indexes for the two houses, which we constructed to reveal special problems that might be indicated by major discrepancies of movement between the indexes for the two houses.

When new varieties of an item appear in the catalog, they are always linked in to our index; that is, we use only the price changes from the first catalog in which they appear to the second and subsequent catalogs. We almost never make deliberate direct comparisons between the prices of nonidentical goods; the few minor exceptions to this rule are noted in the presentation of the item indexes. This rule is probably more rigid in our indexes than in the BLS indexes, since the BLS makes direct comparisons between nonidentical goods if both fall within the same specification. For an item like mattresses, where there can be some appreciable range of qualities within the specification, this could lead to differences between the indexes. The BLS defends its practice by arguing that the change from one variety to another could be accompanied by a price change unrelated to the quality difference between them. The direct comparisons assume that quality changes within specifications are of negligible importance, and the direct comparisons therefore reveal true price changes. Our procedure assumes that the price movements of the continuous varieties in the sample are the best measure of the true price changes for the discontinuous ones over the interval of the change. This would be a mistaken assumption where sellers followed a deliberate policy of disguising price rises by changes in product characteristics that cost or were worth less than the price rise. We may also, of course, make inadvertent comparisons between nonidentical varieties if the catalogs do not disclose the nature of the change in what seems to be the same specific item.

The particular specified-in-detail items included in the BLS indexes seem to be chosen with two primary criteria in mind. First, there is an attempt to get an item of the quality likely to be bought by the population covered by the CPI—wage earners and lower income salaried workers. Second, there is an effort to choose varieties of an item whose style will be reasonably stable over a period of years, rather than those most subject to whims of fashion. Our own coverage of specified-in-detail items will, of course, be restricted to those that are offered to the customers of mail-order houses; it does not seem probable that these are, on the whole, in a very different income range than the CPI index population. If this is correct, then it seems probable to us that the selection of specified-in-detail items for the CPI is often at too low a quality level for the index population, probably because the index population moved up to better qualities after the item was specified. In a number of cases we were unable to find any variety of an item in the catalogs of either house whose quality was as low as that specified by BLS. These cases will be noted in the presentation of the item indexes in the next section.

Our item indexes include more of the unstable, fashion-influenced varieties of an item than the corresponding BLS indexes. However, such varieties are underrepresented in number (not necessarily in importance in total sales) in our indexes simply because it is harder to collect data for them. Thus in the case of women's panties, we can easily make comparisons from period to period for the stable, untrimmed styles. The more and fancier the lace trimming, the smaller the probability that the same variety will be present in successive catalogs.

In addition to our general indexes based on catalog data, we have also computed wherever possible indexes from the catalogs that conform to the BLS specifications for the item in question as they stood at the date of each observation. In some cases, no such index could be constructed, because it was clear that for some periods no items in the catalog would meet the specifications. At other times, we have deliberately gone outside the strict boundaries of the specifications to produce a continuous index that conforms more closely to the specifications than our general index. Even where we regard an observation as conforming to specifications, it may not do so strictly because of some feature not made explicit in the catalog descriptions. The indexes conforming to BLS specifications are based on many fewer observations than the general mail-order indexes and, therefore, their movement is not as smooth. For example, the general index for men's cotton work shirts is based on more than sixty observations in some years; the index for this item conforming to specifications is never based on more than six. In Section II the indexes conforming to specifications will be presented where they seem to have some value, especially where they help to explain differences between our general indexes and the BLS indexes.

Our mail-order indexes do not include sales taxes, though the index for tires includes federal excise taxes. Since the BLS indexes include both sales and excise taxes, this could be a source of minor discrepancies between the two sets of indexes. In general, we would expect indexes including sales taxes to rise somewhat more than those excluding them.

II. The Item Indexes

This section presents our item indexes for selected nondurable goods and compares them with the most closely corresponding AMS and BLS indexes. The plan of presentation is to begin with the items that have had the smallest changes in technology or style over the period and proceed toward those where changes have been most important. This means that items with similar uses such as men's cotton socks and men's nylon stretch socks will not be discussed together; the first is a stable item and the second a new item during the period.

1. Men's Cotton Work Shirts

For this item styles were very stable during the period; several styles appear in the catalogs without change over the whole period. There was also a large number of specific varieties in the catalogs, so that our indexes are based on many observations. The BLS specifications call throughout for cotton chambray shirts in regular sizes (14 to 17 neck), medium heavy weight (3.90 yd./lb., or about 4.5 oz. to the sq. ft. in the gray). Our index includes heavier chambrays (5.5 oz.), extra large sizes, and several other cotton fabrics such as covert, poplin, twill, and denim (but not flannel).

The movements of the indexes for cotton work shirts are shown in Table 1 and Chart 1. Despite the considerable differences in the definition of the item, the movements of our index and the BLS index are extremely similar, though those of our index have a somewhat larger

TABLE 1.—*Men's Cotton Work Shirts*

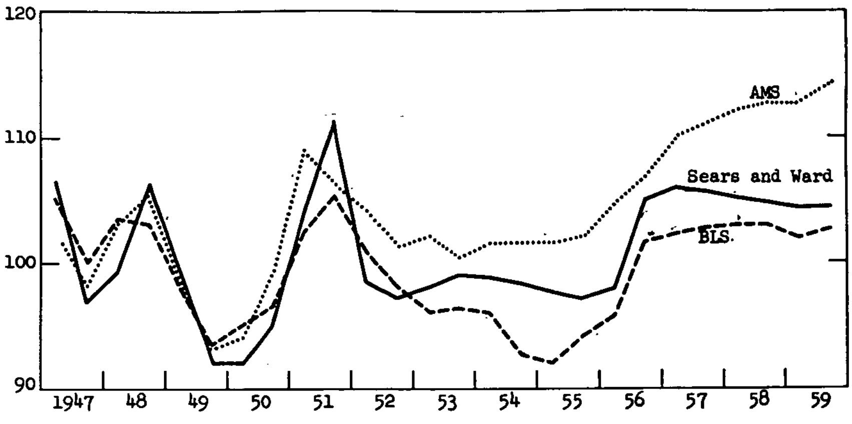
[1947–49=100]

Date	Sears and Ward				BLS	AMS
	All varieties		Conforming varieties			
1947—S [1]	106.4	------------	106.0	------------	105.0	101.5
F [1]	96.8	[2] (10)	90.3	[2] (1)	100.0	98.3
1948—S	99.4	[3] (13)	102.4	(1)	103.4	103.1
F	106.6	(32)	111.3	(2)	103.0	105.2
1949—S	98.6	(28)	98.6	(2)	97.8	98.8
F	92.1	(42)	91.5	(4)	93.3	93.0
1950—S	92.1	(45)	92.6	(4)	95.1	94.0
F	95.0	(50)	94.8	(4)	96.6	99.4
1951—S	104.5	(56)	102.2	(5)	102.5	108.9
F	111.6	(58)	110.5	(5)	105.3	106.3
1952—S	98.6	(57)	94.7	(6)	100.9	104.2
F	97.2	(56)	93.3	(5)	98.1	101.5
1953—S	98.1	[3] (51)	92.2	[3] (5)	96.1	102.0
F	99.1	(58)	92.9	(5)	96.4	100.4
1954—S	98.9	(55)	92.7	(5)	96.1	101.5
F	98.4	(54)	93.5	(5)	92.6	101.5
1955—S	97.7	(54)	93.0	(5)	92.1	101.5
F	97.3	(59)	92.5	(5)	94.2	102.0
1956—S	98.0	(58)	93.3	(4)	95.7	104.7
F	105.0	(65)	96.7	(4)	101.7	106.8
1957—S	105.9	(61)	98.3	(4)	102.2	110.0
F	105.6	(62)	99.0	(4)	102.7	111.1
1958—S	105.1	(63)	95.9	(3)	102.9	112.1
F	104.8	(64)	94.3	(4)	102.9	112.6
1959—S	104.3	(49)	93.9	(4)	101.9	112.6
F	104.4	(58)	94.4	(5)	102.6	114.2

[1] The letters "S" and "F" stand for Spring and Fall. The Spring AMS and BLS data are for March' the Fall for September.
[2] The numbers in parentheses are the number of observations of price changes between the date shown and the preceding date.
[3] Includes number of observations of full year price change where a catalog was missing.

CHART 1

Men's Cotton Work Shirts (1947-49 = 100)



64846—61——10

amplitude, especially during the Korean War. The Fall 1959 levels are within 2 index points of each other, and the maximum difference at any time is about 6 points. The AMS index lies close to the other two at most times. After 1956 it shows an upward drift not present in the other two indexes, and by Fall 1959 it is about 10 points higher than the mail-order index. At all times, the level of prices paid by farmers is higher than the mail-order price of any shirt meeting BLS specifications, though below that of the most expensive shirts in the mail-order index. It seems probable that the upward drift in the AMS index in recent years results from a shift toward heavier or more expensive cotton fabrics.

We also computed an index from mail-order data conforming to the BLS specifications; this is shown in Table 1 but not charted. It deviates more from the BLS index than does our general mail-order index. The conforming index drops substantially more than the others from 1951 to 1952, and is at a lower level at almost all later dates. Because of the rather small number of observations behind this index (never more than six) it is probably less reliable than the main mail-order index. For an item like cotton work shirts, where there have been few major changes in the item during the period, the additional observations provided by broadening the range of specifications would seem to be a good (and inexpensive) substitute for a broad sample of outlets in removing random fluctuation from the index.

2. MEN'S COTTON SOCKS

The heading "Men's Cotton Socks," which is used for one of the published BLS item indexes, is broad enough to cover both work socks and dress socks. We have computed separate mail-order indexes, shown in Table 2, for these two kinds of cotton socks. Chart 2 com-

TABLE 2.—*Men's Cotton Socks*

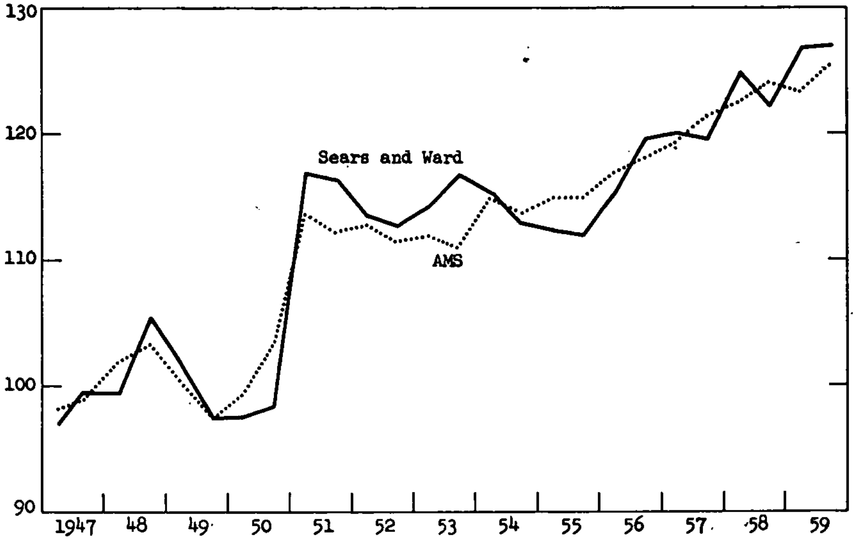
[1947–49=100]

Date	Sears and Ward				BLS	AMS (work)
	Dress		Work			
1947—S [1]	104.7	----------	97.0	----------	102.7	98.1
F [1]	98.5	[2] (14)	99.4	[2] (18)	103.2	98.9
1948—S	100.3	[3] (16)	99.4	[3] (20)	100.8	101.9
F	106.3	(14)	105.3	(21)	100.8	103.3
1949—S	100.1	(18)	101.8	(23)	95.6	100.4
F	90.1	(21)	97.4	(25)	96.6	97.4
1950—S	90.4	(25)	97.6	(24)	96.2	99.3
F	90.9	(25)	98.4	(29)	98.7	103.3
1951—S	103.0	(17)	116.9	(31)	105.8	113.7
F	104.2	(26)	116.5	(28)	107.7	112.2
1952—S	95.3	(21)	113.5	(24)	107.4	112.6
F	96.1	(26)	112.7	(25)	104.0	111.5
1953—S	97.0	[3] (18)	114.3	(25)	103.9	111.9
F	98.3	(18)	116.8	(25)	104.5	111.1
1954—S	97.4	(17)	115.3	(21)	106.7	114.8
F	95.1	(23)	113.0	(19)	105.9	113.7
1955—S	95.3	(16)	112.3	(24)	105.8	114.8
F	94.9	(13)	112.0	(24)	106.5	114.8
1956—S	95.6	(17)	115.2	(24)	108.6	117.0
F	98.0	(17)	119.5	(22)	109.8	118.1
1957—S	101.1	(17)	120.0	(20)	110.4	119.3
F	102.6	(12)	119.4	(20)	108.6	121.5
1958—S	104.6	(13)	124.9	(20)	108.9	122.6
F	101.5	(14)	122.3	(18)	108.6	124.1
1959—S	101.2	(13)	126.8	(18)	108.9	123.3
F	102.9	(8)	126.9	(18)	109.1	125.6

For notes 1, 2, 3, see Table 1.

CHART 2

Men's Cotton Work Socks (1947-49 = 100)



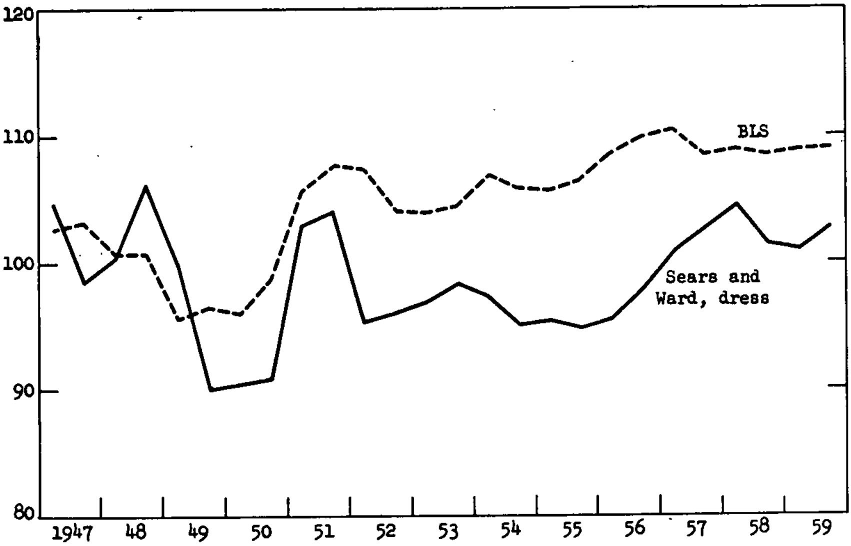
pares our index for cotton work socks with the AMS index for cotton work socks. There is somewhat more fluctuation in our series, but the trends and the major movements of the two series are extremely similar. This close agreement seems to be related to the great stability in the physical characteristics of the item. There are a number of styles for which we have continuous observations covering the entire period. There is also close agreement in the price levels of the AMS and mail-order series. In fall 1959 the average price paid by farmers was 33.3 cents; the average of all the catalog prices was 31.8 cents.

Chart 3 compares our series for dress socks with the BLS series for men's cotton socks. The major difficulty in this comparison is that the BLS series is not confined to dress socks. From 1948 to 1950 the series includes only work socks; for 1950 to 1953 it appears to include both dress and work socks, and for 1953 to 1959 it includes only dress socks. Despite this, the general trend of the BLS series is quite similar to that of our dress sock series. The BLS series is consistently somewhat higher except during the base period. Much of the difference arises after the Korean War, when the BLS series falls less than our dress sock series; this behavior is similar to that of the two series for work socks, and undoubtedly results from the inclusion of work socks in the BLS series at this time. Nevertheless, we have been unable to approximate the BLS series more closely by combining our series for dress socks and work socks, either by averaging or by linking.

A mail-order series following the BLS specifications was constructed, but is of little value. After 1953 it rests largely on a single observation in each period. The principal difficulty in following the

CHART 3

Men's Cotton Socks (1947-49 = 100)



BLS specifications occurs because the BLS specifies two-ply socks. Almost all of the cotton dress socks in the catalogs are four-ply, a few are six-ply. The only two-ply sock is sometimes described as a work sock. Perhaps the BLS prices two-ply cotton dress socks largely in specialized workingmen's stores rather than in department stores and general men's furnishing stores.

The frequent changes in BLS specifications in the early part of the period are somewhat hard to understand for an item such as cotton socks where styles are very stable. For many purposes our dress sock series might be regarded as superior series. The number of observations in this series declines markedly toward the end of the period as cotton socks are increasingly replaced by nylon stretch socks, spun nylon socks, and various blends of natural and synthetic fibers. We discuss one of these newer items, nylon stretch socks, later in this section.

3. MATTRESSES, 54-INCH WIDTH

The price indexes for mattresses are shown in Table 3. Chart 4 compares the BLS, AMS, and mail-order indexes for innerspring mattresses, and Chart 5 compares the AMS and mail-order indexes for felted cotton mattresses. This last item was dropped from the AMS index in the January 1959 revision, but data are available for it through 1959.

The general trend of the three indexes for innerspring mattresses is very similar. The Fall 1959 levels of the BLS and mail-order indexes are only a point apart; the AMS index lies five points lower than the mail-order index. The BLS index shows smaller dips than ours in 1949 and 1955, and is generally more stable. The AMS index rises much less than the other two during the Korean War and in

TABLE 3.—*Mattresses, 54-Inch Width*

[1947-49=100]

Date	Innerspring construction				Felted cotton		
	Sears and Ward		BLS	AMS	Sears and Ward		AMS
1947—S [1]	107.1	----------	101.1	105.0	107.0	----------	111.4
F [1]	98.5	[3] (4)	98.0	99.1	98.1	[3] (2)	102.9
1948—S	105.6	[3] (11)	101.4	100.3	104.5	[3] (3)	101.1
F	100.9	(11)	100.8	101.1	102.5	(4)	100.1
1949—S	98.3	(10)	100.8	98.8	96.6	(5)	95.2
F	89.6	(13)	98.6	95.7	91.3	(5)	89.3
1950—S	91.8	(13)	99.1	96.2	89.8	(5)	88.0
F	96.8	(13)	107.8	101.1	94.5	(8)	93.8
1951—S	123.4	(11)	119.7	112.9	139.1	(5)	107.8
F	125.1	(12)	120.3	113.7	150.9	(5)	109.6
1952—S	116.6	(9)	120.3	113.2	122.8	(8)	110.5
F	118.6	(13)	117.3	112.4	122.8	(9)	109.6
1953—S	116.1	[3] (11)	112.7	110.9	124.4	[3] (9)	107.4
F	116.0	(9)	111.4	110.6	118.9	(9)	106.5
1954—S	111.5	(9)	111.0	109.1	112.7	(5)	103.8
F	109.7	(12)	111.6	110.9	111.2	(5)	105.1
1955—S	107.2	(11)	111.7	109.3	96.7	(2)	105.6
F	103.4	(14)	111.7	110.9	97.8	(6)	104.7
1956—S	105.4	(16)	110.3	109.8	97.8	(6)	104.2
F	108.2	(13)	114.7	111.4	98.0	(7)	103.8
1957—S	114.5	(15)	117.5	112.9	101.8	(8)	104.2
F	115.0	(10)	119.7	114.5	101.8	(5)	105.1
1958—S	119.8	(13)	119.5	112.7	101.8	(8)	104.7
F	119.2	(13)	119.1	113.2	103.6	(7)	103.8
1959—S	120.9	(16)	119.5	113.2	103.6	(7)	103.8
F	119.2	(16)	120.3	114.2	102.8	(7)	104.7

For notes 1, 2, and 3, see Table 1.

CHART 4

Mattresses, Innerspring, 54-inch width (1947-49 = 100)

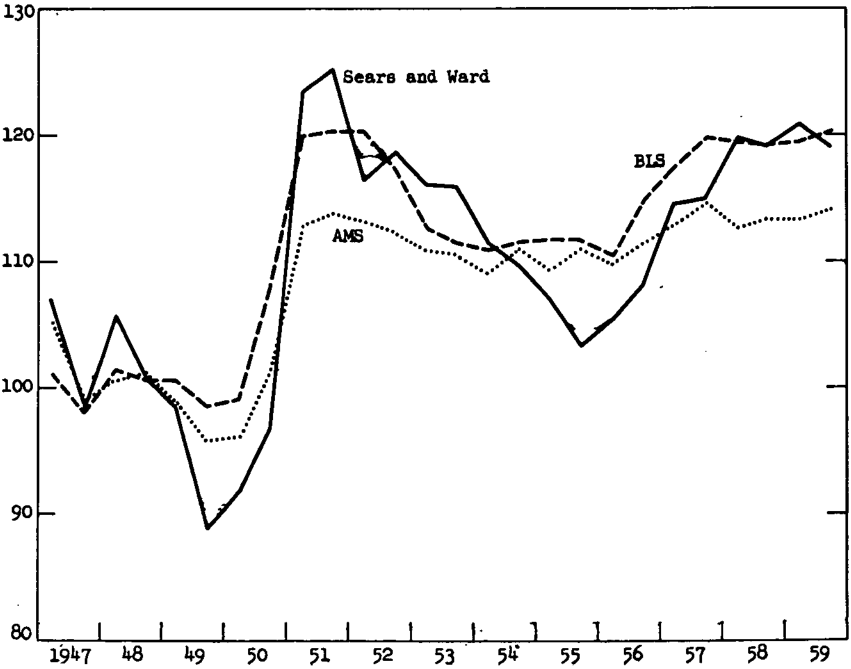
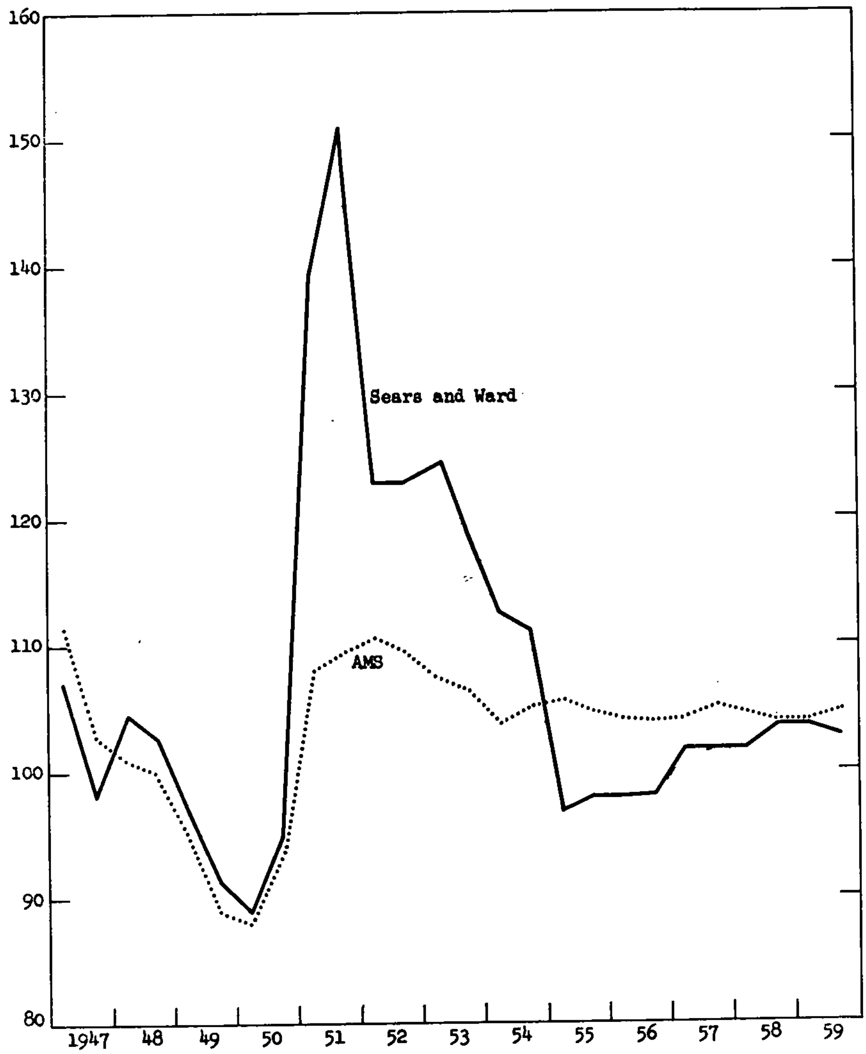


CHART 5

Mattresses, Felted Cotton, 54-inch (1947-49 = 100)



1956–58. It is characteristic of the AMS indexes we have examined that they do not rise as much as the others in the Korean War period, or fall as much afterward. Two possible explanations of this behavior suggest themselves. The AMS outlet sample was confined to independent stores until 1953, and perhaps independent stores in small communities were able to sell off old stock acquired at lower costs without taking more than a normal markup. A more probable explanation is that farmers, confronted with very sharply rising prices for many items, responded in part by trading down—that is, by shifting to lower qualities. The fall of prices a few years later would then be accompanied by a return to the more usual qualities. Such behavior could have contributed to the rise of the parity ratio in 1951 if corresponding effects were smaller on the side of prices received, either because commodities were specified more narrowly or because there was less possibility of year-to-year quality variation.

We prepared an index of innerspring mattresses from Sears and Ward data following the BLS specifications, but have not presented it here. It is similar to the general mail-order index, but falls more sharply from 1952 to 1954, and rises more from 1956 to 1958. Much of the time this index is based on only one observation, and at one point no observations meet the specifications completely. The principal quality change in innerspring mattresses over the period was a gradual increase in the number of coils. This increase is reflected in the BLS specifications, but with a lag, so that just before each change in specifications it becomes very difficult to get observations for mattresses that otherwise met the specification with as few coils as the maximum permitted by BLS. In Spring 1954, when the permitted range was 209–231 coils, there was only one item in the two catalogs that met the specification, and for this we could get no price change observation from Fall 1953.

Our series for felted cotton mattresses is very close to the AMS index as a measure of change over the whole period, but differs widely in intervening movement. The failure of the AMS index to rise as much as mail-order prices during the Korean War noted in the discussion of innerspring mattresses, appears in an exaggerated form in the series for felted cotton mattresses. The sharp rise in the mail-order prices of felted cotton mattresses is undoubtedly due in part to the rise in the wholesale price of raw cotton, which reached 136 percent of its 1947–49 average in the Spring of 1951. Raw cotton is a more important component of cost for these mattresses than for most cotton products. However, we do not know why the mail-order prices of felted cotton mattresses should have risen more than the price of raw cotton.

The other major difference between the series shown in Chart 5 is the drop in our index from Fall 1954 to Spring 1955, which does not appear in the AMS index. Since our index rests on only two observations at this point, it may well be in error. Both houses seem to have made sweeping changes in the specific items in their lines at this time. The average of the mail-order prices in Fall 1959 was $26.65, somewhat higher than the average price paid by farmers, $23.20.

In general, mattresses of all felted cotton are considerably cheaper than the innerspring mattresses, though the most expensive of them cost more than the least expensive innersprings. The average price paid by farmers for innerspring mattresses in September 1959 was $43.10, almost $20.00 more than the average for felted cotton. It seems probable that the latter are bought by low-income groups and might have to be included in a pricing program for either urban or rural areas if a special price index for low-income groups were to be constructed. It is interesting to note that the price rise for felted cotton mattresses is less than that for innersprings according to both the AMS indexes and ours. This contrasts with the findings for food reported in Staff Paper No. 7, where the items with negative income elasticities tended to have larger than average price rises. The effect of rising incomes on mattress purchases seems to have a more important quality than quantity dimension. Between 1924–29 and 1955, the quantity weight for mattresses in the index of prices paid by farmers actually fell. However, felted cotton mattresses had the full weight in 1924–29, about half the weight in 1937–41, and none of it in 1955.[8] The same phenomenon can be seen very clearly in the budget studies for urban consumers. In large cities in the West in 1950, the average price paid for mattresses was under $20.00 for families with incomes under $2,000, and rose to $73.61 for families with incomes of $10,000 and over; the quantity purchased remained quite constant over the income range at 0.1 to 0.2.[9] The mattresses in the catalogs in 1950 that met the BLS specifications ranged in price from $25.95 to $29.95 in the Spring, and $26.95 to $32.95 in the Fall. This corresponds roughly to the average price paid for mattresses in large cities in the West in the income range of $2,000 to $5,000. Since the average city wage and clerical worker family had an income in this range in 1950, the BLS seemed to be specifying an item at this date that was appropriate to the group it sought to represent.

During the period covered by this paper, foam rubber mattresses began to appear in the mail-order catalogs, at prices typically higher than the highest priced innerspring mattresses carried by mail-order houses. We could not construct a price series for foam rubber mattresses, because they were too often sold only in combination with a box spring.

4. RUGS AND CARPETS, WOOL AND WOOL-RAYON BLENDS

Both AMS and BLS price Axminster rugs; BLS prices broadloom carpets in addition. The two BLS series are labeled "rugs, wool Axminster" and carpets, wool broadloom" in the bulletins that present the item indexes. However, the rug series has included a 50-percent wool, 50-percent rayon blend pile as an alternate specification since 1953, and the carpet series included a 50-percent wool, 50-percent rayon blend pile as an alternate specification for 1951–58. Broadloom carpet was deleted from the CPI in December 1947 and not restored until March 1953. However, it was retained for test pricing and the published item indexes are continuous.

Table 4 presents our series for rugs and carpets together with the BLS and AMS series. The series for carpets are shown in Chart 6. The mail-order series rises more during the Korean War and remains above the BLS series thereafter, the difference narrowing gradually to about 8 points by the end of the period (the vertical scale of Charts 6 and 7 is twice that of our other charts because of the large price rise in these items in 1950–51). Except for this difference in level, the two series are remarkably similar after 1952, even in their small movements. The difference between the two series at the peak in 1951 is somewhat exaggerated by the lack of precise correspondence in timing. The peak quarterly level of the BLS index is 146.0 in June 1951; this date is of course not included in the series as we present it in Table 4.

[8] See *Agricultural Economics Research*, April–July 1959, p. 62.

[9] *Study of Consumer Expenditures, Incomes, and Savings, Urban U.S., 1950*, Vol. XIII, p. 107, University of Pennsylvania, 1957. When we use data from the 1950 survey of consumer expenditures, we will use the data for large cities in the West, since our price data come from this region, and the CPI is heavily weighted by large cities. The survey data of interest to us are not averaged over all cities and regions.

TABLE 4.—*Rugs and Carpets, Wool and Wool-Rayon Blends*

[1947–49=100]

Date	Carpets, broadloom			Axminster rug, 9 x 12 ft.			
	Sears and Wards		BLS	Sears and Ward		BLS	AMS
1947—S[1]	95.9	----------	105.9	95.9	----------	95.2	95.1
F[1]	92.9	[2] (7)	98.9	93.5	[2] (5)	95.9	98.0
1948—S	99.4	[2] (8)	96.0	99.7	[2] (5)	99.4	101.9
F	101.8	(8)	100.2	101.3	(5)	103.1	103.8
1949—S	108.6	(9)	101.4	107.2	(8)	105.1	102.5
F	101.5	(11)	101.4	102.9	(10)	102.5	98.6
1950—S	103.7	(11)	103.8	107.2	(9)	109.4	99.2
F	112.9	(18)	119.2	117.4	(13)	131.1	109.8
1951—S	155.6	(13)	142.5	162.7	(10)	157.9	126.2
F	177.5	(10)	126.7	186.0	(9)	151.9	132.2
1952—S	140.9	(9)	120.4	147.7	(6)	142.8	129.5
F	127.9	(11)	114.4	134.4	(7)	138.3	125.0
1953—S	130.6	[3] (11)	118.1	141.7	[3] (6)	142.3	123.4
F	132.7	(7)	117.8	146.4	(3)	142.0	120.8
1954—S	130.7	(15)	113.1	144.2	(7)	140.7	116.4
F	126.0	(16)	111.6	139.7	(7)	143.7	118.6
1955—S	124.4	(11)	113.6	140.4	(4)	144.1	117.9
F	126.0	(16)	114.8	143.6	(8)	144.0	117.6
1956—S	129.0	(17)	119.5	147.2	(7)	147.2	118.2
F	133.0	(17)	118.0	150.1	(7)	147.7	118.7
1957—S	133.0	(15)	123.3	150.1	(6)	154.4	119.0
F	134.2	(11)	126.8	149.6	(4)	157.0	116.8
1958—S	134.2	(10)	127.8	148.4	(4)	154.7	114.8
F	132.6	(7)	123.6	145.3	(4)	151.7	112.0
1959—S	134.2	(6)	125.2	150.2	(3)	151.1	109.4
F	135.0	(7)	128.5	150.2	(3)	151.7	108.2

For notes 1, 2, 3, see Table 1.

CHART 6

Carpets, Broadloom (1947-49 = 100)

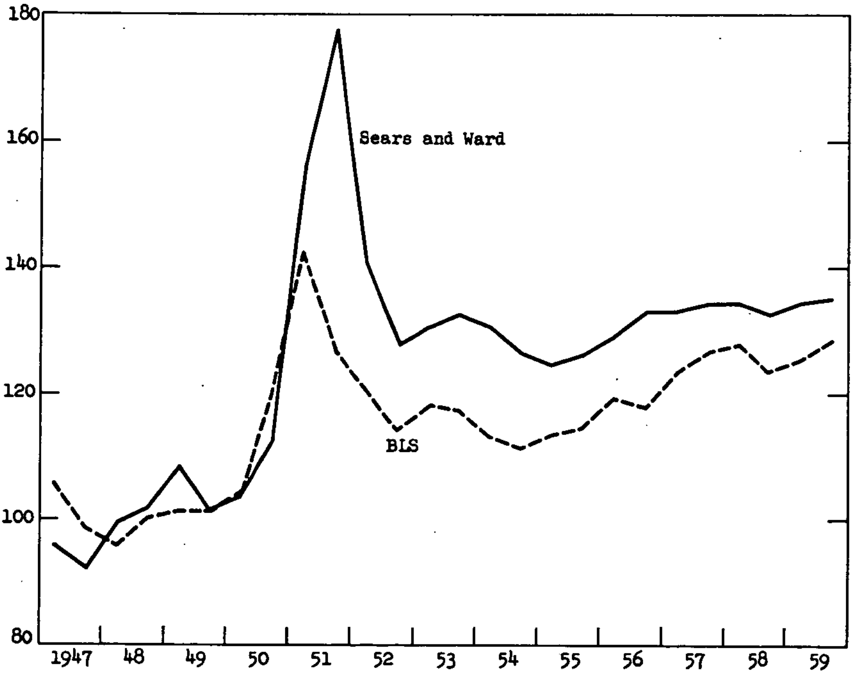
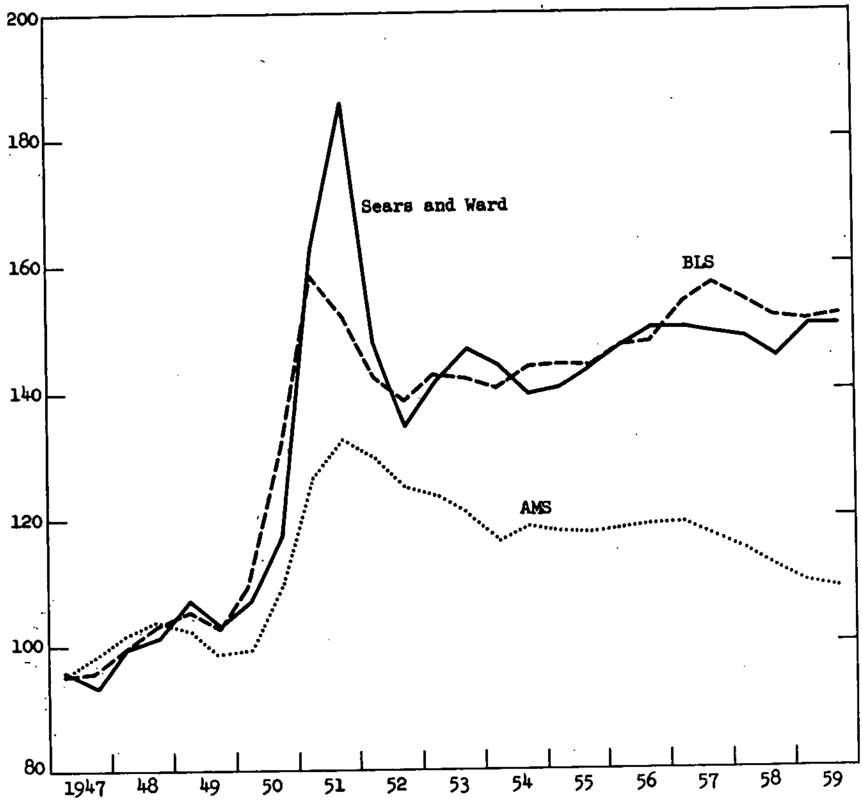


CHART 7

Rugs, Axminster, 9 x 12 (1947-49 = 100)



There is a BLS series for rayon broadloom carpeting beginning December 1952 and ending in 1960. In 1960 this was replaced by a series on nylon broadloom carpeting. The September 1959 level of the index for rayon carpeting was 87.6 on a December 1952 base, although the price of wool and wool blend carpeting had been rising over this period. We collected data for rayon and nylon carpeting, but did not have enough observations to construct an index for either item. We were also unable to construct an index for wool carpeting meeting BLS specifications.

In the case of wool Axminster rugs, our index is again very close to the BLS index (Chart 7). The chart again overstates the difference between the 1951 peaks; the BLS index stood at 162.0 in June 1951. The agreement in level after 1952 is closer than in the case of carpets, though the agreement in movement is not quite as close. The AMS index follows a completely different course from the other two indexes. It rises less than half as much in 1950–51, and falls almost continuously thereafter, ending more than 40 points below the other indexes. The reason for this behavior is not hard to find. The AMS specification is simply "rug, 9′×12′, Axminster, seamless" with nothing at all said about the pile fiber. It seems highly probable that the respondents to the AMS inquiries were reporting the prices of all-wool Adminster rugs before 1951, and thereafter began to report wool-rayon blends with increasing frequency. This inference is supported by comparing the levels of the AMS average prices with the catalog prices. In Fall 1950 the average price paid by farmers for an Axminster rug was $75.2. This is roughly in the middle of the price range for all-wool rugs in the catalogs; the average catalog price is $78.67 and the range is from $49.95 to $123.00. In Fall 1959 the average price paid by farmers was slightly lower than it had been nine years before—$73.8. The lowest priced 9′×12′ all-wool Axminster in the catalogs was $99.00. However, a wool-rayon blend 9′×12′ Axminster was offered for $78.00.

A price series that makes direct comparisons between all-wool rugs and wool-rayon blends does not seem very useful, since neither the costs of production nor the satisfactions offered to consumers would be similar for the two items. The blend might be just as satisfactory at first, but would surely not wear as long. This seems to be a case in which the looseness of AMS specifications deprives the series of any meaning. Nor can it be argued that specification of fiber content would be impossible in a mail survey; respondents would surely be able to state whether they were reporting the price of all-wool rugs or of blends.

We constructed an index for Axminster rugs that comes closer to meeting the BLS specifications than the main mail-order series, but have not shown it here. This series is confined throughout to rugs with 4,700 tufts or fewer per square foot. It is at a slightly higher level than the main mail-order series after 1952; its Fall 1959 level is 158.7. Otherwise, the two series are very similar. At a number of points the series just described is based on only one observation per period. Our inability to follow BLS specifications for rugs at all precisely arises from difficulties similar to those encountered in the case of innerspring mattresses. There is an increase in 1956 in the number of rows to the inch called for in the specifications from 4⅔ to 5⅔ (from approximately 3,000 to approximately 4,600 tufts). It is only by slightly exceeding the limit set in 1956 during the whole period that we can assemble enough quotations to make a continuous index.

5. WOMEN'S RAYON AND NYLON PANTIES

Both AMS and BLS collect data for women's rayon panties. We have prepared mail-order indexes for this item, and in addition for women's nylon panties and for rayon and nylon combined (Table 5 and Charts 8 and 9).

Let us consider first the three indexes for rayon panties shown in Chart 8. Except in 1947–48, there is extremely close agreement between the AMS index and the mail-order index based on a full range of styles. They never differ by more than 4 points after 1948, and seldom by more than 2. However, the BLS index lies consistently above the other two after 1947; the difference becomes substantial in 1951–52 because the BLS index never falls appreciably below the level reached in Spring 1951.

The divergence of the BLS index from the other two is not explained by the mail-order index conforming to BLS specifications. This index could be prepared with little difficulty and is never based

TABLE 5.—*Women's Rayon and Nylon Panties*

Date	Rayon (1947–49=100): Sears and Ward: All varieties		Rayon (1947–49=100): Sears and Ward: Conforming varieties		Rayon (1947–49=100): BLS	Rayon (1947–49=100): AMS	Nylon, Sears and Ward (Fall 1948=100)		Rayon and nylon, Sears and Ward (1947–49=100)
1947—S [1]	111.4		104.0		99.4	112.6	----		111.4
F [1]	96.2	[2] (13)	95.3	[3] (3)	100.5	102.5	----		[4] 96.2
1948—S	101.7	[2] (37)	106.5	[3] (5)	103.4	102.4	----		101.7
F	104.8	(41)	109.0	(5)	106.4	100.3	100.0		104.8
1949—S	97.0	(37)	98.4	(5)	102.0	93.8	90.3	[2] (2)	96.9
F	88.9	(45)	86.8	(6)	90.7	88.3	85.2	(6)	89.1
1950—S	88.7	(40)	87.3	(6)	90.7	85.9	79.2	(10)	87.8
F	89.8	(47)	87.3	(3)	95.1	91.0	85.1	(8)	89.6
1951—S	98.3	(55)	95.2	(4)	100.4	97.2	90.0	(7)	97.8
F	95.7	(66)	95.8	(4)	100.7	94.0	84.1	(7)	94.9
1952—S	92.4	(61)	92.4	(6)	100.3	90.1	76.8	(8)	91.1
F	90.0	(64)	87.8	(7)	99.7	87.6	73.6	(18)	88.4
1953—S	89.8	[3] (54)	87.3	[3] (6)	100.1	86.7	74.0	[3] (20)	88.4
F	90.3	(51)	87.6	(6)	101.0	86.4	72.6	(25)	88.2
1954—S	89.9	(47)	86.5	(6)	100.4	87.2	70.2	(22)	87.1
F	89.1	(55)	86.8	(5)	99.3	87.2	63.6	(20)	84.3
1955—S	89.1	(63)	86.8	(6)	98.8	87.1	62.1	(26)	83.7
F	88.2	(64)	86.4	(6)	98.1	87.6	59.8	(16)	82.4
1956—S	88.8	(50)	86.4	(6)	98.3	87.1	58.9	(26)	82.5
F	89.8	(48)	87.2	(6)	99.6	87.5	57.8	(23)	82.7
1957—S	87.4	(51)	85.5	(6)	99.2	87.6	57.6	(14)	80.9
F	87.4	(41)	85.5	(4)	99.0	87.8	57.6	(20)	80.3
1958—S	88.6	(53)	89.9	(6)	99.9	87.2	56.1	(25)	81.0
F	86.7	(47)	87.7	(5)	99.8	87.1	54.5	(20)	79.2
1959—S	86.2	(47)	91.7	(5)	100.0	88.6	54.2	(17)	78.8
F	87.1	(44)	92.9	(5)	97.7	89.8	57.0	(19)	80.6

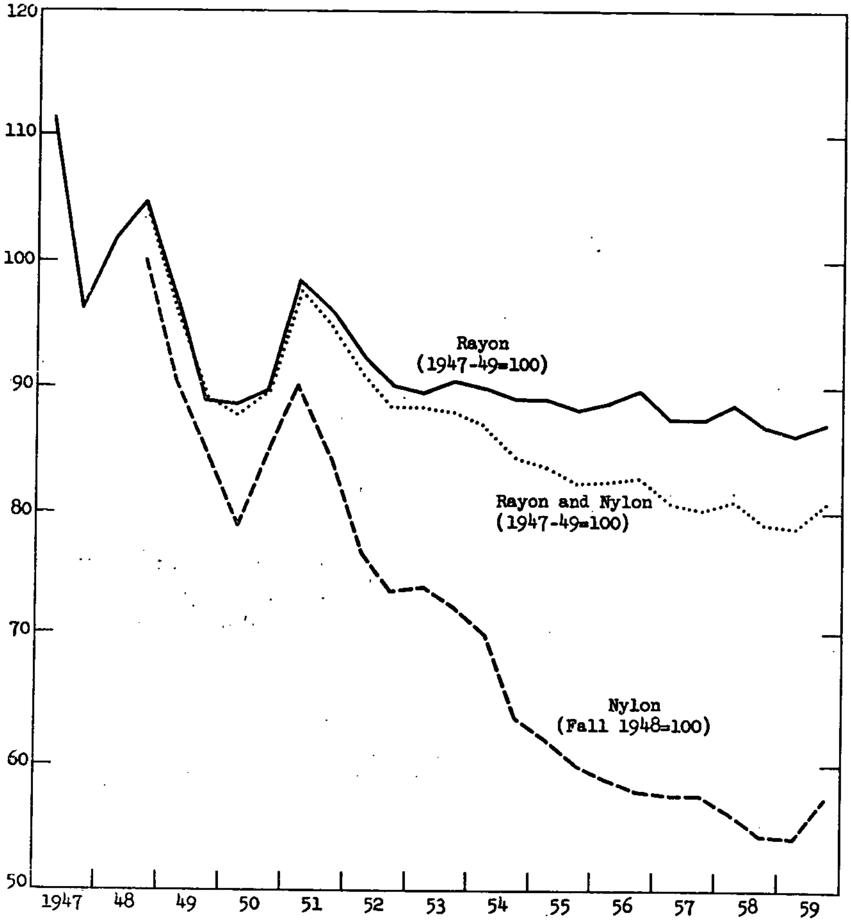
For notes 1, 2, 3, see Table 1.
[4] The number of observations for this column is the sum of the numbers for columns 1 and 5.

on fewer than three observations per period. It is shown in Table 5, but not charted. It is confined to untrimmed styles and, before 1952, is based on flare-leg and band-leg styles, excluding briefs. For 1952 and later, it is based only on briefs. The main mail-order index includes all styles at all times. From its peak in 1951 to Spring 1953 the conforming mail-order index falls almost as much as the all-items index. Its behavior is like that of the AMS series rather than the BLS series. It should also be noted that in the mail-order indexes, the declines are not averages of highly divergent movements in which the price reductions happen to outweigh the advances. Rather, a substantial decline takes place in the price of almost every style considered individually. We are unable to explain the failure of the BLS index to reflect this decline.

Chart 9 compares the movement of the main mail-order series for rayon panties with those for nylon and for nylon and rayon combined. Nylon panties first appear in the catalogs in Fall 1948, and thereafter gradually represent an increasing proportion of the items offered. By 1953, we have about half as many observations for nylon as for rayon, a proportion that holds roughly constant thereafter. The absolute price level of nylon panties is always higher. In Fall 1959 the range of Sears' price is $0.333 to $1.35 for rayon, and $0.84 to $1.65 for nylon. Only 2 of 29 rayon styles were above $1.00; only one of 13 nylon styles was below $1.00. However, the price of nylon panties fell markedly relative to rayon, as shown by the chart. This relative fall is large enough to pull the index for nylon and rayon combined substantially below the index for rayon alone.

CHART 8

Women's Rayon and Nylon Panties
(Sears and Wards)



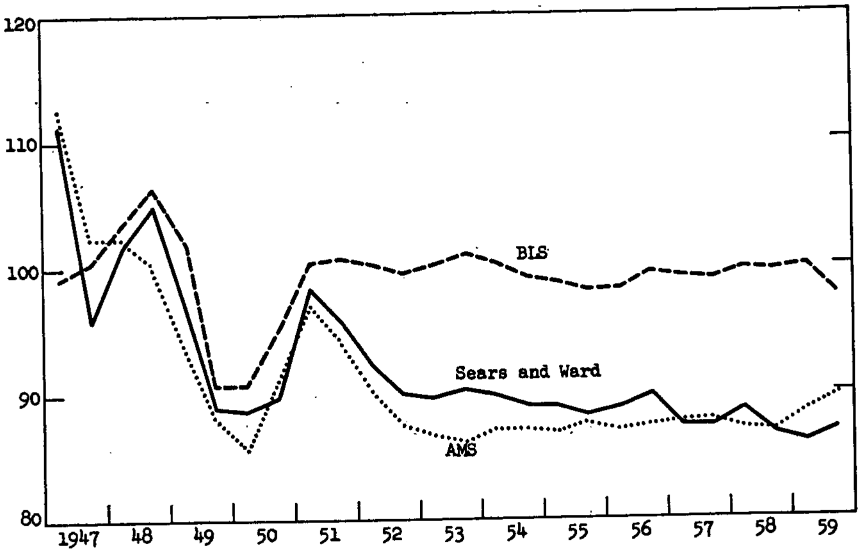
As early as 1950, nylon panties accounted for a substantial portion of expenditures on panties of all fabrics, especially in the higher-income classes. In the income class \$4,000 to \$5,000 the expenditure on nylon panties for women and girls 16 and over was roughly one-third that on rayon panties; thus in large cities in the West it was \$2.25 for rayon and \$0.76 for nylon. In the South, the proportion of nylon was somewhat higher and in the North somewhat lower.[10] It should be remembered that these data were not tabulated until long after 1950.

It can be argued that by ignoring the growing importance of nylon panties, BLS understated the price decline for panties in general over the period. This argument would not be valid, however, if the BLS adequately represented the introduction of nylon in its other series for women's underclothing. Current specifications call for nylon

[10] *Survey of Consumer Expenditures*, 1950, Vol. XIV, pp. 151–224.

CHART 9

Women's Rayon Panties
(1947-49 = 100)



slips and nightgowns; the titles of these item indexes in earlier BLS bulletins suggest that the nightgown was changed from rayon to nylon quite recently, and that for the slip nylon and rayon shared the weight until recently.

6. MEN'S SWEATERS

AMS does not price men's sweaters; BLS prices men's wool coat sweaters. From the catalogs, we have priced a full range of styles of men's wool and orlon sweaters. The indexes for this item are shown in Table 6 and Chart 10. Since BLS does not price sweaters in the Spring, the data are for Fall of each year.

Our main mail-order index for wool sweaters includes pullover, sleeveless sweaters, coat sweaters with zippers or with collars, and stout sizes. The BLS index is confined to 5- or 6-button coat sweaters in regular sizes, for most of the period collarless. This difference in the coverage of styles produces a substantial divergence in the indexes; our main index falls substantially more than the BLS index after the Korean War and remains below thereafter. Our index conforming to the BLS specifications is somewhat more volatile in its movements than the BLS index because of the thinness of the sample, but its general trend is close to that of the BLS index. This seems to be a case in which the BLS has specified a particular style whose price movements are noticeably different from those of the item as a whole. Although the collarless coat sweater may well be the single style most often bought by workingmen, the large number of styles available suggests that no one can represent more than some fairly small fraction of the total market.

In Fall 1950, each house had one sweater that met the BLS specifications; both were priced at $3.94. This is a lower price than the

TABLE 6.—*Men's Wool and Orlon Sweaters*

[Fall of each year]

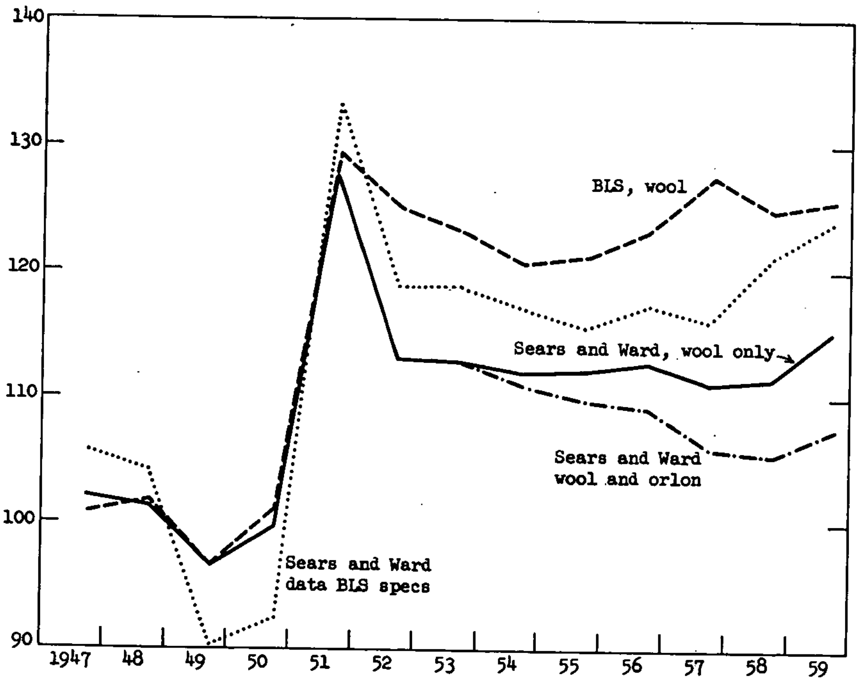
Date	Sears and Ward							BLS, wool (1947–49=100)
	Wool (1947–49=100)				Orlon (1953=100)		Wool and orlon (1947–49=100)	
	All varieties		Conforming varieties					
1947	102.1		105.6		----------		102.1	100.7
1948	101.4	[1] (15)	104.3	[1] (4)	----------		[2] 101.4	101.7
1949	96.6	(19)	90.1	(2)	----------		96.6	96.6
1950	99.6	(17)	92.4	(2)	----------		99.6	101.2
1951	127.7	(13)	133.2	(2)	----------		127.7	129.3
1952	113.0	(20)	118.7	(2)	----------		113.0	124.9
1953	112.9	(21)	118.8	(4)	100.0		112.9	123.3
1954	112.1	(22)	117.3	(4)	87.4	[1] (2)	111.0	120.7
1955	112.2	(25)	115.8	(3)	77.0	(3)	109.7	121.2
1956	112.8	(23)	117.4	(3)	74.8	(8)	109.3	123.2
1957	111.2	(21)	116.2	(3)	69.8	(9)	106.0	127.5
1958	111.5	(22)	121.5	(1)	68.7	(13)	105.6	125.0
1959	115.0	(15)	124.2	(1)	69.0	(15)	107.5	125.6

[1] Numbers in parentheses are number of price change observations between the year shown and the preceding year.

[2] The number of observations for this column is the sum of the number for cols. 1 and 3.

CHART 10

Men's Sweaters (1947-49 = 100)
(Fall of each year)



average price paid in 1950 by men and boys 16 and over for wool sweaters in any income or city size class in the West. The average price paid in large cities at incomes of $4,000–$5,000 was $8.13.[11] The low price of the sweaters meeting specifications is due to a change in the specifications in 1949 from flat knit to rib knit. Some of the flat knit sweaters meeting the 1948 specifications sold in 1950 at about the average prices paid by consumers in western cities. In 1951 the specification was again revised to permit a knit other than rib (interlock knit) as an alternate specification.

Beginning in 1953, orlon sweaters and wool-orlon blends appear in the catalogs. After 1954, these include coat sweaters that would meet BLS specifications except for the fiber. Our index for orlon sweaters is shown in Table 6, but not charted. The price of orlon sweaters falls 31 percent from 1953 to 1959, a period in which the price of wool sweaters was stable or slightly rising. The absolute price level of orlon sweaters was generally above that of corresponding wool sweaters until the end of the period; however, they have certain advantages that enabled them to increase their share of the market. In particular, they are mothproof and do not need to be blocked after washing. The number of price change observations for orlon sweaters gradually increased after 1953, while the number for all wool tended to decrease, so that by 1959 the two fibers were equally represented. When we combine the observations for wool and orlon, we get an index that lies seven points below our main all-wool index by 1959, and 18 points below the BLS index for all-wool coat sweaters.

As in the case of women's nylon panties, it can be argued that BLS makes no error in not reflecting the introduction of orlon in men's sweaters provided that orlon is adequately represented in some appropriate total. However, we have found no evidence of any introduction of orlon in men's clothing prior to September 1959, when specifications were issued for suburban coats and jackets that could (but need not) have orlon pile linings. According to the mail-order catalogs, orlon and orlon blends were also being used in such men's items as socks, long-sleeved sport shirts, robes, and suits. The case of girls' orlon sweaters will be considered next.

7. GIRLS' SWEATERS

Girls' sweaters have not been priced by AMS; they have been priced by BLS each Fall since 1952. The item index begins with December 1952, and the item was included in the CPI beginning in January 1953. The prices referred to wool cardigans until the Fall of 1954, although the published item indexes are called "girls' orlon sweaters" throughout in recent BLS bulletins.

Table 7 and Chart 11 compare our mail-order indexes with the BLS index.

The transition from wool to orlon for girls' sweaters was amazingly swift and complete. In 1952 there were no girls' orlon sweaters in the catalogs; by 1956 there were no wool sweaters left except for matched sets and athletic award sweaters, which we did not price. The method of handling this transition differs in the three indexes. Our main mail-order index includes only wool until 1953, both wool and orlon in 1953–55, and only orlon after 1955. The orlon sweaters

[11] *Survey of Consumer Expenditures*, 1950, vol. XV, p. 181.

TABLE 7.—*Girl's Wool and Orlon Sweaters*[1]

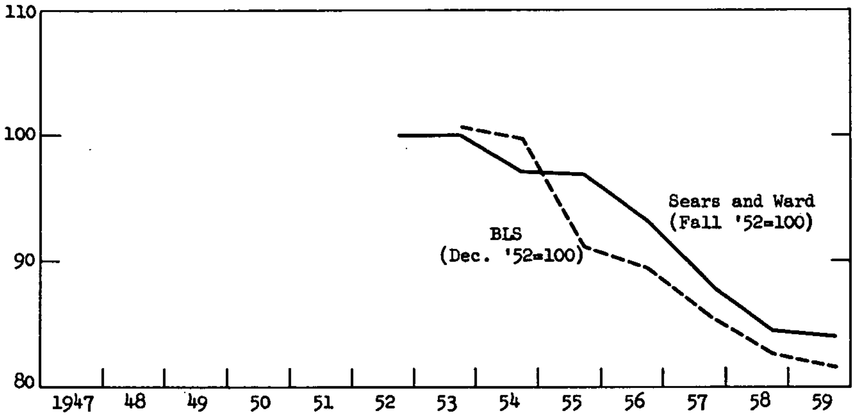
[Fall of each year]

Year	Sears and Ward (Fall 1952=100)				BLS, cardigans (December 1952=100)
	All varieties		Conforming varieties		
1952	100.0		100.0		----------
1953	100.0	[2] (7)	100.0	[2] (2)	100.6
1954	97.1	(9)	100.0	(2)	99.8
1955	96.9	(11)	99.0	(2)	91.1
1956	93.1	(10)	96.4	(2)	89.5
1957	88.1	(12)	96.0	(2)	85.4
1958	84.4	(14)	93.5	(2)	82.6
1959	84.1	(12)	94.8	(2)	81.5

[1] For the timing of changes from wool to orlon, see text.
[2] See note 1 to Table 6.
For notes 1 and 2, see Table 1.

CHART 11

Girl's Sweaters, Wool and Orlon
(Fall of each year)



are linked in, so that direct price comparisons between wool and orlon are never made. In the index of items conforming to BLS specifications, we link in orlon when the BLS specifications change in Fall 1954. This means we use 1954–55 as our first price change observation for orlon, rather than 1953–54 as in the main series. For the 1953–54 price change, seven of the observations in the main mail-order series refer to wool and two to orlon; for 1954–55 seven refer to wool and four to orlon. For the cities included in the item indexes, BLS made the transition from wool to orlon in December 1954, the second pricing of the orlon specification.[12] Thus the introduction of orlon does not affect the 1954 BLS figure shown in Table 7, which is for September. The BLS transition was made not by linking, but by a direct comparison of the prices of comparable orlon and wool sweaters.[13] Had we used the same method, we would have gotten a

[12] This and some of the other information on BLS procedures above is based on a letter to Don A. Proudfoot, Jr., from Arnold E. Chase, Chief, Division of Prices and Cost of Living, August 8, 1960.
[13] Letter to George J. Stigler from Sidney A. Jaffe, Assistant Chief, Division of Prices and Cost of Living, September 16, 1960.

result very different from that in any of the indexes shown in the table, for in the Fall of 1954 the catalog prices of girls' orlon sweaters were still above those of the most nearly comparable wool sweaters. Perhaps this is because the mail-order houses carried wool sweaters of lower than average quality.

Considering the sharply different ways in which they handle the principal problem, the indexes shown stay very close to one another. The deviant is our index for comparable items. This is confined to classic (untrimmed) cardigans, while the main mail-order index includes pullovers, shrugs, trimmed cardigans, and other cardigan styles, such as cardigans with brass buttons or with collars. We cannot be certain that the prices of classic cardigans fell less than those of other styles; with so few observations in the conforming index, its stability could be due to chance factors.

Girls' orlon sweaters are clearly a case in which BLS responded promptly and effectively to a change in the nature of the goods on the market. A cynic might add that this change was so sudden and drastic that it had little choice.

8. MEN'S NYLON STRETCH SOCKS

Nylon stretch socks were introduced into the CPI in June 1956; they have not been priced by AMS. They first appeared in the mail-order catalogs in Spring 1953. Table 8 and Chart 12 show the price history of this item.

The BLS specifications include only solid color rib knit socks without clocking. Our main series includes flat knit socks and socks with patterns and clocking. To get the series conforming with BLS specifications, we have followed the 1956 specifications during the period before they were issued. The number of price change observations in the main series is often substantially less than the total number of varieties in the catalogs, since the patterned socks often appear in one catalog only. Nevertheless, the number of observations increases rapidly from 1953 to 1955; after Spring 1955, it is only slightly lower than for men's cotton dress socks, with which nylon stretch socks are largely competitive, and for some periods it is higher.

The BLS series and our conforming series have exactly the same overall decline from their 1956 base date to Fall 1959, though the

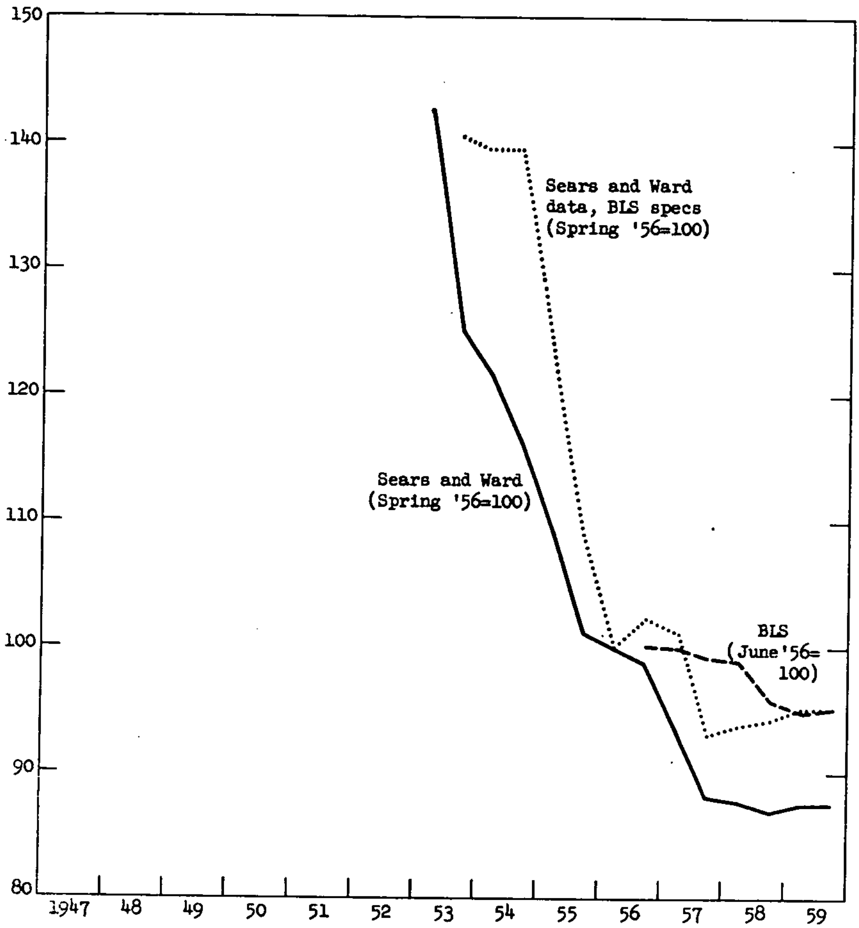
TABLE 8.—*Men's Nylon Stretch Socks*

Date		Sears and Ward (Spring 1956=100) All varieties		Sears and Ward (Spring 1956=100) Conforming varieties		BLS (June 1956=100)
1953	S [1]	142.6		----------		----------
	F [1]	125.1	[2] (1)	140.5		----------
1954	S	121.7	(3)	139.5	[2] (1)	----------
	F	115.9	(4)	139.5	(1)	----------
1955	S	109.4	(7)	123.6	(2)	----------
	F	101.2	(15)	109.4	(3)	----------
1956	S	100.0	(11)	100.0	(3)	----------
	F	98.7	(12)	102.3	(1)	100.2
1957	S	93.2	(9)	101.2	(2)	100.1
	F	88.2	(12)	93.0	(3)	99.3
1958	S	87.8	(8)	93.8	(2)	99.0
	F	87.0	(10)	94.2	(2)	95.8
1959	S	87.3	(11)	95.1	(3)	95.0
	F	87.3	(11)	95.1	(3)	95.1

For notes 1 and 2, see Table 1.

CHART 12

Men's Nylon Stretch Socks



time paths are somewhat different. The more erratic movement of our conforming series is undoubtedly related to the small number of observations underlying it. The mail-order series for all varieties falls substantially more than the other two series in 1956–57, suggesting that the price of the simpler styles stabilized before that of patterned socks. The most striking feature of the two mail-order series is, of course, the very sharp decline in prices before 1956; that is, before the item was included in the CPI. For the more inclusive series, the decline is almost 30 percent from Spring 1953 to Spring 1956; for the rest of the period it is only 13 percent. The contrast is even sharper for the conforming series. The largest fall in the main series rests on a single observation. However, the general magnitude of the fall is confirmed by the conforming series, where the number of observations is somewhat larger for the periods of greatest price decline.

With the advantage of hindsight, one can say that the BLS should have included nylon stretch socks in the CPI earlier than it did, so as to catch more of the price decline. However, at the time the price was falling most rapidly, the item may not have seemed important enought to include. A more extensive discussion of the issues raised by cases of this kind will be reserved for Section III.

9. BLANKETS: WOOL, ORLON, AND ACRILAN

Blankets are another item for which BLS collects prices and AMS does not. The BLS series and several mail-order series are shown in Table 9 and Chart 13. Blanket prices are collected by BLS only in Fall and Winter, so that the comparisons are confined to one observation per year.

The published BLS item index is still called "blankets, wool," although in September 1958 the specifications were broadened to permit the pricing of acrilan blankets in any outlet at the discretion of the agent. Direct price comparisons are not made between wool and acrilan. The inclusion of acrilan does not affect the movement of the BLS index from September 1957 to September 1958; the first effects appear in the movement for the last year shown here, 1958 to 1959.

The first column of Table 9 shows our basic mail-order series for wool blankets. This covers a range of sizes and weights from 66 x 84 inches (a single bed size) to 108 x 90 and from 2¾ to 6 pounds. It includes both solid colors and plaids or other patterns, and blankets bound on two and on four sides. Of course, in every price comparison these features are the same at both dates. Except in 1946, the BLS series is confined to solid color blankets bound on two ends. At any one time, a rather narrow range of weights is specified (e.g., 3¾ to 4¼ pounds) and at most times a particular size. After 1956, two different sizes meet the BLS specifications, 72 x 90 and 80 x 90.

The main difference between our series for wool blankets and the BLS series is the sharper rise in ours in 1950–51. This difference

TABLE 9.—*Blankets: Wool, Orlon, and Acrilan*

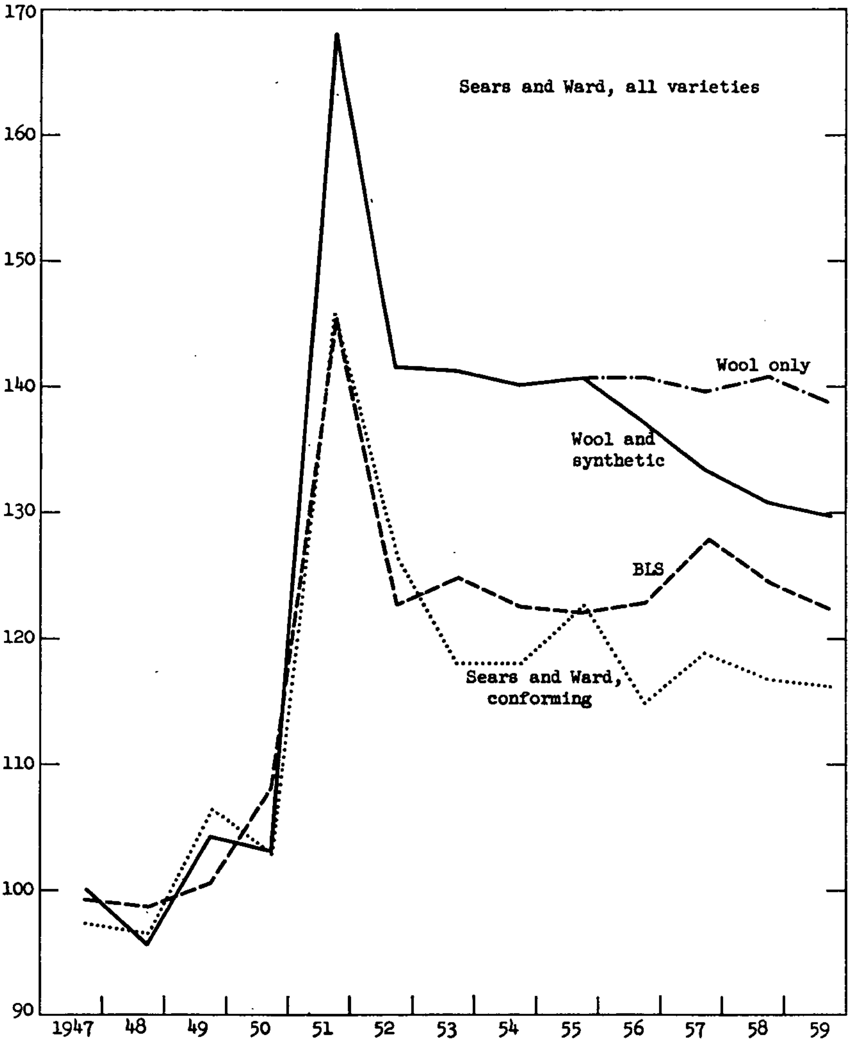
[Fall of each year: 1947–49=100 except as noted]

Year	Sears and Ward							BLS, wool and acrilan [1]
	Wool		Orlon and acrilan (fall 1955=100)		Wool and synthetic			
					All varieties	Conforming varieties [1]		
1947	100.0				100.0	97.3		99.3
1948	95.8	[2] (13)			[3] 95.8	96.5	[2] (4)	98.8
1949	104.2	(7)			104.2	106.2	(2)	100.7
1950	103.1	(12)			103.1	102.9	(2)	108.1
1951	167.7	(9)			167.7	145.9	(2)	145.6
1952	141.5	(8)			141.5	126.1	(2)	122.7
1953	141.1	(11)			141.1	118.0	(2)	124.9
1954	140.0	(16)			140.0	118.0	(2)	122.6
1955	140.6	(15)	100.0		140.6	122.5	(2)	122.4
1956	140.7	(11)	83.8	[2] (2)	137.2	114.9	(1)	122.9
1957	139.7	(11)	78.3	(6)	133.4	118.9	(3)	127.8
1958	140.7	(11)	74.2	(9)	130.7	116.8	(4)	124.5
1959	138.7	(14)	74.7	(7)	129.8	116.4	(8)	122.4

[1] Wool only, 1947–57; wool and acrilan, 1958–59.
[2] Numbers in parentheses are number of price change observations from the preceding year to the year shown.
[3] Number of observations for the column is the sum of the number in cols. 1 and 2.

CHART 13

Blankets: Wool, Orlon and Acrilan
(Fall of each year. 1947-49=100)



results not from the broader range of specifications we use, but from the procedures used by BLS to handle a change in its weight specification. Column 4, the conforming mail-order series, follows these procedures and behaves very much like the BLS series in 1950–51. The BLS weight specification changes from 4 to 4¼ pounds in 1950 to 3½ to 3¾ pounds in 1951. There was no overlap in pricing; instead the lighter blankets were compared directly with the heavier ones on a price-per-pound basis. Our data suggests that this procedure understates the rise in the price of blankets during the Korean War. This can be seen not only from the main mail-order series, but also from an alternative version of the conforming series not shown in Table 9. In this version we follow the BLS specifications throughout, except that we price both 3½- and 4-pound blankets in 1950 and 1951, and use the average change in their price (rather than the change in the price per pound of blankets in different weights) to get the 1950–51 movement. This alternative conforming index rises from 102.9 in 1950 to 161.6 in 1951, or almost as much as the main mail-order index.

Our only price change observation for a 4-pound blanket for 1950–51 is an increase of 37 percent. This is slightly less than the increase obtained by comparing prices per pound, and much less than the increase for 3½-pound blankets. Reasoning from the cost side, one would assume that the price of heavy blankets would rise more than that of light ones, since the price of wool was the most sharply rising cost, and should be a more important part of retail cost for heavier blankets. However, the price per pound of 4-pound blankets is slightly higher than that of 3½-pound blankets in both years, perhaps because other quality differences are associated with weight. It is also possible that the differential price behavior arose on the demand side. Consumers may have responded to the sharp rise in prices by buying lighter blankets; this could have checked the price rise for heavier blankets and contributed to their temporary disappearance from the market. The catalog prices of blankets meeting the BLS specification in 1950 were near the center of the range of prices paid by consumers in Western cities as reported in the Survey of Consumer Expenditures.

After 1951 there is little trend in either the BLS series or our series for wool blankets. Both drop slightly, ours by a somewhat larger amount. In both series, there is a tendency for the width of bindings to increase over the period, and for nylon to replace rayon as a binding fabric after 1957. We have made direct comparisons between blankets that differed only in binding width or fabrics in all cases. The BLS has done so in most cases; the periods when BLS did not make such direct comparisons are for the most part periods when we had no occasion to do so.

The second column of Table 9 shows our price index for orlon and acrilan blankets. The price of these synthetic blankets fell 25 percent from their first appearance in 1955 to the last observation in 1959. Both orlon and acrilan are brand names for acrylic fibers; the two are made by different manufacturers. So far as we are aware they have similar characteristics, but were introduced at first for somewhat different applications. Orlon tended to dominate in clothing applications, and acrilan in blankets and carpets. This seems to have resulted in a preference for acrilan in blankets that made the catalog prices of acrilan blankets about 6 percent higher than the prices of similar orlon blankets in 1957 (this comparison is based on the price per pound of blankets of the same size, but differing in weight by ¼ pound). At one point in the index we have nevertheless made a direct comparison between an acrilan blanket (1955) and an otherwise identical orlon blanket (1956) without any adjustment for the difference in price between the two brands of fiber observed in 1957. If we had made such an adjustment, our index for orlon and acrilan blankets would have fallen even more than it does; the 1956 level would be 81.7 (1955=100) and all subsequent values would be lower by about the same amount. The BLS index never includes any orlon blankets.

To get a continuous series for orlon and acrilan blankets it was necessary on a few occasions to make comparisons on a per pound basis between blankets of somewhat different weights. We have seen in the case of wool blankets in 1950–51 that this procedure does not always give reliable measures of price change. However, it should cause less difficulty in a period when prices were changing slowly than one in which they were changing rapidly.

When we combine our series for wool, orlon, and acrilan blankets for 1955–58, we get a series that falls rather steadily relative to the series for wool blankets alone. In 1958 the number of observations for synthetic blankets is almost as large as for wool blankets. The combined index is 10 points below the index for wool blankets only at this point. In 1958–59 the fall in the relative price of synthetic blankets halted; in fact synthetics rose slightly in price while the price of wool blankets fell. It was precisely at this point that BLS introduced acrilan blankets into its index, missing the entire fall in their relative price as shown by the mail-order data. Even in 1958–59 acrilan blankets were being introduced into the BLS index at the discretion of the agent, and there is reason to feel that they were still underrepresented. Agents may often have switched to acrilan only where they could no longer get quotations for wool. Materials furnished to the Price Statistics Review Committee by BLS on the pricing of blankets in Cincinnati show that in 1958–59 there were three wool blankets and one acrilan blanket being priced in that city. The ratio of wool to acrilan in the mail-order observations at this time was two to one. Like the mail-order data, the Cincinnati data show a rise in the relative price of acrilan blankets after their introduction to the CPI. However, the Cincinnati data are based on the substitution of one acrilan blanket for another within the same outlet, and probably overstate the true rise. We can summarize by noting that the BLS index for 1955–59 is much more like our index for wool blankets only than like our index for wool and synthetic blankets combined, despite the introduction of acrilan into the BLS index in 1958.

10. AUTOMOBILE TIRES, FOUR-PLY, 6.00X16 AND 6.70X15

We have left until last the item that has given us the most difficulty: automobile tires. It is the only item for which no price series we have been able to construct from mail-order data bears more than a faint resemblance to any official price series, and for which we are therefore generally unable to analyze reasons for differences among the series.

The price indexes for tires are shown in Table 10 and Chart 14. The mail-order series includes both of the most popular sizes during the period, 6.00 x 16 and 6.70 x 15, the second size coming into the series in 1949. The other series shown make a complete transition from the 16-inch to the 15-inch size at a particular date—the BLS series in Spring 1953 and the AMS series in Fall 1955. The mail-order series includes both tube type and tubeless tires, and tires with cotton, rayon, and nylon cord for all dates at which tires of these kinds were offered in the catalogs. It is nevertheless a much narrower index than we might have constructed, since it excludes six-ply tires, whitewall tires, snow tires and the many other sizes of tires that were on the market during all or part of the period.

TABLE 10.—*Automobile Tires, Four-Ply, 6.00 x 16 and 6.70 x 15*

[1947-49=100]

Date	Sears and Ward [1]		BLS [2]	AMS [3]
1947—S [4]	112.1		104.6	106.4
F [4]	100.1	[5](1)	94.7	95.7
1948—S	101.2	[6](3)	99.0	99.5
F	97.1	(5)	103.2	102.0
1949—S	97.5	(8)	103.5	102.0
F	92.0	(8)	95.8	94.5
1950—S	92.5	(7)	102.4	98.2
F	94.1	(8)	120.9	115.1
1951—S	119.9	(7)	130.6	128.9
F	120.0	(7)	130.6	130.8
1952—S	113.8	(7)	130.9	127.0
F	108.3	(6)	129.3	123.3
1953—S	107.9	[6](10)	130.0	122.6
F	107.5	(10)	129.4	120.8
1954—S	110.1	(10)	132.4	123.3
F	104.5	(11)	114.8	120.1
1955—S	105.1	(13)	123.1	122.6
F	111.2	(8)	127.7	117.6
1956—S	112.8	(10)	129.5	118.9
F	115.4	(13)	129.7	118.9
1957—S	116.6	(14)	127.5	118.2
F	111.9	(14)	131.8	113.9
1958—S	109.6	(14)	133.2	115.1
F	108.5	(16)	134.8	109.5
1959—S	110.9	(16)	136.7	108.2
F	107.0	(14)	122.9	105.1

[1] 6.00 x 16, 1947–48; 6.00 x 16 and 6.70 x 15 combined, 1949–59.
[2] 6.00 x 16, 1947–52; 6.70 x 15, 1953–59.
[3] 6.00 x 16, 1947–Spring 1955; 6.70 x 15, Fall 1955–1959.
[4] See note 1, Table 1.
[5] See note 2, Table 1.
[6] See note 3, Table 1.

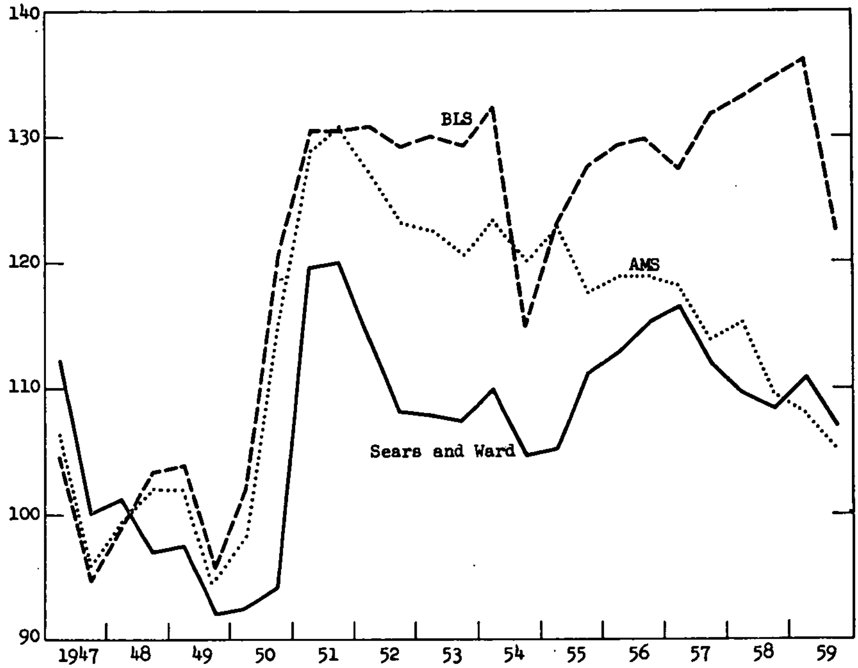
The BLS specified cotton cord tires until Fall 1950. From Fall 1950 through Spring 1955 it specified tires with cotton or rayon cord; in 1955 it permitted rayon or nylon cord for two months only—too briefly to affect the series shown here. After 1955, rayon cord was specified. Beginning in Spring 1959 the BLS series includes tubeless tires; this affects only the movement between the two dates shown in 1959. The AMS series specifies only four-ply tires of a particular size. All the series include federal excise taxes; the BLS series includes as well a charge for mounting, which is not part of the mail-order price. The mail-order series is based on a very small number of observations in the earliest part of the period because during the immediate postwar shortages of tires, the mail-order houses sold almost all of their available supply through their retail stores.

The mail-order series rises less than the others during the Korean War and falls much more rapidly after it. The AMS also shows a fall in the period after 1951, but the BLS index does not. Since the AMS series fails to rise in 1955–57 as the other series do, it ends the period at very much the same level as the main mail-order series.

It can easily be determined that the differences among the series are not the result of different handling of the change from 16-inch to 15-inch tires. We have constructed separate mail-order indexes for the two sizes, and these behave very much like the mail-order index for the combined sizes. At the time of the BLS transition to 6.70 x 15 tires (Spring 1953) our index for 6.00 x 16 tires alone was only 0.2 point different from the combined index for the two sizes. Thereafter it fell less, ending at 112.8 in Fall 1959 as compared with 107.0 for the combined index. If we had eliminated 6.00 x 16 tires in 1953,

CHART 14

Automobile Tires, 4 Ply, 6.00 x 16 and 6.70 x 15
(1947-49 = 100)



our index would therefore have diverged more sharply still from the BLS index. The 6.70 x 15 size accounts for one of the eight observations in the period ending Spring 1949. By 1953, it accounts for half the observations and by Fall 1959 for thirteen of sixteen.

The AMS index introduces 6.70 x 15 tires by linking in June 1955. This linking had been performed by AMS and was incorporated in the data as we received them. The average price paid by farmers for tires in Spring 1955, was $23.0; in Fall it was $22.1. These prices are considerably higher than the catalog prices of all but premium quality tires at this time; prices in this range were usually tubeless nylon-cord tires, and were probably not the volume leaders. The AMS price is also somewhat higher than the average price paid by farmers for automobile tires as reported in the 1955 survey of the farmer's expenditures. This survey shows an average expenditure of $19.62 for automobile tires, including recapping.[14] It is hard to know how recapping entered into the quantity measure. If a "recap" job was counted as a tire purchased, the average price is biased downward. If it is not counted in quantity, but is counted in expenditure, the average price is biased upward.

We attempted to construct a mail-order series conforming to BLS specifications, but it was based on very few observations. Later in-

[14] *Farmers Expenditures*, Volume III, Part 11 of the 1954 Census of Agriculture, p. 21. The figure shown was computed from total quantity purchased and total expenditures.

spection of the work sheets revealed serious errors in following the BLS specifications; we did not have time to reconstruct the series. Because the tire series includes some items whose characteristics change very little over the whole period, we can learn a good deal by examining the prices of these items at the beginning and the end of the period. One such item is the Ward's Riverside DeLuxe or Air Cushion DeLuxe tire, 6.70 x 15. This is a first line tire, introduced at $14.40 in Spring 1949. At that time the cord was not specified, which undoubtedly means that it was cotton. In Spring 1959, the same item had rayon cord and sold at $14.62. The same quality tire in the 6.00x16 size was introduced at $12.95 in Fall 1947 and sold in Spring 1959 for $13.45. Again, the cord is unspecified at the beginning of the period and is rayon at the end. Even if we make no allowance for the improvement in the cord, the price rise for these items is much less than that shown in the BLS index. For the 6.70x15 size, the price rise for 1949–59 is less than 1 per cent, while the BLS index rose 32 per cent. For the 6.00x16 size, the price rise for 1947–59 was less than 4 per cent while the BLS index rose 44 per cent. These items seem to meet BLS specifications, except of course for size during portions of the period. The direct comparisons suggest that the mail-order index does not contain serious errors from the possible drift of a chain index.

Our best hypothesis about the divergence among the tire indexes has to do with discounting. Many tire sales take place at discounts from list prices, either in the form of trade-in allowances on old tires, or cash discounts if the buyer has no trade in. Such discounts would be especially important in periods of falling prices, like that following the Korean War. Mail-order sales cannot involve discounts, but must be kept competitive with actual prices that do. The BLS specifications first instructed agents to deduct cash discounts in September 1953. They first instructed agents to deduct cash discounts and trade-in allowances in August 1954. This presumably accounts for the very sharp drop in the BLS series in the Fall of 1954; apparently discounted prices were compared directly with previous undiscounted prices. This produces an error in short-run movement, but corrects earlier errors in the long-run trend. From Fall 1954 to Spring 1957, the movements of the BLS and mail-order series are quite similar, though the rise in BLS prices is a bit more abrupt. After Spring 1957 a new divergence occurs for which we have no explanation. The BLS series continues to rise, while the other two fall appreciably.

III. Conclusions

This paper has examined alternative price indexes for eleven different nondurable goods. This is not a very large sample from which to draw conclusions, and the conclusions offered below must be regarded as tentative. Nevertheless, the work needed to prepare alternative indexes is time consuming, and there is little likehood that a larger body of such comparisons will be available in the near future. The conclusions that follow therefore seem worthy of some attention as the best that can be offered at this time.

1. Where there has been considerable stability in the physical characteristics of commodities over time, as in the cases of work shirts and work socks, the indexes constructed from mail-order data (two out-

lets in one region of the country) turn out to be surprisingly good approximations of indexes based on much larger samples of outlets and areas. Thus our index for work socks closely approximates one based on about 2,400 outlets. This suggests that too large an amount of resources may be devoted to maintaining large outlet and area samples for some commodities, and that an improvement of the official indexes could be obtained within a fixed budget by reducing the size of outlet samples and increasing the size of samples of items or varieties. We also observe that for stable items, the indexes based on all varieties of the item are often closer approximations to the BLS indexes than the indexes based only on the varieties conforming to BLS specifications. This suggests that to some extent, large samples of varieties and large samples of outlets may perform the same role, that of smoothing out random or erratic fluctuations possible in series based on small samples. If it is cheaper to sample several varieties in one outlet rather than one variety in several outlets (and we suspect that it sometimes is) this again suggests a possible gain from the reallocation of resources devoted to the price statistics programs.

2. Where there are few changes in the physical characteristics of an item, the AMS indexes, despite their loose methods of specification, give results very close to those of true specification indexes. Indeed, there seem to be cases where loose specification combined with consistency in procedures over time, as in the AMS indexes, produce results superior to those of rigid specifications in which frequent changes are made. If we were to accept the mail-order indexes as a benchmark (and it is, of course, doubtful that we should), we would conclude that the AMS series performs better than the BLS series for women's rayon panties and for automobile tires. On the other hand, the loosely specified AMS indexes are subject to serious error when there are important changes in the characteristics of goods or when there are very sharp changes in the price level of the item. In general, one expects these problems to result in an upward bias in the AMS indexes from failure to catch quality improvement. In this study, however, the principal instance of bias in an AMS index turns out to be failure to catch quality deterioration in the case of Axminster rugs. The conclusion that AMS should specify fiber content for this item seems inescapable. There is some possibility that AMS has failed to catch quality upgrading in work shirts in recent years. A much more important upward bias in an AMS index (automobiles) is reported in Staff Paper No. 3. Several of the AMS indexes discussed here fail to reflect the full rise in prices during the Korean War or the full fall thereafter, as measured by specification indexes. This suggests strongly that there was temporary substitution of lower qualities in the face of a sharp rise in prices.

3. The extreme narrowness of the BLS specifications and their uniformity over the whole country in most cases produces a need for very frequent changes in the specifications, and makes it very difficult for BLS to make available histories of the specifications and procedures used. The absence of published information on the history of specifications greatly reduces the usefulness of the published BLS item indexes. In a number of cases, the titles of item indexes as published seem inexcusably misleading: "wool blankets" for a series that includes acrilan and "girls' orlon sweaters" for a series that includes

wool. These misimpressions could be removed by the use of footnotes to the titles of item indexes.

4. Despite the frequent changes in BLS specifications, they often lag behind the changes in the goods offered on the market to such an extent that nothing to meet specifications can be found in the mail-order catalogs. Since the catalogs do not always give enough information to make it certain that a variety meets specifications, we have followed the rule of assuming that it does unless it is clear that it does not. Physical examination of the catalog merchandise would undoubtedly have revealed more cases in which the specifications could not be met. We are completely convinced that this problem does not arise because the quality level of the catalog merchandise is not that bought by the BLS index population. In every case we have examined, the average prices paid by middle income urban consumers as shown in the Survey of Consumer Expenditures were well within the price range of varieties offered in the catalogs. Rather the problem arises because the BLS often specifies what the index population was buying yesterday, and not what it is buying today. The resulting attrition in the number of observations collected makes the CPI much less reliable simply from the point of view of sampling error than it appears to be from the size of the outlet sample. The problem under discussion need not arise from any sudden change in the item priced. In two cases, carpets and innerspring mattresses, we encountered such problems simply through quality change along very old dimensions (number of tufts per square foot and number of coils).

The impressions on this point arising from this study are entirely consistent with those arising from two other kinds of evidence. One of these is observations made in the field when we were privileged to accompany a BLS agent in her pricing. The second is the material furnished to the Price Statistics Review Committee by BLS giving the history of the pricing of certain items in particular cities and showing the effect of alternative methods of processing the data collected. These histories with alarming frequency show the entry "nothing to meet specifications" in two or three outlets out of four, and sometimes the item priced in the remaining outlets will not be identical at the two dates compared, and substantially different prices will be compared directly. A broader range of specifications would reduce the influence of such direct comparisons of nonidentical items on the movement of the index.

5. The problem of changes in specifications blends imperceptibly into the even more important problem of the handling of new items. We have followed the rule of considering a commodity as an item if BLS publishes a separate item index for it. Thus we have treated men's nylon stretch socks as an item, and women's nylon panties as a variety of an item broader than that defined in the BLS item index. It is clear, however, that any line drawn between the new variety and the new item will necessarily be arbitrary.

In a number of cases, we have found that the introduction of a new item into the CPI took place quite some time after its first appearance in the mail-order catalogs. This in turn may have been after its appearance in specialty shops or department stores, since it is easier in a store than in a mail-order house to take a chance on stocking a small quantity of a new item. The high cost of producing and distributing catalogs and the need for streamlining order-filling and warehousing operations militates against experimentation in offering catalog merchandise. In all of the cases of new items or major new varieties we have examined, there was a substantial decline in the price of the new variety relative to the old. In every case except that of girls' orlon sweaters the BLS index missed all or most of this relative price decline. The circumstances of the case of girls' sweaters suggest that BLS was forced by the suddenness of the change in the goods on the market to depart from its ordinary procedures.

At this point one must consider the argument that introducing new goods into the price index "too soon" may overrepresent them and cause a price index that is biased downward. This argument is certainly correct if the whole weight of an item is shifted to a new variety while it is still in its infancy, and the price decline of a small but growing fraction of sales of an item is treated as a price decline for the item as a whole. This is not the procedure we have followed here. New varieties have been included in the item indexes with a weight equal to their numerical importance as a fraction of all varieties. It would have been better to weight each variety by its sales, but this information was not available.

In principle, we believe that a system that weights varieties by their current importance in the market understates the true extent of price declines for two reasons. First, it fails to take account of the fact that at their high initial prices, these varieties are preferred to the old varieties by those who buy them. Second, it fails to take account of the fact that part of the growth in importance of new varieties is caused not by the fall in their relative price, but by the growth and transmission of knowledge about them, and that at any time in this growth process there are consumers who would prefer the new variety at its current price if they had adequate information.

The objection is sometimes raised against the argument of the preceding paragraph that there are also people who regard old products as worth more than they cost and people who lack relevant information about old products. This is true, but both circumstances are much more likely for new products that result from substantial technological change. An alternative way of looking at the price decline or welfare gain implicit in the introduction of a new product is to consider the price before the innovation of getting the particular bundle of services or attributes embodied in the innovation. Thus before the introduction of acrilan blankets it might have been possible at some considerable cost to treat wool blankets so that they were permanently mothproof and free from shrinkage. The difference in cost between a wool blanket so treated and an acrilan blanket is not reflected if the acrilan blanket is linked into the index at the time of its appearance. This does not mean that we are advocating any procedure that would measure this implicit price decline, for we know of none that is operational. It does mean, however, that the early introduction of new items with current weights, instead of creating a downward bias as is sometimes suggested, does not fully correct the upward bias inherent in present procedures—at least on one reasonable interpretation.

An objection closely related to the one just considered is that there are some people to whom the new product is less attractive than the old, or for whom it has serious disadvantages. For example, it is pointed out that many synthetic fabrics do not resist cigarette burns as well as natural fabrics. If such disadvantages cause the old product to remain on the market alongside the new, a system of current weights gives full recognition to them. It is difficult to imagine many cases in which the old product disappears completely despite substantial advantages, particularly if it is produced by a competitive industry. When a new product greatly increases its share of the market over a short period, as was true of all the new products considered in this study, it is hard to argue that on the whole its disadvantages outweigh its advantages.

The arguments advanced above are applicable to changes in varieties that arise from changed composition or techniques of production rather than from changes in style. The fact that in any period people prefer the goods considered stylish in that period raises the classic index number problem, which we have sought to evade in this study by omitting the goods most subject to style change.

The danger in introducing new varieties early is that resources will be wasted collecting data on what prove later to be ephemeral goods. We believe that BLS agents are in close enough touch with the market so that this error would not be committed very often in a procedure where agents had more discretion in the selection of varieties. At any rate, the error almost never seems to be made now, and there is something to be said for a procedure in which offsetting errors are about equally likely. We have noticed only one case in the items considered in this study in which the BLS introduced a new variety and then quickly retracted it (in a change involving technology rather than style). This was the brief broadening of the tire specifications to permit nylon cord tires in the summer of 1955. Nor is it clear that this broadening was a mistake; while rayon cord tires have retained a virtual monopoly in the original equipment market, the mail-order catalogs suggest that nylon cord has remained important on the replacement market. It is only the replacement market that is represented by the BLS index for tires, since the original tires are part of the price of the car and are thus included in the BLS item index for new automobiles.

6. Apart from the problem of new varieties, there are several cases in which the BLS indexes based on a narrow range of varieties behave somewhat differently from indexes based on a broader range. We count here only the cases in which a mail-order index based on BLS specifications lies close to the BLS index, supporting the view that the scope of varieties included is the source of the original difference. These cases are women's rayon panties, men's nylon stretch socks, and men's sweaters. In all three cases, the broader indexes rose less than the narrowly specified ones. This is too small a sample to permit any conclusion on the general effect of narrow specifications on the movement of the CPI, except in the case of new varieties.

STAFF PAPER 3

HEDONIC PRICE INDEXES FOR AUTOMOBILES: AN ECONOMETRIC ANALYSIS OF QUALITY CHANGE[1]

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1. Introduction and Summary

"If a poll were taken of professional economists and statisticians, in all probability they would designate (and by a wide majority) the failure of the price indexes to take full account of quality changes as the most important defect in these indexes."[2] In spite of its potential importance, there is almost no published empirical work devoted explicitly to this problem. The only available book that deals with problems raised by changes in quality reaches essentially defeatist conclusions.[3]

The main purpose of this paper is to investigate a relatively old, simple, and straightforward method of adjusting for quality change and find out whether (a) this method is feasible and operational, and (b) whether the results are promising and different enough to warrant the extra investment. It is standard practice in the price index industry to adjust for those quality changes to which a price can be attached. The appearance of automatic transmissions on the market at $200 extra will not raise the price of automobiles in the conventional indexes (except those of the USDA) even though eventually almost all cars are sold with it and the base price incorporates it as "standard equipment." However, only a few of the observed quality changes come in discrete lumps with an attached price tag. Most of the changes are gradual and are not priced separately. Nevertheless, many dimensions of quality change can be quantified (e.g., horsepower, weight, or length for automobiles); a variety of models with different specifications can be observed being sold at different prices at the same time; using multiple regression techniques on these data one can derive implicit prices per unit of the chosen additional dimension of the commodity; and armed with these "prices" one can proceed to adjust the observed price per "average item" for the changes that have occurred in its specification. There are many technical problems to be solved, but the main idea is quite simple: Derive implicit specificaton prices from cross-sectional data on the price of various "models" of the particular item and use these in pricing the time series change in specifications of the chosen (average or repre-

[1] This paper is an outgrowth of my concern about the quality of the available capital measures and their use in productivity studies. It is a part of a larger study of technical change that is being supported by a National Science Foundation grant. I am indebted to Irma Adelman, George Stigler, and Lester Telser for valuable comments.

[2] Report of the Price Statistics Review Committee, III, 3.

[3] Erland von Hofsten, *Price Indexes and Quality Changes*, Stockholm, 1952.

sentative) item.[4] Alternatively, one can interpret the procedure as answering the question of what the price of a new combination of specifications (or qualities) of a particular commodity would have been in some base period in which that particular combination was not available, by interpolating or extrapolating the apparent relationship of price to these specifications for models or varieties of the "commodity" that were available in that period. This latter interpretation avoids some of the more metaphysical problems involved in the notion of "quality" and "quality change."

In this paper I investigate the relationship of automobile prices in the U.S. to the various dimensions of an "automobile" in 1937, 1950, and 1954 through 1960. A limited number of specifications or dimensions explain a very large fraction of the variance of car prices (as among different models) in any one of these years. Due to the high intercorrelation between some of these dimensions, there is some instability in the estimated "implicit prices" (the coefficients) of the dimensions. Also, there appears to have been a very substantial secular decline in the "price" of some of these dimensions (e.g., horsepower). Thus, estimates of the actual price change (after the quality change adjustments are made) differ markedly depending on whether they are based on beginning or end period weights. If we value the quality changes at their 1950 "implicit prices," we find that all the apparent increase in car prices between 1950 and 1960 can be explained by quality improvements, the hedonic price index actually falling during 1950–1960. Valued at 1960 implicit quality prices, these same quality changes account for a little over half of the apparent price increase over this period. Over the whole period since 1937, the CPI may be overestimating the rise in automobile prices by at least a third. Since the CPI is a Laspeyres index, the appropriate quality adjustment should also be based on "base" (beginning) period weights. If this is done, about three-fourths of the rise in automobile prices in the CPI since 1937 could be attributed to quality improvements.

Some limitations of this type of approach are explored in the last part of the paper and, in light of these, it is not yet recommended that such adjustments should be made routinely as part of the price index computations. Continuous studies of this sort, however, covering a wide range of commodities, would be of great value. They could provide us with estimates of the order of magnitude of the possible upward drift in the official price indexes due to their inability to cope adequately with the ever-present quality change problem. Moreover, they would spot for the price data collecting agencies what appear to be the more relevant dimensions or specifications of a commodity, providing them with a better basis for judging which specifications should be controlled in the pricing process.

2. Theoretical Considerations

It is impossible to deal here with all the index number problems raised by the changing quality of commodities.[5] Since we are in-

[4] As far as I know, this procedure was first suggested by A. T. Court in his paper "Hedonic Price Indexes With Automotive Examples", in *The Dynamics of Automobile Demand*, New York, 1939. A more recent exposition is given by R. Stone in *Quantity and Price Indexes in National Accounts*, OEEC, Paris, 1956, ch. IV.

[5] The reader is referred to the literature on this problem, and in particular to Hofsten and to Stone, op. cit.; see also Irma Adelman, "On an Index of Quality Change," paper given at the August 1960 meeting of the American Statistical Association, Stanford, California, which presents an approach very similar to the one outlined here.

terested in the effect of quality change on measured prices and price indexes, our first job is to find what relationship, if any, there is between the price of a particular commodity and its "quality."

Most commodities, particularly consumer and producer durables, are sold in many varieties or models. Thus at any one time we can observe a population of prices—p_{it}—where i is the index of varietal designation (e.g., No. 2 corn, or a Chevrolet Impala four-door hardtop with a V-8 engine) and t stands for the time period of observation. The reason why these different varieties or models sell at different prices must be due to some differences in their properties, dimensions, or other "qualities," real or imaginary. Thus we can write p_{it} as a function of a set of "qualities" X, and some additional small, and hopefully random, factors measured by the disturbance u.

$$p_{it}=f_t(x_{1it},\ x_{2it},\ \cdots\ x_{kit},\ u_{it}). \tag{1}$$

These qualities do not necessarily have to be numerical. Given a sufficient number of observations, we can use variables which take the value one if the item possesses the particular quality and zero if it does not and derive the average contribution of this "quality" to the price of the item. Nor do they have to be desired for their own sake. It will suffice if they are well correlated with some more basic dimension which may be more difficult to measure. For example, for many commodities, and at least over some range, "size" or "capacity" are very important qualities. They are, however, quite elusive and difficult to measure. On the other hand, they can often be approximated quite well by variables such as volume, weight, or length, even though none of these "proxy" dimensions may be desirable per se.

The existence and usefulness of such a function is an empirical rather than theoretical question.[6] To estimate such a function we have to make additional assumptions about the number and kind of relevant qualities and the form in which they affect the price of the product. There is no a priori reason to expect price and quality to be related in any particular fixed fashion. This again is an empirical question. In this study, I have used the semilogarithmic form, relating the logarithm of the price to the absolute values (pounds, inches, etc.) of the qualities:

$$\text{Log}\, p_{it}=a_0+a_1x_{1it}+a_2x_{2it}+\ \cdots\ +u_{it}. \tag{2}$$

This choice was based on an inspection of the data and the convenience of this particular formulation.[7] Other forms, e.g., linear, or linear in the logarithms, may however be more appropriate in a study of other commodities and qualities.

Assuming that the equation can be estimated with enough precision it can be used to estimate the value of certain quality changes in the base period. Moreover, one can use it to estimate the price of a new bundle of qualities which may not have been available in this period, provided that the new bundle differs only quantitatively in its "quali-

[6] It can always be made into a tautology by specifying enough factors or qualities.

[7] If natural logarithms are used, an "a" coefficient will provide an estimate of the percentage increase in price due to a one unit change in the particular quality, holding the level of the other qualities constant.

ties" from the previously available items and does not contain some new, previously unknown or unavailable qualities. Even if the new item possesses some previously unknown qualities, the equation can be used to estimate the change in price due to changes in the subset of quantifiable qualities, and half a loaf may be better than none.

An equation of this type can be computed for each period for which we have enough observations to do it. If the results are not the same in different periods, and they are unlikely to be so, we are faced with the general index number problem of changing weights. The implicit prices we obtain will depend on the particular period or periods chosen as "weight" or reference periods, and Laspeyres' and Paasche's indexes may diverge sharply. If the periods are not too far apart and the weight pattern not too different, we can estimate the average price change directly by assuming that the equation holds well enough in both periods except for the change in the additional variable "time."

$$\text{Log } p_{it} = a_0 + a_1 x_{1it} + a_2 x_{2it} + \cdots + a_d D + u_{it} \qquad (3)$$

where D is a variable that is zero in the first period and one in the second.[8] The coefficient a_d provides us with an estimate of the average percentage increase in price of these models or varieties between the two periods, holding the change in any of the measured quality dimensions constant. If we want to impose the same set of weights on more than two cross sections, this can be achieved by specifying additional "time" or "dummy" variables, taking the value one in their reference period and the value zero in all other periods. The necessary number of such variables is one less than the number of cross sections that are being estimated together. The resulting coefficients measure the percentage change in the average price, holding qualities constant, with the average price for the earliest cross section being the base of measurement.

Having estimated such equations, instead of adjusting the prices or price indexes directly, we can first define an index of quality change and use that to adjust the official indexes. Consider a particular variety of a commodity, say a Plymouth Savoy four-door sedan with a six-cylinder engine, whose qualities may have changed over some time period. Then the quality change measure g is defined as

$$g_{1i}^{0} = \frac{\hat{P}_{i1}}{\hat{P}_{i0}} \text{ where } \hat{P}_{i0} = f_0(x_{1i0}, \cdots),$$

and $P_{i1} = f_0(x_{1i1}, \ldots)$.[9] That is, the p's are each predicted prices for variety i on the basis of estimated equation f_0, one for the combination of qualities this variety had in period 0 and the other for the combination of qualities it has in period 1. More simply g_1^0 measures the percentage increase in price predicted by the function f_0 on the basis of the change in the level of different qualities (the x's) between the two periods. Of course, if we had used the estimated function for the second period, f_1, or a price quality function for some other period, we would have gotten a somewhat different measure.

[8] This was the procedure followed by Court, op. cit.
[9] The designation g is borrowed from Hofsten, op. cit.

For a larger number of varieties, or models, these g's can be aggregated into a quality change index, using the same weights that are used in aggregating their prices in the price index. To get at the adjusted "real" change in prices, we would "deflate" the observed price index by the estimated quality change index.[10]

$$\text{“true price index”}=\frac{\text{observed price index}}{\text{quality change index}}=\frac{P_1}{P_0}\Big/\frac{\hat{P}_1}{\hat{P}_0}=\frac{P_1/\hat{P}_1}{P_0/\hat{P}_0}.$$

Note that this "quality change" index is based only on those "qualities" for which a price is being paid or exacted, and only to the extent of the price differential. If these price differentials are "phony" or "too high" or "too low" from some omniscient point of view, the index will not take this into account. In fact, it may not take into account some aspects of "quality" which may be important, and incorporate other "imaginary" qualities such as brand names whose "superiority" over unbranded items would be denied by many people. Thus, if we observe that garments bearing one union label sell on the average at a 5 percent higher price than comparable unlabeled items, and also that garments bearing the labels of three different unions sell for 15 percent more than comparable unlabeled items, we would predict that if a similar garment were available with two union labels, it would probably sell for about 10 percent more than the unlabeled items. And we would use this in calculating our price index (or price relative) for the two-label garment, even though we are morally certain (and supported in this by extensive test laboratory findings) that there is no "real" quality difference among all these items. We would do this since we are answering only a relatively modest question: What would the price have been if it were available? And not: Would consumers be "right" in paying this particular price, or for that matter the price of any other item? Once raised, the doubt whether the evidence of the marketplace reflects adequately, if at all, the "true" marginal utility of different items or qualities to the consumer can be turned against any other price or commodity. It is not a problem peculiar to the measurement of "quality."

While it is not necessary for our purposes, it would be nice, however, if these quality indexes represented something "real" and not just the mistakes and idiosyncracies of manufacturers' pricing policies. There are two possible sources of evidence on this point. The first, which will be explored to some extent at the end of the paper, is the evidence of second-hand markets. Do different qualities command approximately similar relative prices in the used market, a market which could be considered to be more competitive than the market for new items? If they do, this would indicate that consumers are still willing to pay these differentials even when they are not imposed by manufacturers. A second and more stringent test, which will not be pursued here, could have been made by investigating what happens to the sales of varieties or brands if their prices are too high or too low relative to their quality content. Given an estimated price-quality equation for a particular period, the estimated residual for a specific

[10] Compare this with Adelman, op. cit., where the quality change index is defined additively rather than multiplicatively. Ideally the varietal prices should be deflated individually before they are aggregated into an overall price index. Only for geometrically weighted indexes will the ratio of the two equal the "true" index exactly.

model or brand could be interpreted as a measure of over or under pricing relative to the quality content of this model. If, with the help of these residuals, we were able to predict reasonably well the market share experience of different models or brands, i.e., "over priced" items losing and "under priced" items gaining, this would provide strong support for the correctness of our price-quality equation and its interpretation.

3. The Sample and the Variables

The analysis of price-quality relationships reported below is based on data for U.S. passenger four-door sedans for the years 1937, 1950, and 1954 through 1960. In each of these years an attempt was made to collect price and specification data for all models and brands for which such data were easily available.[11] Since these calculations were viewed as being exploratory, no special attempts were made to assure completeness of coverage, nor were the model observations weighted by their relative importance in the market. The number of observations in each cross section varies from a low of 50 in 1937 to a high of 103 in 1958.

The new car prices used throughout this study are factory-delivered "suggested" (list) retail prices, at approximately the beginning of the model year.[12] Unfortunately, there are no published data on actual transaction prices for a wide range of models. Discounts from list prices may have varied over time, and this will make it somewhat difficult to compare our results with the CPI, since the CPI has tried to take discounts into account, at least since 1954. Only to the extent that relative discounting is correlated with some of our quality dimensions will the use of list prices lead to any special bias in the estimates of the quality coefficients. This same difficulty would not be present if an official government agency were doing such a study. The WPI actually collects the manufacturers' wholesale price to dealers for most automobile models. Similarly, it should not prove difficult to expand the CPI sample, at least once a year, to include a wider range of models.

No adjustment was made for any changes in minor equipment items that became standard equipment at some later point in time, such as directional signals or electric clocks.[13] Major items, such as automatic transmissions, power steering, and power brakes were treated by defining independent variables that took the value of one if the item was "standard equipment" on a particular model and zero if it was not.

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[11] The 1937 price and specification data for new 1937 automobile models are taken from the *Red Book* (National Used Car Market Report), September-October 1937. The 1950 model data are from the *Red Book of Official Used Car Appraisal* (National Market Reports, Inc.: Chicago, Nov. 15, 1956.) For 1954 through 1960 the data are taken from various issues of the National Automobile Dealers Association, *Used Car Guide,* Washington. For 1955 through 1958 the data are from the February issue of the corresponding year. For 1954 models, the figures are taken from the July 1959 issue; for 1959 models from the January 1959 issue; and for 1960 models from the December 1959, issue. Data on power brakes come from various issues of *Ward's Automotive Reports.*

[12] Factory-advertised delivered price includes only standard equipment, Federal excise tax, and dealer handling and preparation charges. Transportation, State, or local taxes are not included.

[13] The possible consequences of this omission are explored briefly in the Appendix of this paper.

The major numerical "quality" variables used in this study are horsepower (advertised brake horsepower), weight (shipping), and length (wheelbase for 1937 and 1950, and overall from 1950 on). In addition, "dummy" variables, i.e., variables that take the value of one if the particular model possesses this particular "quality" and zero if it does not, are defined for the following "qualities": V–8 engine or not, hardtop or not, automatic transmission as standard equipment or not, power steering as standard equipment or not, power brakes as standard equipment or not, and for 1960 models whether a car is a "compact" or not. Note that some of these variables do not measure the consequence of having a particular item of equipment as much as they stratify and control for the type of car on which such equipment is "standard" (included in its base price). Thus, for example, the variable for power steering effectively identifies most of the large luxury cars that differ from other cars in other ways besides sheer size or the presence of power steering as standard equipment.

A variety of variables for which no convenient data are available was not included in the calculations. Most important of these are the various "performance" variables: gasoline mileage, acceleration, handling ease, durability, and styling. Scattered data already exist on some of these qualities, and I am sure that it would not prove very difficult to collect more and include such variables explicitly in a similar price-quality analysis. Variables reflecting the level of "workmanship" associated with a particular car and variables accounting for small design changes, such as the substitution of an alternator for the generator were also omitted for lack of data. Nor were brand or manufacturer differentials taken into account. In fact, as far as the numerical qualities that are included in the analysis are concerned, they could probably all be interpreted as different aspects of one underlying quality "size" or "capacity."

The characteristics of the sample are summarized in Table 1. Note the sharp increase in horsepower per car since 1950, due to a large extent to the introduction of the V–8 engine, and the lengthening of cars which reached its peak in 1959. The drop in the average price and specification level of cars in 1960 is due mainly to the introduction of the "compacts" and the decline in the number of high- and medium-priced models on the market.

TABLE 1.—*Characteristics of the Cross Sections Used in This Study: U.S. Passenger Four-Door Sedans—1937, 1950, and 1954–1960*

Years	Number of models	Average (geometric) price	Average horsepower	Average shipping weight in pounds	Average length in inches	
					Wheelbase	Overall
1937	50	$1,183	109	3,506	122	
1950	72	2,113	115	3,533	122	205.7
1954	65	2,360	141	3,452		205.0
1955	55	2,281	166	3,429		205.4
1956	87	2,594	200	3,616		207.5
1957	95	2,785	226	3,696		208.9
1958	103	3,054	252	3,835		211.6
1959	87	3,180	251	3,907		213.7
1960	78	2,800	211	3,666		208.6

See footnote 11 for sources of data.

4. The Regression Results

It is impossible to reproduce here the very large number of multiple regressions that were computed for different years and different combinations of years and independent variables. Due to the very high multicollinearity between the three numerical "qualities" chosen for analysis (see Table 2) there was substantial instability in the coefficient estimates for some of the years. Usable estimates were obtained only for years in which there was some independent variation along the three numerical quality dimensions, and for combinations of years where the larger number of observations allowed us to determine the separate coefficients with greater precision.

Table 2.—*First-Order Correlation Coefficients: r*

Between	Year					
	1960	1959	1957	1954	1950	1937
H and log P	0.89	0.85	0.85	0.89	0.84	0.88
W and log P	.90	.92	.95	.88	.87	.92
L and log P	.77	.75	.84	.81	.91	.88
H and W	.85	.82	.90	.92	.76	.80
H and L	.72	.75	.79	.73	.74	.84
W and L	.92	.86	.85	.87	.83	.92

H=Horsepower.
W=Weight.
L=Length, overall, except wheelbase in 1937.
log P=logarithm of list price.

Regression estimates for selected years are summarized in Table 3. Table 4 summarizes a set of regressions utilizing two adjacent annual cross sections each and introducing an explicit variable to estimate the average price change holding quality change constant. It also presents the estimated coefficients of the overall regression for 1954–60, lumping all of the seven (1954 through 1960) cross sections together and allowing them to differ from each other in level but not in slope.

Since our dependent variable is the logarithm of price, the resulting regression coefficients can be interpreted as the estimated percentage change in price due to a unit change in a particular "quality," holding the other qualities constant. Thus, for example, the results for the 1960 cross section (column 1 in Table 3) imply that the following was true, on the average, for the 1960 model cars and their list prices. An increase of 10 units in horsepower, ceteris paribus, would result on the average in a 1.2 increase in the price of a car (with a standard error of 0.3 percent). An increase of 100 pounds in the weight of a car was associated with a 1.4-percent increase in price. An increase of 10 inches in the length of a car, holding the other qualities constant, was associated with a 1.5 increase in the price of the car (but was not significantly different from zero at conventional significance levels). A V–8 engine, holding horsepower, weight, etc., constant was associated with a 4-percent lower price than a six having comparable characteristics.[14] A "hard

[14] There was very little overlap in horsepower between the sixes and the V–8's in the sample. What the coefficient measures, actually, is the fact that higher horsepower levels could be achieved at a price that was about 4 percent cheaper than would be indicated by the extrapolation of the price-horsepower relationship for six-cylinder engine cars. For more on this, see the text below.

TABLE 3.—*Coefficients of Single Year Cross-Sectional Regressions Relating the Logarithm of New U.S. Passenger Car Prices to Various Specifications, Selected Years*

Coefficients of	Model year					
	1960	1959	1957	1950		1937
				(1)	(2)	
H	0.119 (.029)	0.118 (.029)	0.117 (.030)	0.365 (.110)	0.585 (.133)	0.867 (.181)
W	.136 (.046)	.238 (.034)	.135 (.040)	.111 (.066)	.145 (.096)	.388 (.078)
L	.015 (.017)	−.016 (.015)	.039 (.013)	.192 (.026)	.147 (.045)	−.009 (.078)
V	−.039 (.025)	−.070 (.039)	−.025 (.023)	−.054 (.032)	−.091 (.040)	−.023 (.060)
T	.058 (.016)	.027 (.019)	.028 (.012)	----------	----------	----------
A	.003 (.040)	.063 (.038)	.114 (.025)	----------	----------	----------
P	.225 (.037)	.188 (.041)	.078 (.030)	----------	----------	----------
B	----------	----------	.159 (.026)	----------	----------	----------
C	.048 (.039)	----------	----------	----------	----------	----------
R^2	.951	.934	.966	.892	.835	.904

NOTES.—While the original computations were all done with logarithms to the base 10, the results in this Table are converted to natural logarithms (to the base e) as an aid to interpretation. The resulting coefficients, if multiplied by a hundred, measure the percentage impact on price of a unit change in a particular specification or "quality," holding the other qualities constant. The numbers in parentheses are the calculated standard errors of the coefficients. For 1950 regression (2) and 1937: length of wheelbase rather than overall length.

H = Advertised brake horse power in 100's.
W = Shipping weight in thousand pounds.
L = Overall length, in tens of inches.
V = 1 if the car has a V-8 engine; = 0 if it has a 6-cylinder engine.
T = 1 if the car is a hardtop; = 0 if it is not.
A = 1 if automatic transmission is "standard" equipment (included in the price); = 0 if not.
P = 1 if power steering is "standard"; = 0 if not.
B = 1 if power brakes are "standard"; = 0 if not.
C = 1 if the car is designated as a "compact"; = 0 if not.

top" was on the average 6 percent more expensive than other comparable ("soft top"?) models. Holding other "qualities" constant, the inclusion of an automatic transmission as "standard equipment" was not associated with any significant price increase. The presence of power steering as "standard equipment" led to a 22-percent higher price over comparable models.[15] The cars designated as "compacts" were selling for about 5 percent more than other cars, holding other "quality" differences constant, but again, this premium was not significantly different from zero.

If we look now across the rows of Tables 3 and 4, several things are worth noting. The fit of these equations is quite good. With the help of a few numerical and shift variables, we manage to explain most of the time 90 or more percent of the variance of the logarithm of car prices in a particular year or set of years, even though the range of our sample extends from Ramblers to Cadillacs.[16] The coefficient of "weight" is almost always significantly different from zero, at conventional levels, and its magnitude remains rela-

[15] This is more related to the "luxuriousness" of these models than to the presence of power steering per se.

[16] This does not mean, necessarily, that we are able to predict the price of any one particular car very well. The average standard error of regression for these equations is around 8 per cent.

TABLE 4.—*Coefficients of Regressions of the Logarithms of Price on Various "Qualities": U.S. Passenger Cars, 2 Years Taken Together, and All the 7 Years, 1954 Through 1960*

Coefficients of	Model years							
	1954 through 1960	1959–60	1958–59	1957–58	1956–57	1955–56	1954–55	1937–50
H	0.056 (.013)	0.114 (.018)	0.062 (.025)	0.040 (.026)	0.095 (.028)	0.091 (.055)	0.241 (.059)	0.538 (.108)
W	.249 (.021)	.212 (.029)	.285 (.034)	.271 (.038)	.211 (.039)	.241 (.056)	.009 (.060)	.328 (.053)
L	.023 (.007)	−.006 (.011)	−.018 (.013)	.007 (.013)	.045 (.011)	.053 (.015)	.082 (.016)	.108 (.039)
V	.010 (.013)	−.059 (.023)	−.026 (.031)	.005 (.026)	−.037 (.020)	−.043 (.031)	−.031 (.024)	−.093 (.035)
T	.023 (.009)	.040 (.013)	.030 (.012)	.024 (.013)	.022 (.010)	.018 (.018)		
A	.090 (.016)	.034 (.027)	.070 (.039)	.075 (.026)	.058 (.021)	.079 (.028)	.236 (.037)	
P	.088 (.017)	.206 (.028)	.125 (.040)	.113 (.030)	.089 (.023)	.062 (.029)	.035 (.038)	
B	.109 (.016)		.115 (.038)	.162 (.028)	.138 (.019)	.098 (.029)	−.045 (.045)	
C	.157 (.031)	.052 (.031)						
D		−.023 (.011)	.005 (.014)	.027 (.012)	.027 (.011)	.020 (.018)	−.093 (.020)	.527 (.027)
D_1	−.044 (.015)							
D_2	−.015 (.0.4)							
D_3	.019 (.015)							
D_4	.044 (.016)							
D_5	.044 (.016)							
D_6	.023 (.016)							
R^2	.922	.943	.915	.929	.945	.924	.904	.916

NOTE.—See notes to Table 3 for the definition of most of the variables.

D=1 in the second of two periods being estimated together; =0 in the first. The coefficient of D can be interpreted as the percentage change (if it is multiplied by 100) in the average price of cars between the two periods, holding all the qualities constant. Thus, e.g., for 1937–50, the estimated "true" price change is approximately 53 percent.

D_1=1 in 1955;=0 in other years.
D_2=1 in 1956;=0 in other years.
D_3=1 in 1957;=0 in other years.
D_4=1 in 1958;=0 in other years.
D_5=1 in 1959;=0 in other years.
D_6=1 in 1960;=0 in other years.

The coefficients of these variables measure the average percentage change in price holding quality constant as of 1954. Thus for 1960, it indicates that since 1954 the average price holding quality constant increased only by about 2 percent and that, moreover, this increase is not significantly different from zero. To get the estimated percentage change between two adjacent years, one has, in this case, to take the difference between the two coefficients. Thus, e.g., the 1954 through 1960 equation estimates the average percentage change in price between 1957 and 1958 as 1.5 (4.4—1.9), against a 2.7 estimate given by the equation for 1957–58 alone.

tively stable from cross section to cross section. The coefficient of horsepower is also statistically significant in a large fraction of cases, but varies somewhat more in magnitude around a downward trend. The coefficient of length is perhaps the most unstable of all the estimated coefficients, being very large and significant in 1950, declining rapidly in the middle fifties, and becoming insignificant and sometimes negative by 1958 and in subsequent years. This is partly the result of the generally very low variability of "length" in the sample (its coefficient of variation was only about 4 percent, on the average) and the very marked increase in the length of the lower priced cars since 1957.

Looking at the coefficients of the shift or "dummy" variables representing the presence or absence of certain "qualities," perhaps the most interesting result is the consistently negative sign attached to the coefficient of the V–8 versus six-cylinder engine variable. It is true, that most of the time this coefficient is not significantly different from zero, but the consistency in sign from period to period is both surprising and instructive. While we know that a V–8 engine costs about $100 more than a six on a "comparable" car, this is not what is meant by "comparable" in the context of our equations. What the coefficient says is that if we hold horsepower and the other variables constant, a V–8 is cheaper by about 4 percent. Since the "comparable" cars are likely to differ much only in horsepower, and since there is very little overlap in the sample between the horsepower levels achieved by six-cylinder engines and the horsepower generated by the V–8's, what this coefficient is really saying is that higher horsepower levels can be achieved more cheaply if one shifts to V–8 engines than would be estimated by extrapolating the price-horsepower relationship for the six-cylinder engines alone. It is a measure of the decline in the "price" per horsepower as one shifts to V–8's, even though the total expenditure on horsepower goes up.

The coefficient of the "hard top" variable is reasonably stable over time, indicating a premium of around 3 to 4 percent for this type of car. The coefficient of the "automatic transmission included in the price" variable is always positive, but varies substantially from time to time. The coefficients of the "power steering" and " power brakes standard equipment" variables are usually very significant and relatively large in size.[17] It is quite apparent that what they measure is not so much the presence or absence of these particular equipment items, as the presence of many other "luxuriousness" attributes associated with cars on which these items are "standard equipment." In a sense, these shift variables take care of some of the nonlinearity in the relationship of the logarithm of price to numerical qualities such as weight or horsepower. Usually the high-medium and high-priced cars are priced somewhat higher than would be predicted just by extrapolating the price-horsepower (or length or weight) relationship from the lower price range. Allowing the cars having power steering, power brakes, or automatic transmission as standard equipment, to have separate constant terms, brings these cars "into line" and reduces the possible bias in the estimated price-quality relationship for the numerical qualities.

5. Price and Quality Indexes for U.S. Automobiles

A. HEDONIC PRICE INDEXES FOR THE SAMPLE AS A WHOLE

As we have noted already in our discussion of Table 4, the results presented there provide us with an estimate of the average price change that occurred between two periods in the list prices of automobiles, holding all the specified qualities constant. This is comparable to the deflation of the change in the price of the average car in the sample by a quality index with "average" rather than base or end period weights. These "average" weights are derived from the coefficients of the regression that provides the best fit simultaneously

[17] The power brakes variable is not included in the years when all (or almost all) the models on which power steering is "standard equipment" have also power brakes included in their price. Note that in those years the estimated coefficient of power steering alone equals approximately the sum of the two coefficients in the other years.

to data for two years, a regression that imposes the same price-quality relationship (slope) on both years, but allows them to differ in level. The weights are used then to adjust for the change in the specifications of the average car in the sample that has occurred between the two periods.

The resulting price indexes are summarized in Table 5 and compared to the Wholesale Price Index "Passenger Cars" component. The comparison with the WPI is more appropriate for two reasons. First, it is the only one of the official indexes that covers all passenger cars rather than just a few selected makes and models, and second, it is based on manufacturer prices to dealers whose relationship to the list prices used in this study has remained approximately constant over time. Unfortunately, the comparison is imperfect in the sense that the WPI is a weighted index of car prices, with weights based on the market shares of various makes (in some base period?), while our list price index is an unweighted average of all makes and models.[18] Relative to the WPI, our index gives too much weight to the high and medium priced cars.

TABLE 5.—*U.S. Cars: Percentage Change in Various Price Indexes, Selected Years*

Model Year	List Prices			WPI [3]
	Average car in sample [1]	Hedonic price index based on [2]		
		Estimated adjacent two-period weights	Estimated average 1954 through 1960 weights	
1937-50	79.0	52.7	----------	83.0
1954-55	−3.3	−9.3	−4.4	2.7
1955-56	13.7	2.0	2.9	4.1
1956-57	7.7	2.7	3.4	4.7
1957-58	9.6	2.7	2.5	0.6
1958-59	3.6	0.5	0.0	5.1
1959-60	−11.9	−2.3	−2.1	0.1
1954-60	18.7	[4] −4.2	2.3	19.7

[1] Percentage change in the geometric average of all list prices in the sample.
[2] Computed from Table 4.
[3] From various BLS releases. For 1937 and 1950 models, price as of December of the previous year. For 1954 models, price as of January 1954. For all subsequent model years, price as of November of the preceding calendar year.
[4] Computed by multiplying all the estimated two-year price relatives.

If we disregard these reservations, or limit the implications to our sample only, the results presented in Table 5 attest strongly to the importance of "quality" change. About one-third of the price change between 1937 and 1950 and almost all of the price increase between 1954 and 1960 is attributable to changes in a few selected specifications. If we use a chain-link index for the 1954–60 period, adjusting the 1954–55 price change by a quality index with average 1954–55 weights, adjusting the 1955–56 price change by a quality index with 1956–57 weights, and so on, we actually come to the conclusion that the average 1960 car in our sample was cheaper than the 1954 average

[18] Different makes are weighted, in a sense, by the number of models of each make included in the sample. This mitigates the problem somewhat, since the more popular makes are likely to have a larger number of models on the market, but does not solve it.

car, once some of the appropriate quality adjustments are made. If we use average 1954–60 weights derived from the joint multiple regression equation for all seven cross sections, we do indicate a small price rise for the 1954–60 period (2.3 percent) but we cannot reject the hypothesis that actually there was no real change in price over the period as a whole.

B. QUALITY AND PRICE INDEXES FOR THE "LOWER PRICED THREE."

Since two of the most important automobile price indexes (the automobile components of the CPI and of the Prices Paid by Farmers Index of the USDA) are based on prices for the "low priced three" makes—Chevrolet, Ford, and Plymouth—it is of some interest to develop quality and quality-adjusted price indexes that are restricted to this particular group of cars.[19] An attempt will be made to approximate a quality index appropriate to the group of cars priced by the CPI. Since it is impossible, from the published material alone, to discover all the details of the pricing and specification procedure used by the CPI, we cannot reproduce it exactly, adding only our quality adjustments.[20] In principle, however, our methods can be applied directly to the CPI data by the BLS, allowing a more firm estimate of the possible "quality bias" in the index.

The specification and list price history of the "average" Chevrolet, Ford, and Plymouth in the sample is presented in Table 6. Some attempt is made at weighting the different makes by including only two Plymouth models in this sample versus three models each for

TABLE 6.—*Specifications and List Prices of the Average*[1] *"Low Priced Three" Car*

Year	Horsepower	Weight, (pounds)	Length		Price[2]
			Wheelbase	Overall	
SIX-CYLINDER ENGINES					
1937	81	2,756	112	196.0	$703
1950	94	3,099	116	196.1	1,521
1954	111	3,149		195.8	1,795
1955	120	3,129		198.7	1,839
1956	135	3,172		199.7	1,938
1957	139	3,255		203.6	2,140
1958	142	3,349		206.6	2,275
1959	138	3,448		209.6	2,415
1960	141	3,539		211.5	2,425
V-8 ENGINES					
1955	163	3,185		198.7	1,939
1956	176	3,246		199.7	2,039
1957	184	3,354		203.6	2,240
1958	210	3,440		206.6	2,390
1959	202	3,525		209.6	2,533
1960	190	3,615		211.5	2,537

[1] Average for 3 Chevrolets, 3 Fords, and 2 (the 2 lower priced series) Plymouth models, except in 1937 and 1950. The 1937 sample consists of 2 Chevrolets, 2 Plymouths, and 3 8-cylinder Fords. The 1950 sample consists of 4 Chevrolets, 2 Fords and 2 Plymouths. The 8-cylinder Fords in 1937 were included to raise the sample size to approximately the same levels as in the subsequent years. Since these 8's (not V-8's) had a lower list price than comparable 6's in 1937, their inclusion, if anything, will bias the quality indexes downward.

[2] Arithmetic average.

[19] The USDA index also includes one Buick model. The CPI will probably introduce "compact" cars into its calculations in the Fall of 1960.

[20] It is not clear which models within a make are being priced; what weights, if any, are attached to each model and make; whether the index averages price relatives for each model or make, or takes the relative of the average price of these models, and so forth. See also the Appendix for additional discussion of the CPI.

Chevrolet and Ford cars. Also, the specification and price history of six-cylinder engine cars and V-8 engine cars is recorded separately. Since the CPI switched over in 1956 from pricing six-cylinder cars to pricing the V-8 models of these same cars, we shall follow suit by computing separate indexes for each type of car and linking them at 1956.[21]

Table 7 presents some of the weights used in aggregating these "qualities." It is immediately apparent that the computed quality indexes will differ substantially depending on which set of weights is used. To provide historical perspective, this table also records weights derived by Court in his earlier study of the same problem. The weights reproduced in this table and additional weights taken from Table 4 are used in construcing the set of quality indexes summarized in Table 8.

TABLE 7.—*Estimated Quality Weights or "Prices": Percentage Change in the Price of Cars as the Result of a Unit Change in Selected "Qualities," in Selected Years*

Years	Percentage change in price per—		
	10-unit change in horsepower	100-pound change in weight	One-inch change in length [1]
1930 to 1935 [2]	5.5	5.7	0.31
1935 to 1937 [2]	5.3	5.8	.01
1937 to 1939 [2]	7.1	3.0	.15
1937 [3]	8.7	3.9	-.09
1950 (2)[3]	5.8	1.5	1.47
1950 (1)[3]	3.6	1.1	1.92
1957 [3]	1.2	1.4	.39
1959 [3]	1.2	2.4	-.16
1960 [3]	1.2	1.4	.15
1954 through 1960 [4]	.6	2.5	.23

[1] Wheelbase length, 1935 through 1950 (2), overall length thereafter.
[2] From Court, op. cit., p. 111.
[3] From Table 3.
[4] From Table 4.

TABLE 8.—*Quality Indexes for the "Low Priced Three" (6-cylinder engines to 1956, V-8's thereafter)*

Period	Percentage change			
	Beginning period weights [1]	Adjacent year weights [2]	1954 through 1960 weights [3]	End period weights [4]
1937 to 1950	24.3	22.7		18.7
1950 to 1960	61.0		18.7	15.1
1937 to 1960 [5]	100.1			36.6
1950 to 1954	6.1		2.2	2.3
1954 to 1955	9.3	5.7	.7	
1955 to 1956	8.1	2.9	2.2	
1956 to 1957	12.4	4.8	4.1	
1957 to 1958	16.9	3.4	4.4	
1958 to 1959	4.3	1.4	2.3	
1959 to 1960	.6	.3	2.0	
1954 to 1960	51.7	20.0	16.1	12.4

[1] 1937 weights for the 1937-50 comparison and 1950(1) weights for all the subsequent comparisons. For example, the 1937-50 figure is arrived at by multiplying the change in the average specifications given in Table 6, by the 1937 weights given in Table 7 and adding them together ($8.7\times1.3+3.9\times3.43-0.1\times4.0=24.3$).
[2] Weights from Table 4, i.e., the 1954-55 comparison uses average 1954-55 weights, and so on. The figure for 1954-60 is the product of all the paired year comparisons.
[3] Weights from Table 4.
[4] 1950(2) weights for the 1937-50 comparisons and 1960 weights for the 1950-60 and 1954-60 comparisons.
[5] Derived by adding 100 each to the first 2 rows, multiplying, and subtracting 100.

[21] Alternatives to this linking procedure are discussed below.

The quality indexes measure how much higher the price of the particular car (or the average price of a particular class of cars) would have been, in the weight period, if its specifications had changed by the same amount as they did between the two periods that are being compared. Using beginning period weights, we find that "quality per car" practically doubled since 1937, with most of the increase occurring since 1950. Using end period weights, the indicated increase is only about 37 percent, which is still quite substantial. Using chain-link weights, or average 1954–60 weights, produces intermediate results. Since the CPI is a Laspeyres based fixed weight index, with the latest set of weights being based on the 1950 Consumer Expenditure Survey, the "beginning period" weighted quality index is the most appropriate deflator for it. From a theoretical point of view, the chain-link index with its frequently changing weights is probably the best single measure of quality change.

Before proceeding to "deflate" the CPI by our quality indexes we have to convince ourselves that it is legitimate to do so. Since our indexes were derived from list prices, we have first to compare the CPI to an unadjusted list price index for the same makes and models. Such a comparison is presented in the first two columns of Table 9. It is apparent that the list prices and the CPI moved fairly closely together until 1954. Since 1954 the CPI has risen much less than the list prices of comparable cars (or the comparable WPI index, see Table 5). It is not exactly clear how and why this happened, and the problem is explored in greater detail in the Appendix. In part this may be due to the BLS beginning to ask for discounts in 1954; in part to absolute or relative declines in transportation costs and the cost of various attachments which were not included in the list prices. Be this as it may, unless the recent divergence between list prices and the CPI index is somehow associated with one or the other of our quality dimensions, these indexes are still appropriate deflators for the CPI. They would be inappropriate if either relative discounting were associated with some of the quality dimensions, e.g., higher

TABLE 9.—*The "Low Priced Three" (Sixes to the 1956 Model Year, V–8's Thereafter): Percentage Changes in Price—List Prices, the CPI, and the CPI Adjusted for Quality Change*

Years	List prices unadjusted [1]	CPI unadjusted [2]	CPI adjusted for quality change using [3]			
			Beginning period weights	Adjacent year weights	1954 through 1960 weights	End period weights
1937–50	116.0	101.3	61.2	64.1	—	69.2
1950–60	58.5	31.3	−18.4	—	10.6	14.1
1937–60	242.4	161.3	30.6	—	—	91.3
1950–54	18.0	18.0	11.2	—	15.5	15.3
1954–55	2.5	−1.7	−10.0	−8.0	−2.4	—
1955–56	5.4	−.9	−8.3	−3.7	−3.0	—
1956–57	9.9	5.1	−6.5	.3	1.0	—
1957–58	6.7	4.2	−10.9	.8	−.2	—
1959–60	.2	.1	−.2	−.2	−1.9	—
1954–60	34.4	11.3	−26.6	−7.8	−4.1	−1.0

[1] Computed from Table 7.
[2] From BLS Bulletin No. 1256 and various CPI releases. For 1937 and 1950 as of March of the same year; for 1954 as of January 1954; for subsequent years as of November of the preceding year.
[3] Computed by dividing the figures in the second column by the appropriate entry from Table 8 (adding first 100 to each and subtracting 100 from the result).

horsepower cars being discounted disproportionately, or if the CPI had, in collecting its prices, linked out the particular horsepower, weight, and length increases we have used in constructing the quality indexes. Since we have no reason to believe that either is true, deflation of the CPI by these indexes appears to be warranted.

The results of deflating the changes in the CPI by the appropriate entries from Table 8 are presented in Table 9. For the 1937–50 period about a third of the price rise can be attributed to quality change no matter which set of weights we use.[23] In the 1950–54 period the role of quality change appears to have been minor, unless we weight it by 1950 weights. All weights point to the conclusion that "real" automobile prices fell rather than rose during 1954–60.[24] Using beginning period (1950) weights, the fall was around one-quarter. Using end period (1960) weights, the fall was very small, indicating roughly no change in "real" automobile prices. For the 1937–60 period as a whole, quality change accounted for about one-third (using end period weights) to about three-fourths (using beginning period weights) of the recorded price change in the CPI. These results are quite tentative and subject to various limitations to be discussed below. Nevertheless, if we realize that we have only scratched the surface as far as quality adjustments are concerned, considering only a very limited and narrow class of "qualities," the conclusion is inescapable that the lack of adequate quality adjustments has resulted in a very serious upward bias in the official automobile price indexes.[25]

6. Additional Tests, Limitations and Conclusions

A. THE EVIDENCE OF THE USED CAR MARKET

One of the problems associated with the use of list prices in this study is the extent to which they may just represent pricing mistakes by manufacturers at some point in time. A manufacturer may overprice or underprice a particular innovation and there is nothing in our method that would catch it. Of course, if we had sales data broken down by makes, models, and attachments, an appropriate weighting of the original data would go a long way toward the solution of this problem. In the meantime, however, we may want to investigate the prices of these cars. The prices of used cars are not

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[23] Loosely speaking. Since the quality index is defined multiplicatively, there is no unique way of decomposing a given price change into additive "quality" and "pure" price change components. With 1937=100, the CPI stood at 201 in 1950, the beginning period weighted quality index at 124, and the "adjusted" CPI at 161. $1.25 \times 1.61 \approx 2.01$. The "role" of quality in change could be measured as

$$\frac{24}{101}, \text{ or } \frac{101-61}{101}=\frac{40}{101}, \text{ or as } \frac{1/2(24+40)}{101}.$$

The last procedure leads to the "one-third" statement in the text. On this problem see the note by H. S. Levine. "A Small Problem in the Analysis of Growth" in *Review of Economics and Statistics*, May 1960, pp. 225–228.

[24] If we had deflated the list price index instead of the CPI, we would have shown some price rise for the 1954–60 period with all but the 1950 set of weights.

[25] And in the CPI as a whole. Adjusting the overall CPI for quality change in only *one* commodity—automobiles (applying 1950 quality weights to the 1950–60 changes in specifications and using the 1950 weight of automobiles in the index —3.7 percent), results in a reduction of the index from 125.6 (in November 1959) to 123.7 (1947–49=100). Over 7 percent of the increase in the CPI since 1947–49 may be due just to the changing quality of one commodity.

tied any more to the manufacturers' list prices and are set, presumably, more directly by the "market."

Since a used and a new car are not exactly the same commodity, we should not expect a perfect agreement between estimates of "quality prices" from these two different sets of data. In particular, as cars age, one might expect that some of the "qualities" depreciate much faster than others. Nevertheless, relatively "new" used cars should be reasonably good substitutes for new cars and their prices should reflect similar quality differentials.

Table 10 compares the results of using used prices instead of list prices for selected cross sections. For the 1960 models the used prices are for approximately 6-month-old cars. For the other cross sections they are for a little over one-year-old cars. As can be seen by comparing the coefficients of the "new" and "used" regressions respectively, the difference between the two are relatively minor and usually well within the range of their respective standard errors. Thus, the quality weights that could be derived from the regressions using the prices of 1-year-old cars are roughly similar to those that we obtain using new car (list) prices.[26]

TABLE 10.—*A Comparison of Price-Quality Regression Coefficients of New and Used Cars*[1]

Coefficients of	Model year									
	1960		1959		1957		1954			
	New	Used in 1960	New	Used in 1960	New	Used in 1958	New	Used in 1955	Used in 1956	Used in 1957
H	0.052 (.009)	0.040 (.011)	0.058 (.011)	0.029 (.015)	0.051 (.013)	0.042 (.015)	0.149 (.038)	0.067 (.038)	0.057 (.038)	0.052 (.050)
W	.063 (.009)	.069 (.011)	.090 (.013)	.112 (.017)	.059 (.017)	.053 (.020)	.084 (.032)	.126 (.032)	.122 (.032)	.118 (.042)
L	-------	-------	-------	-------	.017 (.006)	.024 (.007)	-------	-------	-------	-------
V	−.017 (.010)	−.011 (.021)	−.035 (.015)	−.030 (.020)	−.011 (.010)	−.011 (.012)	−.022 (.015)	.024 (.015)	.035 (.015)	.049 (.020)
T	.026 (.007)	.039 (.008)	.011 (.008)	.028 (.011)	.012 (.005)	.047 (.006)	-------	-------	-------	-------
A	-------	-------	-------	-------	.050 (.011)	.026 (.013)	-------	-------	-------	-------
P	.102 (.011)	.094 (.013)	.104 (.014)	.077 (.018)	.034 (.013)	.001 (.015)	.037 (.030)	.091 (.029)	.123 (.030)	.145 (.038)
B	-------	-------	-------	-------	.069 (.011)	.095 (.014)	-------	-------	-------	-------
R^2	.950	.919	.934	.872	.966	.948	.828	.854	.854	.793

[1] The results differ from those presented in Table 3 in two ways. First, they exclude variables which turned out to be insignificant in the particular years such as length or "automatic transmissions." Second, they are presented as computed, using logarithms to the base 10. To make them comparable to the results in Tables 3 and 4, all the coefficients and standard errors should be divided by 0.4343 ($\log_{10} e$).

The used prices in 1960 are taken from the July issue of the N.A.D.A. *Used Car Guide.* For all other years they are taken from the February issues of the *Guide.*

[26] There are some minor differences that foreshadow the results that would be found if we were to use prices of 3-, 4-, 5-, and 6-year-old cars in our analysis. The relative price of horsepower falls somewhat with age, while the coefficient of weight remains stable or rises somewhat. The discount on V–8's turns to a premium with age. The premium on "hardtops" rises. The "automatic transmission" premium depreciates very rapidly. In general the results for 5-, 6-year-old used cars look quite different from those reported here. They will be described elsewhere.

B. RELIABILITY

One of the advantages of the approach outlined above is the possibility of computing confidence intervals for the quality indexes or the quality adjusted price indexes. For each new combination of specifications we can compute not only its predicted price in some base period but also the "prediction interval," the probable range of the error of prediction based on the goodness of the fit of the equation and the distance of the new specifications from their mean values. Since this computation is somewhat laborious and since time was limited, no such calculations were actually performed.[27] Some insight, however, into the possible magnitude of such an interval can be obtained by examining the standard error of regression (the standard deviation of the residuals from the equation). The average error of "prediction" for any *one* particular car is quite large. It varies from about 5 percent in 1957 to about 8 percent in 1950 for single year cross sections, from about 6 percent for the 1956–57 combined regression to about 9 percent in the 1958–59 regression, and is about 8 percent for the overall 1954 through 1960 regression. This figure is applicable if we want to predict the price of a particular make and model. We are interested, however, in predicting the *average* price for the three "low-priced" makes. In our case this is an average of eight models and the error of predicting an average goes down, approximately and under suitable conditions, as the square root of the number of items. Thus, the average residual for this group of cars as a whole is only about a third ($\sqrt{8}=2.8$) of the individual errors quoted above. It would be even smaller if we had computed a weighted regression, since the three "low-priced" makes would probably account for about 60 percent of the weights.

C. SHIFTING SUPPLY CONDITIONS AND TASTES

To the extent that shifting supply conditions or changing tastes change the relative "price" of a particular quality we are back to the classical index number problem of changing weights. Not much can be done about this in practice except to shorten the timespan of comparison, compute base and end period weighted indexes, and hope that they are not too far apart. In our case, the more striking examples of such changes are the rapid decline in the "price" of horsepower with the introduction of the V–8's and the fall in the "price" of length.

The CPI in switching to the pricing of V–8's in 1956 linked them to the previously priced six-cylinder engine cars without allowing the index to rise or fall as the result of this substitution, and we have followed suit in the calculation of our indexes. If we use contemporary weights (e.g., for 1955–56) this is about right. Our estimates of the horsepower coefficients are based on a sample that includes V–8's and thus it is not surprising that the increase in horsepower weighted by its coefficient comes close to the difference in price.[28] For the "low-priced three," if we use the horsepower and weight difference between the sixes and the V–8's in 1956 and weight them with 1955–56

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[27] But they present no problem, in principle. See A. Mood, *Introduction to the Theory of Statistics,* 1950, pp. 304–305, and G. C. Chow, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," *Econometrica,* July 1960, pp. 591–605.

[28] A V–8 engine has usually 50 more horsepower units than a comparable "six" and costs about $100 more. Since our horsepower coefficient during this period is around 1 percent per 10 horsepower units, we would predict a 5-percent higher price. But 5 percent on a $2,000 car is $100.

quality prices, we predict that comparable V–8's should cost about 6 percent more. Actually, they were only 5.5 percent more expensive. Using the 1959 horsepower differences between these cars and 1959–60 weights we predict a 9-percent price differential against the observed 5 percent.[29] This agrees with our finding for the sample as a whole that the V–8's were about 3 or more percent cheaper than would be predicted from an extrapolation of the price-horsepower relationship for six-cylinder engine cars.

The introduction of the V–8's represented a decline of a few percentage points in the "real" price of cars that is not caught by the linking procedure. But this is only an "economies of scale" effect along a given relationship, and does not represent the total possible contribution of the V–8 engine. In fact, the appearance of the V–8 on the market in substantial quantities brought the whole level of horsepower "prices" down. Thus, if we were to value the V–8 at 1950 horsepower "prices," when there were only a few V–8 engine cars in the sample, we would estimate it to be a 15-percent "more car" (to have a 15-percent higher "quality" index) as against only a 5-percent increase in its price. The very fact of the rapid rise of the V–8 to market dominance would indicate that it was somewhat "underpriced" relative to the sixes. This is also supported by the used car price-quality regressions. In a large number of cases, the negative coefficient (discount) of the V–8 variable observed for new car prices turns into a positive coefficient (premium) once these cars get to the used car market.

Another problem is created by our use of proxy variables, of dimensions that may not be desirable per se, but which are correlated with other, more difficult to measure, but basically more desired dimensions. Weight, for example, is unlikely to be desired very much for its own sake. Rather, it is a proxy for "size." The relationship between price and weight may involve, however, other things besides "size," and the relationship between weight and the underlying desired characteristics may change over time. Our weight coefficients are derived on the basis of the difference in price between the cheap and the expensive cars, but the "large" cars may be expensive for reasons other than just "size." We have tried to control this by introducing a variety of dummy variables such as power steering and automatic transmissions which are standard equipment on the more expensive cars.[30] This prevents these cars from exerting an undue influence on the price-weight relationship for the sample as a whole. Alternatively, we could have computed separate estimates for different groups of cars; for example, the "low," "medium," and "high" priced cars. Still another approach would have been to estimate "compar-

[29] This brings out an additional problem associated with the linking procedure. The additional cost of a V–8 engine has remained approximately constant at $100 while the absolute price of cars increased. Thus a price index based on six-cylinder engine cars would rise somewhat faster than the V–8 based index. The inclusion of attachments in the pricing procedure may lead to an underestimate of the price rise of the attachmentless car if, as appears to have happened recently, attachment prices do not rise as much as the price of the "basic" unit or at all. To the extent that a substantial fraction of cars is bought without them, this could bias the index.

[30] This is one reason why these estimated coefficients should not be used directly in estimating the "value" of a particular attachment. We know that power steering and brakes come to about $130, which is far from the 20-percent or so increase in price indicated by their coefficients. The main purpose of these variables is not to estimate the price of these attachments, which we know, but to reduce the possible bias in our slope estimates for the numerical qualities by allowing different groups of cars to differ in the position or intercept of these slopes.

able" prices for different models by subtracting from the more expensive cars the estimated "value" of most of the attachments and features not available on the lower priced cars. Since many of these are listed as "extras" for other cars, one could probably go some distance in "standardizing" prices.

The basic method would of course be seriously compromised if the relationship between any one of the measured dimensions and the more basic "real" qualities were to change from one period to the next. For example, suppose all cars were, after a given date, made of an aluminum alloy which halved their weight, but absolute and relative prices did not change. This change in weight would increase the apparent price of weight and reduce its level per car while in fact nothing may have happened except for a change in units of measurement. If we did not know what had happened, we would have mistaken this weight change for a quality change. But in practice this should not present an insuperable problem. We usually know enough about what is happening in a particular market and to a particular product to be able to make some adjustments for it. More important, such changes are unlikely to be sudden and all inclusive. Aluminum cars will probably sell for several years together with more "old-fashioned" cars, and we shall be able, by the use of dummy variables or other techniques, to detect the difference between these cars and build it into our equations.[31]

D. SUGGESTIONS FOR FURTHER RESEARCH AND CONCLUSIONS

It is obvious that our investigation is only illustrative of a promising line of attack on the quality change problem. There are more than just a half-dozen dimensions to an automobile and they may not interact in any simple linear fashion.[32] Further work along these lines would include the introduction and testing of a number of additional "qualities"; an examination of the residuals from the various price-quality regressions which could reveal overlooked variables or nonlinearities; use of weighted regressions, where different cars would be weighted according to their importance in the market; division of the sample into separate subgroups to test hypotheses about the linearity of the various price-quality relationships; use of actual transaction prices instead of list prices in the analysis; and the extension of this type of analysis to a variety of other commodities such as trucks, refrigerators, and cameras.[33]

Continuous studies of the present type by the price collecting agencies, should prove of great value. First, they would eventually perfect the method enough so that it could be used routinely in the computation of the official indexes. Second, they would provide them with much more information on the various dimensions of a commodity, allow the use of a more sophisticated linking procedure, and isolate the qualities or dimensions which appear to be most important. Third, the availability of such information is also likely to lead to a more useful specification of commodities for price collection purposes.

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[31] The next few years will provide a good test of this assertion. One of the 1961 model year cars is already using an aluminum block engine.

[32] For evidence on how complicated a machine an automobile really is and for the many changes that actually occurred in it since the 1930's, see the history of the Plymouth and its specifications summarized in *Administered Prices*. Hearings before the Subcommittee on Anti-Trust and Monopoly, U.S. Senate, 85th Congress, 2nd session, Part 7: Appendix, 3655–65 and 3734–49.

[33] A study of wheel tractor prices along these same lines is in progress.

And finally, such studies, if done for a wide enough range of commodities, could provide an estimate of the probable upward drift of the price indexes due to their inability to control adequately for many of the constantly occurring quality changes.

APPENDIX

The Official Automobile Price Indexes

There are three official automobile price indexes: The "new automobiles" component of the CPI, the "passenger cars" component of the WPI, and the automobile component of the Prices Paid Index of the U.S. Department of Agriculture. The CPI new automobile price index is a retail price index for Chevrolet, Ford, and Plymouth sedans with V–8 engines (sixes before 1956 except Ford), automatic transmissions (since 1956), and other minor items such as extra trim, radio and heater, gasoline and antifreeze. The WPI is a wholesale (manufacturer to dealer) index of car prices, presumably covering all or most makes and models weighted by some base period production. The Agricultural Marketing Service index, which is not published separately, is based on a mail survey of prices paid by farmers for six-cylinder Chevrolets, Fords, and Plymouths, and for V–8 Chevrolets, Fords, Plymouths, and Buicks. Average prices paid for six-cylinder cars and for V–8's are published separately each quarter in *Agricultural Prices*. Again, it is not clear how the different makes and models are weighted, and what weights are used in aggregating state data into national averages.

Of the three indexes, the AMS stands alone in not specifying exactly what attachments are included in the model being priced. The CPI explicitly deals with the items that are being priced with the car, and adjusts for changes in "extras." The WPI presumably prices the "standard equipment" car and adjusts for major changes in what is being considered as standard. The AMS, however, has collected prices paid by farmers for specified models and makes "together with the usual equipment bought by farmers." It has tried to control for some aspects of size by comparing similar "price lines" of each make in different years, and has priced V–8's and sixes separately, but its failure to specify other attachments allows the index to drift upward as the result of farmers shifting to the purchase of more heavily equipped cars, cars that include radios and heaters, automatic transmissions, power steering and brakes, and other extras. That this drift is serious is indicated by the fact that the difference between the average six- and eight-cylinder car priced by the AMS which stood at $200 in 1947–49 increased to $660 by November 1959. Since, the price of V–8's and Buicks probably did not increase as much, percentagewise, as the price of the "low-priced-three" sixes, most of this increase must be due to the increasing number of attachments bought with the more expensive cars.

Percentage changes in these indexes are tabulated in Table 11 for selected periods and are compared to changes in a list price index of the "low-priced-three" makes. Note that in almost all of the comparisons, the AMS prices rise more than all the other indexes, including the list price one. This is another indication of the upward drift

TABLE 11.—*A Comparison of Official Indexes and List Prices for U.S. Cars: Percentage Change, Selected Periods*

Period	WPI [1]	CPI [2]	AMS [3]	List prices: Unadjusted [4]	List prices: Adjusted for minor equipment changes [5]
1937–50	83.0	101.0	129.0	116.0	----------
1947–49 to January 1954	20.6	29.7	32.7	[6] 18.0	16.9
January 1954 to November 1954	2.7	−1.7	[7] 2.2	2.5	----------
November 1954 to November 1955	4.1	−.9	[8] 3.8	5.4	----------
November 1955 to November 1956	5.7	5.1	5.4	9.9	----------
November 1956 to November 1957	.6	4.2	3.8	6.7	----------
November 1957 to November 1958	5.1	4.2	11.8	6.0	----------
November 1958 to November 1959	.1	.1	3.0	2.0	----------
January 1954 to November 1959	19.7	11.3	33.6	34.4	----------
1947–49 to November 1959 (1960 models)	44.3	44.3	68.4	[9] 58.6	----------
January 1954 to November 1957	13.8	6.7	29.8	[9] 26.7	21.6

[1] See Table 6.
[2] See Table 7.
[3] Sixes before November 1955, V–8's thereafter; the V–8's include Buick Special in addition to the "low priced three." From various issues of *Agricultural Prices*. The 1937–50 comparison is based on an unpublished index used to deflate farmers' expenditures on automobiles.
[4] From Table 7: The "low priced three." The model year is assumed to start in November of the previous calendar year.
[5] Adjusting list prices for differences in minor equipment items included in the price, such as directional signals and electric clocks, based on data from *Administered Prices, op. cit.*, pp. 3548–9, 3622–6, and 3730–3. Also, including automatic transmissions in the list prices as of 1956.
[7] January 1954 to January 1955.
[8] January 1955 to November 1955.
[9] Beginning with 1950 models.

in the AMS index as the result of its relatively loose specification policy. Looking at the other indexes, we note that the movements to 1954 are roughly similar, with the WPI rising somewhat less than the CPI and the list price index. The main divergence between these indexes comes in the 1954–58 model year period, with the CPI rising substantially less than either the WPI or list prices. It is not too surprising that the WPI rose less than the list price index for the lower priced makes. About half of its weight is given to medium and higher priced cars which have risen less percentagewise than the lower priced makes.[34] The sharp divergence between the CPI and list prices during 1954–58 is, however, surprising and requires explanation.

A reconciliation of the two series is seriously hampered by the lack of a detailed description of how the CPI is actually computed. There is no published information on whether the index is a ratio of the average price for these makes or an average of their price relatives; what weights, if any, are used in averaging the price data for different makes and models; which models of a given make are being priced in a particular year and to what models they are being compared in the previous year; and what quality changes were "linked-in" or "out," and when and how.[35] The list price index was constructed in such a way as to approximate the CPI closely.[36] It differs from the

[34] Between 1954 and 1958 the prices of Buicks, Pontiacs, Mercurys, and Dodges advanced relatively less (about 15 percent) than the prices of Chevrolets, Fords, and Plymouths (which rose 23 percent). Compare also with Table 5.
[35] Many of these problems could have been settled by a consultation with BLS personnel and an examination of their records. Unfortunately, previous commitments, deadlines, and distance prevented this from being accomplished in time.
[36] It differs from the CPI in that before 1956 it prices only six-cylinder engine cars (except in 1937) whereas the CPI priced eight-cylinder Fords throughout, and in not including automatic transmissions in its price which the CPI has done since 1956.

CPI in that it does not adjust for changes in minor equipment items, it does not include transportation costs, state and local taxes, and minor accessories sold with the car, and it does not allow for changes in the discount from list prices.

It is possible to adjust the list prices for some of the minor equipment changes using more detailed price data presented in the Kefauver Hearings.[37] This will reduce the rise in list prices somewhat (see the last column of Table 10), but it still leaves a very substantial difference between the CPI and list prices (or the WPI) unexplained. Some of this difference could be due to the inclusion in the CPI of various "trim" items, transportation costs, and taxes, which may have remained constant or risen less than the price of the "basic" (stripped) car. Still it could not explain it all—the actual difference is too large for that.

Another source of this difference could lie in the fact that the CPI started in 1954 to collect data on discounts offered by retailers. But even this is unlikely to explain much of the difference between the two series. Assume that before 1954 the CPI did not include discounts, that it does so since 1954, and that no linking was done to account for this. We know that list prices went up by about a third during 1954–60, that the spread between the price to the dealer and the list price remained at approximately the same percentage level (24 per cent) throughout the period, and that during the same period the CPI rose only 11 per cent. Consider the following arithmetic example: A representative car cost $1,350 wholesale in 1954, listed for $1,800 at retail, with the dealer's margin being $450. No discount was given in 1954. The same type of car lists for $2,400 in 1960 (a rise of 33 per cent) and costs the dealer $1,800. If the actual retail price had risen only 11 per cent, to $1,998, the dealer's return would have dropped from $450 to $198 per car, or from a 25 to an 8 per cent margin. This seems to be too big a drop in the return to dealers in a period of rising prices to be plausible.

An additional explanation for this divergence has been suggested by John M. Blair, who was also puzzled by it.[38] He has argued that since the BLS agent first asks for the list price and then separately for the magnitude of the discount the difference between the two may not equal the actual price charged. It is said to have been common practice during 1955–58 for dealers to "pack the price," i.e., to quote a discount that was not calculated from the list price but from some higher figure. Subtracting this "unrealistic" discount figure from the list price would lead to a downward bias in the estimated price actually paid by consumers. But this should be a transitory phenomenon. Once eliminated, as it apparently has been in the most recent years, it should have led to a comparably higher rise in the CPI. This has not happened.

The final possibility is that the CPI has been much more thorough in its quality adjustments than is reflected in the published literature. That is, it could have been argued in some year, for example, that "this year's cheapest Ford model is equivalent in size, trim, and horsepower to last year's medium-priced Ford." The only detailed de-

[37] *Administered Prices.*
[38] *Administered Prices*, pp. 4000–4002.

scription of automobile prices in the CPI suggests this possibility by saying:

> . . . the automobile retail price indexes have been designed to measure solely the trend of prices paid by city workers for automobiles of as nearly fixed quality as possible . . . Therefore, prices are collected for automobiles which are regarded as most nearly equivalent to the cars priced in the preceding year.[39]

But then the next sentence reduces the probability of this by stating:

> Equivalent quality of new cars has been assured to a great extent by specifying as a basis of pricing the same make and body style, the *same or equivalent price series*, and the same number of cylinders as the car which was priced in the preceding year. [Emphasis supplied.]

Thus, it appears quite unlikely that the CPI has linked out the type of horsepower, weight, and length changes used in constructing our quality indexes. If this is true, then it is quite probable that for some unknown reason, the CPI underestimated the rise in new car prices (given its own definition) between 1954 and 1958.

[39] "Automobile Prices in the Consumer Price Index," *Monthly Labor Review*, November 1955, p. 5.

STAFF PAPER 4

SAMPLING CONSIDERATIONS IN THE CONSTRUCTION OF PRICE INDEXES WITH PARTICULAR REFERENCE TO THE UNITED STATES CONSUMER PRICE INDEX

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I. Introduction

Theoretical discussions of price indexes have been concerned primarily with an economic approach to problems arising out of such questions as:

1. Is it a price index or a cost-of-living index that is needed?
2. How should a price index or a cost-of-living index be constructed? (Indifference curve approach, Laspeyres, Paasche, etc., and the relations between these various forms.)
3. How does one choose a base period and a period in which weights are determined?
4. What methods are to be used in dealing with quality changes, with the disappearance of old items and the appearance of new items, and with related problems?
5. How does one aggregate over consumers, over cities, over States, and so on?

The problems suggested by these questions exist whether one is dealing with "samples" or with complete sets of data, and an excellent summary of the literature on many of these problems has been given by von Hofsten (*1*, Chap. 13).[1]

Leaving aside for the moment the problems of sampling, most index numbers start from some fixed formula. That is, given a single consumer and the complete universe of prices and quantities, some basic way of computing the index is chosen. For example,

$$R^{(1)}=\frac{\Sigma q_{i0}p_{i1}}{\Sigma q_{i0}p_{i0}}$$

is the Laspeyres formula which serves as a model for practically all of the currently computed price indexes. In this formula q_{i0} represents the quantity of commodity i consumed in the base period, designated as time zero, p_{i0} represents the price per unit of this commodity at time zero, and p_{i1} represents the price of the same commodity at time one. Thus $R^{(1)}$ is the Laspeyres index for time one with time zero as base. Presumably the principal reason for choosing the Laspeyres form is that it uses base quantity weights (which are all that are usually available), and can therefore be easily explained as the relative cost of a fixed market basket of goods and services (see Jaffe, *2*, p. 7). Even after deciding that a price index, as opposed to a cost-

[1] Italic numbers in parentheses refer to bibliography at end of paper.

of-living index, is needed and that a fixed formula such as Laspeyres can be taken as a starting point, the theoretical and practical problems mentioned under points (3), (4), and (5) above still remain. Comments on some of these problems as they influence sampling considerations will be made later in this report.

Because many individuals seem to desire a cost-of-living index rather than a price index, and because it does not appear possible to translate the indifference curve approach into a form that has practical applications, there have been attempts to develop formal statistical and economic models that will provide cost-of-living indexes. Thus Stone (*3*) describes a linear expenditure system for consumers, and gives references to papers that show how this system can lead to a cost-of-living index; Brady and Hurwitz (*4*) refer to additive or multiplicative models that have been used to explore the international comparisons of food costs; and Neiswanger (*5*) recommends the use of varying weights in the Laspeyres formula, the weights being determined from current prices and the estimated direct and cross elasticities between commodities included in the index. In these situations, one would be using data (even for the entire universe of consumers and of prices and quantities) to estimate parameters of a model rather than for direct substitution into a formula. Model considerations would then provide the index.

No matter how one chooses to resolve the questions and problems that have thus far been mentioned, the actual construction of a price index will always be based upon samples of data rather than upon data derived from complete enumerations of the pertinent universe. The quality of the index will, therefore, depend to some extent upon how these samples are obtained. This fact has long been recognized, but the sampling aspects of index number construction have never been accorded the attention that has been devoted to their economic aspects. The purpose of this report is to present some comments and observations concerning the sampling problems that arise in the computation of the more or less traditional Laspeyres-oriented indexes, with special reference to the United States Consumer Price Index.

II. A Brief Description of Where Sampling Enters the Consumer Price Index

There are clearly many points at which sampling is used in the determination of a value of the Consumer Price Index. These are:

A. DETERMINATION OF THE ITEM WEIGHTS (CONSUMER EXPENDITURE SURVEYS)

1. Selection of points or intervals in time at which consumer expenditure surveys will be made.
2. Selection of a sample of cities in the United States.
3. Selection of a sample of consuming units in the selected cities.

B. SELECTION OF THE SAMPLE OF CITIES FOR THE INDEX

1. This sample is customarily selected from among the cities used in the Consumer Expenditure Surveys, although other index designs would be possible. Thus one could impute weights to cities not originally included in the consumer expenditure survey.

2. In making up a national index, the individual city results are evidently averaged with weights proportional to both the city wage-earner and clerical-worker population that each city represents and to the value of the city market basket in the base period.

C. SELECTION OF A SAMPLE OF ITEMS OF EXPENDITURE THAT IS TO BE PRICED IN COMPUTING THE INDEX

1. The items of expenditure are divided into major groups (food, housing, apparel, etc.), then into subgroups, sub-subgroups, etc.

2. Ultimately the subdivision process leads to a group of items that are "somewhat similar." One or more specific items are selected to represent this subdivision.

3. Finally, one or more "specified-in-detail" items are chosen to represent the specific items and also represent the "somewhat similar" group of items.

D. DETERMINATION OF THE POINTS IN TIME AT WHICH PRICE QUOTATIONS FOR THE "SPECIFIED-IN-DETAIL" ITEMS ARE TO BE OBTAINED

1. The index is published monthly. Thus one or more points in time during the month must be chosen for pricing.

2. Some items in some cities are not priced each month, and so a scheme for sampling months, etc., is integrated into the program.

E. SELECTION OF A SAMPLE OF PRICE REPORTERS FROM WHOM PRICE QUOTATIONS ARE OBTAINED

1. The sampling problem here varies with the item. Thus samples of families are used for rent reports, samples of stores for food reports, etc.

It will not be possible in this brief report to examine each of these components in the overall sampling design of the Consumer Price Index, or even to list the other possible sources of random variation that may to some extent influence a reported value of the index (e.g., variability among enumerators, random errors in the reporting of prices, and the like). Rather, attention will be focused primarily on the sampling of items of expenditure, since this is an area in which there appears to have been a great deal of controversy, and on the problem of measuring the total sampling error of the Consumer Price Index. It should be noted that a detailed description of the methodology of the 1950 Survey of Consumer Expenditures has been provided by Lamale (*6*).

III. The Computation of the Consumer Price Index

Once the individual price quotations have been obtained for the "specified-in-detail" items, the next problem is that of combining these into the various desired indexes. At this point we shall only be concerned with the computational details of this combination process. The relationship of this computational procedure to the design used in selecting a sample of index cities will be discussed in Section VI.

Suppose we have c index cities. Let the population (city wage-earner and clerical-worker population) weight assigned to the i-th city be W_i, $i=2, \ldots, c$, where $\Sigma W_i = 1$. Within the i-th city, let the base weight assigned to a specific item, but not a "specified-in-detail" item, be ${}_iw_{jklm}^{(0)}$ . . ., where i represents the city, the superscript (0) represents the base time period, and the subscripts j, k, l, m, etc., represent successively finer classifications or subdivisions of the items. Thus j represents major expenditure groups (food, housing, apparel, etc.), k represents a subgroup within a major expenditure group, and so on until the individual items are reached. Thus a man's nylon business shirt might be a specific item, although it would not yet be a "specified-in-detail" item for which prices would be obtained. The number of subgroup classifications depends upon j. The quantities ${}_iw_{jklm}^{(0)}$ . . . are relative weights so that $\sum_{j,k,\ldots} {}_iw_{jklm}^{(0)} \ldots = 1$ for each i.

These weights for specific items are essentially relative expenditure weights. That is, they can be viewed as the average proportion of total expenditures, for consumer expenditure survey families in a city, that was spent on these specific items in the base period. (Actually, it is very difficult to determine the exact steps that were followed in arriving at the weights since published accounts—e.g., BLS Bulletin 1168 (*8*, p. 3)—are not very explicit on the details of the procedure.) Once weights have been determined for specific items, weights for the various classes of the subdivision process are obtained by summing these item weights. Thus we have ${}_iw_j^{(0)}$, ${}_iw_{jk}^{(0)}$, etc.

For the present purposes, let us assume that ${}_iw_{jklm}^{(0)}$ represents the weight for a specified item or for a "price family" of related items. There can be more or fewer subscripts for a given j, but assuming an equal number of subgroups for each major group makes notation easier and the general argument goes through no matter what the number of subscripts. Then a single specified-in-detail item is selected out of the jkl-th subdivision. Denote this sampled item by $jklx$.

For item $jklx$, in city i, at time t, a number of price quotations are obtained by sampling households, food stores, etc. Call these price quotations ${}_ip_{jklx_1}^{(t)}$, ${}_ip_{jklx_2}^{(t)}$, ... By some appropriate averaging process, we end up with an average price ${}_i\bar{p}_{jklx}^{(t)}$. Then the price relative for this specified-in-detail item is:

$${}_iR_{jklx}^{(t)} = \frac{{}_i\bar{p}_{jklx}^{(t)}}{{}_i\bar{p}_{jklx}^{(0)}}$$

Not only does this procedure give a price relative for item $jklx$, but it also gives an index for the jkl-th subgroup since item x was selected to represent the entire group. That is, ${}_iR_{jklx}^{(t)}$ is taken as an approximation to:

$${}_iR_{jkl}^{(t)} = \frac{\sum_m {}_iw_{jklm}^{(0)} \dfrac{{}_i\bar{p}_{jklm}^{(t)}}{{}_i\bar{p}_{jklm}^{(0)}}}{{}_iw_{jkl}^{(0)}}$$

where the summation is taken over all specified-in-detail items contained in the jkl-th subgroup. Note that this is essentially of Laspeyres form, since, approximately,

$${}_iw_{jklm}^{(0)} = K \cdot {}_i\bar{q}_{jklm}^{(0)} \cdot {}_i\bar{p}_{jklm}^{(0)}$$

Actually, the expenditure surveys do not obtain individual quantities for specified-in-detail items. Rather, quantities are determined for specific items, and these are translated into the fraction of an average family's expenditures that goes for each of these specific items. Of course, base period prices must be obtained for the specified-in-detail items that go into the index.

If one now wishes to make up a city index for the jk–th subgroup, or for all items combined, the following procedure is used:

$$ {}_iR^{(t)}_{jk} = \frac{\sum_l {}_iw^{(0)}_{jkl} \dfrac{{}_i\bar{p}^{(t)}_{jklx}}{{}_i\bar{p}^{(0)}_{jklx}}}{{}_iw^{(0)}_{jk}} $$

$$ {}_iR^{(t)} = \sum_{j,k,l} {}_iw^{(0)}_{jkl} \frac{{}_i\bar{p}^{(t)}_{jklx}}{{}_i\bar{p}^{(0)}_{jklx}} $$

Note that no divisor is required for the all-item index since the ${}_iw^{(0)}_{jkl}$ sum to one when all major groups, subgroups, etc., are considered.

These expressions for city indexes are often expressed in terms of the current relatives,

$$ \frac{{}_i\bar{p}^{(t)}_{jklx}}{{}_i\bar{p}^{(t-1)}_{jklx}} $$

Thus algebraic manipulation leads to:

$$ {}_iR^{(t)} = {}_iR^{(t-1)} \sum_{j,k,l} {}_iw^{(t-1)}_{jkl} \frac{{}_i\bar{p}^{(t)}_{jklx}}{{}_i\bar{p}^{(t-1)}_{jklx}} $$

where

$$ {}_iw^{(t-1)}_{jkl} = \frac{{}_iw^{(0)}_{jkl} \dfrac{{}_i\bar{p}^{(t-1)}_{jklx}}{{}_i\bar{p}^{(0)}_{jklx}}}{\sum_{j,k,l} {}_iw^{(0)}_{jkl} \dfrac{{}_i\bar{p}^{(t-1)}_{jklx}}{{}_i\bar{p}^{(0)}_{jklx}}} $$

The quantities ${}_iw^{(t-1)}_{jkl}$, which also sum to one when all major groups, subgroups, etc., are considered, are what are ordinarily referred to as "current value" or "current importance" weights. They are, of course, only approximations to value weights because of the previously noted restrictions on ${}_iw^{(0)}_{jkl}$, and because a single item, here denoted by x, is used to represent all items in the class jkl. They can also be expressed in terms of current relatives and the current value weights for the preceding time period.

The foregoing would appear to be a faithful representation of the computation of Consumer Price Indexes at the city level. An alternative computational procedure that uses "hypothetical" base quantities is sometimes described in the literature (e.g., 7). That is, consumer expenditure survey data would be used to determine an average dollar expenditure for items in group jkl. Call this value ${}_i\bar{v}^{(0)}_{jkl}$. If the average price of item $jklx$ at time zero is, as before, ${}_i\bar{p}^{(0)}_{jklx}$, then a hypothetical base quantity can be obtained to associate with item *jklx* that will account for all expenditures in group *jkl*. That is:

$$ {}_i\bar{q}^{(0)}_{jklx} = \frac{{}_i\bar{v}_{jkl}}{{}_i\bar{p}^{(0)}_{jklx}} $$

Then we would have, for example,

$$ {}_iR^{(t)} = \frac{\sum\limits_{j,k,l} {}_i\bar{q}^{(0)}_{jklx}\ {}_i\bar{p}^{(t)}_{jklx}}{\sum\limits_{j,k,l} {}_i\bar{q}^{(0)}_{jklx}\ {}_i\bar{p}^{(0)}_{jklx}} $$

where the hypothetical quantities now appear explicitly. This expression can also be written in terms of price relatives and the index for the preceding time period.

The final problem in the computation of the Consumer Price Index is that of describing how the city price relatives and city indexes are combined into United States indexes. Here the published accounts of the Bureau leave much to be desired. The most detailed published account appears in BLS Bulletin 1168 (*8*) and consists of the following sentences:

> Weighting of price relatives to calculate the average price change for groups of goods and services and for all items combined is carried out for each city separately. In combining the cities into the United States all city index, each city is given an importance or weight proportionate to the wage-earner and clerical-worker population it represents in the index. . . . The importance of cities in the index is now based on the Census figures for 1950. As new Census population figures become available, the Bureau will adjust the city weights accordingly.
>
> In the actual calculation of the index, population and expenditure weights are combined, so that index value weights are the product of three factors—base year quantities, population, and current prices. Aggregates for the United States index can therefore be calculated by a simple summation of value weights for the individual cities.

There would appear to be many possible interpretations of this quotation, but the general descriptive material given by Mudgett (*7*) and a passing comment (in *9*, p. 129) would suggest that the following procedure is used for obtaining the United States all-item index. Using the hypothetical quantity form for ${}_iR^{(t)}$, we define

$$ R^{(t)} = \frac{\sum\limits_i W_i \sum\limits_{j,k,l} {}_i\bar{q}^{(0)}_{jklx}\ {}_i\bar{p}^{(t)}_{jklx}}{\sum\limits_i W_i \sum\limits_{j,k,l} {}_i\bar{q}^{(0)}_{jklx}\ {}_i\bar{p}^{(0)}_{jklx}} $$

Thinking of the W_i as actual population figures, we see that this is essentially the value of the contents of all consumers' market baskets (the contents of the basket differ from city to city) at time *t* relative to the value at time zero. This expression can be rewritten to show its relation to the individual city indexes in the following manner:

$$R^{(t)}=\sum_i W'_{i\,i}R^{(t)}$$

$$=\sum_i W'_i \sum_{j,k,l} {}_iw^{(0)}_{jklx} \frac{{}_i\bar{p}^{(t)}_{jklx}}{{}_i\bar{p}^{(0)}_{jklx}}$$

where

$$W'_i=\frac{W_i \sum_{j,k,l} {}_i\bar{q}^{(0)}_{jklx}\,{}_i\bar{p}^{(0)}_{jklx}}{\sum_i W_i \sum_{j,k,l} {}_i\bar{q}^{(0)}_{jklx}\,{}_i\bar{p}^{(0)}_{jklx}}$$

Thus a city index is weighted in proportion to the population it represents and to the value of the city market basket in the base period. It is assumed that the W'_i are what are referred to as "relative cost-population weights Dec. 1952" in Table 1 of BLS Bulletin 1168 (*8*). This behavior of a Laspeyres index, where the aggregation is over individual consumers rather than over cities, has been noted by von Hofsten (*1*, p. 123).

The foregoing expression for the all-item United States Consumer Price Index can also be written in terms of average U.S. prices and quantities if we define

$$\bar{q}^{(0)}_{jklx}=\sum_i W_i\,{}_i\bar{q}^{(0)}_{jklx}$$

and

$$\bar{p}^{(0)}_{jklx}=\sum_i\left(\frac{W_i\,{}_i\bar{q}^{(0)}_{jklx}}{\sum_i W_i\,{}_i\bar{q}^{(0)}_{jklx}}\right){}_i\bar{p}^{(0)}_{jklx}$$

$$\bar{p}^{(t)}_{jklx}=\sum_i\left(\frac{W_i\,{}_i\bar{q}^{(0)}_{jklx}}{\sum_i W_i\,{}_i\bar{q}^{(0)}_{jklx}}\right){}_i\bar{p}^{(t)}_{jklx}$$

Then,

$$R^{(t)}=\frac{\sum_{j,k,l}\bar{q}^{(0)}_{jklx}\,\bar{p}^{(t)}_{jklx}}{\sum_{j,k,l}\bar{q}^{(0)}_{jklx}\,\bar{p}^{(0)}_{jklx}}$$

$$=\sum_{j,k,l}\left(\sum_i W'_i\,{}_iw^{(0)}_{jklx}\right)\frac{\bar{p}^{(t)}_{jklx}}{\bar{p}^{(0)}_{jklx}}$$

where W'_i is as previously defined. The quantity $\sum_i W'_i\,{}_iw^{(0)}_{jklx}$ is the relative importance of item *jklx* in the national all-item index. Thus this national relative importance figure is merely a weighted average of the city relative importance figures, where the city weights are proportional to the city population and to the value of the city market basket in the base period.

It should be observed that this last form of the national CPI, in terms of average U.S. prices and quantities, is essentially the form used by the Agricultural Marketing Service in computing the Index of Prices Paid by Farmers (*10* and *11*). However, the following differences between the CPI and the Living Component of this index might be noted for present purposes:

1. The 1956 Farm Expenditure Survey, on which the weighting pattern of the 1959 revision of the index was based, covered a national sample of farmers located in 306 primary sampling units (counties or pseudo-counties) and the results were expanded to U.S. totals on a basis representing all farms. Similarly, the AMS obtains price reports widely throughout the United States. Thus the BLS emphasis on a relatively small sample of cities, for many of which a city index is actually published, does not have its counterpart in the Index of Prices Paid by Farmers.

2. In obtaining an average U.S. price, an unweighted average price for a commodity is computed for each State (*10*, p. 36) and a weighted average of the state values then gives the national average. Apparently the state average prices are weighted by estimates of *current* purchases. This is at variance with the practice already described for the CPI where city average prices are essentially weighted by estimates of *base year* quantities.

3. The AMS does not price a "specified-in-detail" item but prices a specified item. Furthermore, reporters are requested to report prices for the item commonly bought by farmers, that is, "the volume sellers." This practice follows from the desire of the AMS to obtain estimates of the prices that would be secured if the total amount of money spent by all farmers in the United States for the commodity under discussion as of the 15th of a given month were to be divided by the number of items bought.

In concluding this discussion of the computation of the national CPI, we observe that an alternative way of combining city indexes would be to use weights W_i instead of W'_i. That is, the price change occasioned by a group of individuals would be weighted only in proportion to their number, and not additionally in proportion to their expenditures in the base year. This is essentially a problem in aggregation, as has been observed by von Hofsten (*1*, p. 125), and is in some respects related to the work of H. Theil (*12*) on "Linear Aggregation of Economic Relations." This in turn carries us back to the comments and references made in the first section of this report to formal statistical and economic models.

The foregoing account of the mechanical details of computing the Consumer Price Index represents a synthesis of bits and pieces of information culled from a wide variety of sources. I would like to suggest that it is the responsibility of the Bureau of Labor Statistics to publish technical materials that will describe in precise detail at least the major outlines of the actual procedures used by the Bureau. One has only to examine descriptions given in statistics textbooks of the city weighting procedure of the CPI in order to appreciate the need for such descriptions. Similar comments could undoubtedly be made about the Index of Wholesale Prices and the Indexes of Prices Paid and Received by Farmers.

It should be apparent from the discussion of this section that the procedures used by the Bureau of Labor Statistics lead not only to an all-item United States Consumer Price Index but also to a wide variety of subindexes (e.g., U.S. indexes for subgroups of items such as food, dairy products, housing, and the like; city all-item indexes; and in some instances city indexes for subgroups of items.). The remainder of this report will be devoted almost entirely to sampling problems as they relate to the all-item U.S. index, although many of the ideas and comments could be applied in a somewhat changed form to the subindexes. An extensive discussion of sampling for the food-at-home portion of the index, with particular reference to city indexes, has recently been published by Kruskal and Telser (*13*).

IV. Views on Sampling Variability and Price Indexes

It is clear from the foregoing discussion, as well as from publications of the BLS (e.g., *8*), that the data used in computing a value of the CPI are derived almost entirely from samples—samples of consumer families, samples of cities, samples of commodities, samples of points in time, and samples of price reporters. Furthermore, we have seen that these extremely numerous bits and pieces of sample data are combined in a most complex manner in order to arrive at a value of the CPI for a given month.

No individual can quarrel with the fact that a value of the CPI depends in some way on the particular samples from which the index data are obtained. It must therefore follow that a possibly different value of the index would result if a different sample were used at any stage in the process, and that it would be desirable to be able to attach a measure of sampling variability to a particular value of the index. Once this general area of agreement is reached, however, many diverse views have been expressed concerning the sampling variability of price indexes.

Many of the writers who have dealt with the problems of index number construction have assumed, either explicitly or implicitly, that "good" data are available. They have then simply not concerned themselves with the problem of attaching a measure of sampling variability to a computed value of the index. Thus Stone (*3*, p. 118) does not directly discuss problems of sampling but does say the following:

> The quality of index-numbers must depend to a large extent on the quality of the statistical data available, empirical information about product heterogeneity and the factors with which it is associated, and a skillful use of resources in making the innumerable adjustments and approximations that arise in practice.

When the expressed views of individuals who have been intimately associated with the actual production of index numbers are examined, we find a recognition of the need for "good" sampling and "large" samples, but, at the same time, a feeling of doubt that one can or should measure the sampling precision of an index number. Their arguments run somewhat as follows: The fixed market basket concept underlying the Laspeyres index formula is impossible to realize completely in the market place because some items disappear between two points in time, new items are continually introduced into the stock of existing items, and many of the items that are nominally available at both points in time have changed in quality and are thus, in reality, different items. The combined effect of these factors (including the manner in which one chooses to deal with them) is so large that it overwhelms the sampling effects. The conclusion drawn from this line of reasoning is that it is impossible and/or unnecessary to discuss the sampling precision of an index number. Some typical comments along these lines are von Hofsten's (*1*, p. 42):

> It may thus seem as if the important thing would be to select the items to be priced in such a way as to guarantee a good sample. (*Footnote:* This point of view is stressed by Mudgett (1951). He does not, however, consider the remaining problems which will be discussed presently.) One finds in practice, however, that the selection of items in current price index series is based on common sense and not on proper sampling methods. A consideration of the remaining problems, which will be undertaken presently, will show that this is no serious drawback. Moreover, the use of sampling would be expensive, as it would require complete lists of commodities.
>
> There is also another sampling problem involved here, viz, the selection of retail outlets where the prices shall be collected. In a large city only a few shops may be visited and the price of a single article may vary considerably from shop to shop, or, at least, from district to district. Although the difference in price *change* may not be so important, the selection of retail outlets will have a certain influence on the index. To be satisfactory the price collection should be based on an efficient sample of retail outlets. The construction of such a sample cannot be too difficult.

Jaffe (*2*, pp. 10–12) says:

> Statisticians who ask how well the CPI measures the price movements of the wage-earner's basket of purchases often have in mind the precision of the index in terms of its sampling error. I must regretfully assure them that while we believe the CPI provides a measurement of price change sufficiently accurate for practical uses, we are unable to supply a statistical measure of its precision. Before going on with the reasons for this, I would like to state further that I don't consider this lack terribly important. The idiosyncracies of the price data are far more significant in determining the character and accuracy of a price index. I am afraid that a measure of sampling error that ignored the problems of price measurement and comparison would, by giving the wrong impression of accuracy, defeat its own purpose.
>
> Since the probability sampling is so generally accepted as desirable, its honoring in the breach calls for some explanation. Given unlimited resources it would probably be possible to establish probability sampling procedures for all components of the Consumer Price Index. However, because of the wide scope of the index, the diversity of elements that

must be sampled, and the complexity of the marketing situations in which prices must be gathered, there is no practical probability sampling approach that can be applied with present resources. This does not mean that we at the Bureau ignore the statistical principles of sampling. They are applied to the extent that is practical and are always held forth as guides to our day-to-day sampling decisions.

In sharp contrast to these views, a number of authors have implied or stated that it is possible to take existing sampling theory—as is set forth, for example, by Hansen, Hurwitz, and Madow (*14*) or by Cochran (*15*)—and apply it more or less directly to a Laspeyres-type index, particularly with reference to the sampling of commodities. Thus, Mudgett (*7*, p. 51) says:

> The sampling error of index numbers arises from the fact that calculations are based on a set of n commodities found in the two periods of the comparison and this set is used to represent the whole list of N common commodities. * * * The index based on n, however, is an estimate. * * * In the usual statistical sense it is a variable, and, therefore, for all possible samples of n that could be taken from N there is a frequency distribution of these errors. We need only a knowledge of some of the properties of this distribution in order to gain needed insight into the accuracy of any determination of I_{01}. This knowledge is readily available from modern statistical theory. * * *

Mudgett does not apply these ideas to the actual computation of sampling errors for index numbers, nor does he cite instances where others have performed such computations. A somewhat similar, but more detailed, account of this view has been given by Banerjee (*16*), who states:

> Whereas it was necessary to construct the True Index in the precise estimation of CLI, and whereas, instead, Laspeyres' formula is being used at the cost of precision, it would, at least, only be reasonable to make sure that Laspeyres' Index be precisely calculated. This aspect of precision does not appear to have been paid the attention it deserves, so much so that it sometimes causes an embarrassment, when different organizations, while calculating the CLI for the same area and the same economic stratum of population, come out with different figures for the same index. Difference in the figures for the same index could have been appreciated if the coverage (the sample, or the way the sample is selected) and the error of estimation were made available. In absence of such information, controversies arise causing difficulties at administrative levels. With a view to systematizing the study, the concept of standard error in index number calculation was introduced in an earlier note (Banerjee, 1956a) where it was shown that it would be possible to calculate the standard error for an estimated CLI under certain assumptions.

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A somewhat more extreme view of the sampling of commodities for index construction has recently been set forth by Adelman (*17*). She essentially espouses the approach given by Mudgett and Banerjee, but suggests the use of a more or less continually changing probability sample of items. To some extent at least, this approach is advocated as a solution to the dilemma of a continually changing universe of commodities. An appropriate quotation from the Adelman article is the following (*17*, p. 240):

> The construction of an index number is normally associated with the selection, on an *a priori* basis, of the sample of commodities which is to be utilized in the evaluation of the index. The use of such a judgment sample precludes the determination of the extent to which an observed difference in two indexes can be ascribed to sampling errors, rather than to real causes. This defect is extremely important, since index numbers are generally employed for intertemporal, interregional, or intersectoral comparisons, where differences are often quite small, and their significance correspondingly uncertain. Furthermore, the use of an arbitrary fixed sample permits neither changes in product quality nor the introduction or disappearance of consumer products readily to be incorporated into the standard type of index. Any attempt to take such effects into account must of necessity impair the continuity of the index through time.
>
> At present, the author knows of no method in use which will allow the realistic evaluation of the statistical errors associated with an index number. In view of the practical significance of this problem, it is suggested in this paper that the items used in the computation of an index be chosen in a statistical manner. The use of a probabilistic sample would, in principle at least, remove all the above mentioned deficiences inherent in the normal method of sample selection. And, while the proposed procedure would not solve the problem of appropriate weighting, it would have the further advantage of being in conformity with the modern statistical trend towards the replacement of judgment samples by probability samples.

As a conclusion to this brief and *purposive* selection of views on the sampling variability of index numbers, we observe that the appearance of the Banerjee and Adelman papers led von Hofsten (*18*, p. 403) to reply in the following words:

> My conclusion from the above arguments is that there is no such thing as a statistical precision for a price index. Attempts to define the index in a statistical way, applying modern theory of sampling, only demonstrate that there is no satisfactory solution available. We may, therefore, just as well keep to the old practice and define the price index in an operational way and abstain from giving standard errors. This, of course, does not exclude the usefulness of applying the chain index solution or of basing the selection of items on probability sampling and making analyses of the precision of price measurements.

The preceding views seem to offer three mutually exclusive choices for treating the sampling variability of a price index, namely: (1) ignore it, (2) determine it by a more or less direct application of existing sampling theory, or (3) modify the definition of the price index so that existing theory will apply. If any one of these choices could be adopted in its entirety, then it would simply be a case of carefully setting forth the full consequences of the choice. Unfortunately, there would appear to be elements that cannot be ignored in each of the views, and the real situation can be described only in composite terms. An attempt will now be made to present such a composite view.

V. The Sampling of Commodities

It is clear that the feelings of doubt that have been expressed concerning the possibility and desirability of attempting to measure the sampling precision of an index number arise primarily from difficulties encountered in maintaining a fixed market basket of goods and services when the universe of commodities available to the consumer is continually changing. The accepted approach to this problem by the producers of index numbers, as discussed, for example, by von Hofsten (*1*) and Stone (*3*, pp. 47–59), has been to maintain the fixed market basket as nearly as possible, but to make a variety of adjustments for the disappearance of old items, for the changing quality of continuing items, and for the appearance of new items. Adelman (*17*), as indicated in the previous citation, not only questions this method of constructing an index number but also states that it is impossible to attach a measure of sampling precision to an index so determined. Finally, von Hofsten (*18*) seems to accept Adelman's statement about the impossibility of computing sampling precision, but is unwilling to accept her solution of a continually changing sample of commodities.

It is not the purpose of this report to argue the meaningfulness of the Adelman approach to index number construction, or to justify or criticize the techniques that are being used to adapt a Laspeyres-type index to situations where there is a continually changing universe of commodities. Rather, we shall argue that it is quite reasonable to talk about the sampling precision of an index determined by the latter method, provided (1) that a very general view of sampling precision, similar to that described by Stephan and McCarthy (*19*, Chap. 10), is adopted, (2) that sampling theory is not asked to take over a task of which it is incapable, namely that of specifying the form of a "true" index, and (3) that one does not always expect to measure this precision by the application of more or less standard formulas from the theory of sampling. Furthermore, we shall argue that it is necessary to talk about and measure the sampling precision of such an index.

For present purposes, assume that a price index of Laspeyres' type is to be computed under circumstances (e.g., for an individual consumer or for a single city) where sampling variability arises *only* from the fact that a sample of items is selected at time zero. That is, base year weights (or other appropriate weights) are known without error; base year prices for specified-in-detail commodities are known without error; and given year prices are known without error for any specified-in-detail item. Furthermore, we ask that there exist a well-defined set of procedures for making adjustments for quality change, and for introducing new items into the index. In other words, we require that these procedures be set forth in such detail that any two individuals or organizations who start with the same sample of commodities at time zero and who independently follow these procedures through successive time intervals will arrive at time t with indexes that are identical in all respects—items, weights, price relatives, and value of the index. It may well be that it is impossible to devise a set of procedures that will uniquely determine the entire process of index number construction, but comments on this aspect of the problem will be deferred until later.

At this point, it is assumed that some well-defined sampling procedure will be used to select a sample of specified-in-detail items from the universe of such items as it exists at time zero. If complete generality is desired, then the only requirement is that this sampling procedure be so specified that repeated and independent applications of the procedure can be made. For example, one might think of a population of teams of experts in consumer price index construction. If each of a number of teams independently chose a sample of items on the basis of their expert judgment, subject possibly to some general set of instructions relating to such sample features as size form of stratification, and the like, then this would conform to the present requirements. Actually, there are strong arguments for using some form of probability sampling at this stage in order to obtain a "good" sample of items and this matter will be discussed later. (The suggestions of Adelman (*17*) and Banerjee (*16*) are therefore pertinent.) Suppose now that one thinks of drawing an indefinitely large number of independent samples in accordance with the defined sampling procedure, and of following each of these samples of items through to time t as specified by the quality and new item adjustment procedure. The values of the index, say $\hat{R}_1^{(t)}, \hat{R}_2^{(t)}, \hat{R}_3^{(t)}, \ldots$, that result from these and successive independent applications of the sampling procedure will undoubtedly differ among themselves, and will define the sampling distribution of the index with respect to the sampling of items. The variance $V(\hat{R}^{(t)})$ of this distribution, if it were known, would provide a perfectly acceptable measure of sampling precision for the index. Furthermore, it is quite clear that an estimate of $V(\hat{R}^{(t)})$ can actually be obtained in this situation by the simple expedient of drawing two or more independent samples of commodities, following each of them through time in accordance with the defined adjustment procedures, and computing the variance among the resulting estimates. Such estimates of variance will, of course, be very "poor" (i.e., their values will be subject to a large amount of sampling variability) if they are based on only a small number of repetitions, but one may perhaps justifiably argue that a "poor" estimate of sampling variability is better than no estimate.

From the foregoing discussion, where it has been assumed that the quality and new item adjustment procedure gives a unique index result for any given sample of commodities, we see that the existence of a continually changing universe of commodities is in itself no reason for arguing that one can neither define nor estimate a measure of sampling precision to associate with the index. However, this measure of sampling precision is obviously defined about the mean of the sampling distribution of $\hat{R}^{(t)}$, namely $E(R^{(t)})$. This is consistent with ordinary sampling theory usage. Thus, Cochran (*15*, p. 10) says: "Accuracy usually refers to the size of deviations from the true mean μ, whereas precision refers to the size of deviations from the mean m obtained by repeated application of the sampling procedure." If the "true" value of the index at time t is denoted by $R_P^{(t)}$, where $R_P^{(t)}$ would be obtained by applying the quality and new item adjustment procedures to the complete universes of commodities as they exist at times 0, 1, 2, —, t, then the difference $E(\hat{R}_P^{(t)}) - \hat{R}_P^{(t)}$ is the bias of the estimate arising from the sampling and estimation procedures. If the selection were based on expert judgment, then such bias might arise because all the experts might consciously or unconsciously eliminate from the selection process items having a different form of price behavior from those items that were considered for selection. This would be not unlike the bias of "self-selection" that was of vital concern in the evaluation of the Kinsey investigation (*20*).

As a final point, we note that one usually questions the procedures that are used to adjust for quality and to introduce new items into the index and therefore views $R_P^{(t)}$ as only an approximation to a *true* index say $R_T^{(t)}$. Thus the overall bias in the estimate $R_p^{(t)}$ is composed of two parts: $E(\hat{R}_P^{(t)}) - R_P^{(t)}$, which arises from the sampling and estimation procedures and $R_P^{(t)} - R_T^{(t)}$ which arises from the quality and new item adjustment procedure. (Of course, $R_T^{(t)}$ represents a Laspeyres-type index computed from all commodities in accordance with "perfect" quality and new item adjustment procedures. This might still differ from the index that is really desired, but this problem will not be considered here.)

On the basis of the foregoing description, the total error in a single estimate, say $R_P^{(t)}$, can be written as:

$$[R_P^{(t)} - R_T^{(t)}] = [R_P^{(t)} - E(R_P^{(t)})] + [E(R_P^{(t)}) - R_P^{(t)}] + [R_P^{(t)} - R_T^{(t)}]$$

The first term on the right represents the error or variability which arises from the use of sampling, and the sampling precision of an index refers only to the magnitude of this error. The second term represents the bias arising from the sampling and estimation procedures, and the third term represents the bias that arises through the use of imperfect quality and new item adjustment procedures.

It would appear that at least some of the differences in opinion that have already been cited can be traced to a failure to distinguish carefully among these three components of error and, in particular, to distinguish between the first and third components. All writers agree that it is unlikely that anyone will ever be able to devise a "perfect" set of rules for treating quality changes and for introducing new items into the index. In other words, the exact value of the quantity $(R_P^{(t)} - R_T^{(t)})$ is unknown and will remain so, although it is to be expected that a continuing program of basic research would lead to improved sets of procedures that would reduce the magnitude of this difference. But, as argued earlier, these facts in no way lead one to the conclusion that it is impossible to estimate the value of the first component, namely $\hat{R}_P^{(t)} - E(\hat{R}_P^{(t)})$. Neither do they lead to the conclusion that it is unnecessary to estimate the value of this component, and some observations will now be set forth in relation to this aspect of the problem.

Clearly the designer of a procedure for constructing an index number of prices is making some sort of judgment about the magnitude of the possible errors due to the sampling of commodities when he states, as von Hofsten does (*1*, p. 74) that ". . . the interpretation of the price development for the different items constitutes a problem which is of much greater numerical importance than the selection and the weighting of the items." This conclusion of von Hofsten's was based upon an investigation in which he used two different procedures to determine price relatives (between December 1946 and December 1949) for 189 of the 236 items that made up the Swedish cost-of-living index at that time. Items that appeared in the index for only a portion of this period were not included in the investigation. Furthermore, items falling into the two groups "rent" and "fuel and light" were treated as in the official computations and the indexes for these two groups were weighted with results obtained from the 189 experimental items by the two experimental procedures, say P_1 and P_2. Von Hofsten obtained an index value by P_1 of 109.2 and an index value by P_2 of 106.6, a difference of 2.6 index points. This difference was due mainly to differences arising in the clothing group. However, we are not here concerned with the reasons for such differences but only with their magnitudes. An examination of the price relatives used in this investigation appears to substantiate von Hofsten's previously quoted general conclusion, but it is also of interest to attempt to obtain an actual numerical estimate of the possible error due to the sampling of commodities.

The 189 price relatives used by von Hofsten, together with their base weights, were classified into four major groups—food, clothing, shoes, and miscellaneous items. Let us regard these four major groups as four strata where the individual price relatives are denoted by R_{ij}, i being the stratum subscript and j being the item subscript within a stratum. Then the variance among price relatives within the i-th stratum is given by

$$\sigma_i^2 = \frac{\sum_j w_{ij}(R_{ij} - \mathrm{R}_i)^2}{\sum_j w_{ij}}$$

where w_{ij} is the base weight for the ij-th item and

$$R_i = \frac{\sum_j w_{ij} R_{ij}}{\sum_j w_{ij}}$$

The values of R_i are given in von Hofsten's book, but it has been necessary to compute the values of the σ_i^2. The results are given in Table 1.

For present purposes, let us imagine that we are in a somewhat more ideal situation than was outlined in the beginning of this section.

TABLE 1.—*Variances of Price Relatives for 189 Items in the Swedish Cost-of-Living Index* [a]

[Relatives are for December 1949 on December 1946 as base]

Group of items	Number of items	Weight, Kr., December 1946	"Index figure actually used"	
			R_i	σ_i^2
Food	69	2,406	109.5	184.89
Clothing	23	829	101.7	57.05
Shoes	13	182	99.6	14.18
Miscellaneous	84	1,326	108.0	154.13
Rent	(b)	634	103.6	(b)
Fuel and light	(b)	306	101.9	(b)
Total	-------------	5,683	106.6	-------------

[a] The relatives used for these computations are given in Tables 4.1, 4.2, 4.3, and 4.4 of (*1*) under the heading "Index Figure Actually Used."
[b] Not given in (*1*).

That is, the data of Table 1—and the data of von Hofsten from which they are derived—will be regarded as the complete population of price relatives from which samples are to be drawn. With reference to the model for the components of error, $R_P^{(t)}-R_T^{(t)}$ is unknown but we will accept von Hofsten's conjecture that $R_{P_1}{}^{(t)}-R_{P_2}{}^{(t)}=2.6$ places an upper bound on this error. It is quite likely that the actual value of the error is smaller than 2.6. Furthermore, we will assume a sampling model is used such that $E(\hat{R}_P{}^{(t)}-R_P{}^{(t)})$ is known to be zero and such that the value of $\hat{R}_P{}^{(t)}-E(\hat{R}^{(t)})$ can be estimated. A reasonable form for such a model, following Adelman (*17*), would appear to be:

1. From within the i-th item group, or stratum, a sample of n_i relatives are drawn with replacement and with probability proportionate to w_{ij}. Then it can be shown, if we take

$$\hat{R}_i=\frac{\sum_{j=1}^{n_i} R_{ij}}{n_i},$$

that

$$E(\hat{R}_i)=R_i$$

and

$$V(\hat{R}_i)=\frac{\sigma_i^2}{n_i}$$

where R_i and σ_i^2 are as previously defined.

2. If the individual strata indexes are now combined in accordance with strata weights, we have

$$\hat{R}=\frac{\sum_i(\sum_j w_{ij})\hat{R}_i}{\sum_i \sum_j w_{ij}}$$

and

$$V(\hat{R})=\sum_i\left(\frac{\sum_j w_{ij}}{\sum_i \sum_j w_{ij}}\right)^2\frac{\sigma_i^2}{n_i}$$

Applying this variance formula to the data of Table 1, we obtain

$$V(\hat{R}_P^{(t)})=(.423)^2\frac{184.89}{69}+(.146)^2\frac{57.05}{23}+(.032)^2\frac{14.18}{13}+(.233)^2\frac{154.13}{84}$$

$$=.63$$

This result can be viewed as a crude approximation to the first component of error in the model for components of error since

$$V(\hat{R}_P^{(t)})=E[\hat{R}_P^{(t)}-E(\hat{R}_P^{(t)})]^2$$

It is obviously only a crude approximation to the first component of error for a wide variety of reasons, among which are the following:

1. We have assumed a fixed population of items for which the variance among price relatives, for a three-year period, could be computed. The effects on sampling precision of the procedures used by von Hofsten in following through the quality changes of the items are certainly mirrored to some extent in the computed value. However, there would be no way of knowing whether this type of analysis catches the full effects of a complex quality and new item adjustment procedure without actually following through with independent samples of items as outlined previously.

2. The sampling model which has here been applied to the data was almost certainly not used in the original selection of items for the Swedish Cost-of-Living Index. Nevertheless, this would appear to be a reasonable type of model if one were going to obtain a sample on a probability basis.

3. The strata used in the present computations are much larger than would be found in practice, and thus the observed value of .63 is too large. As a matter of fact, references *2* and *11* would seem to indicate that a stratum would often be defined in terms of a single specified item and would be composed of different qualities of this item, i.e., different specified-in-detail items. If we assume 200 strata of equal weight, with a single item to be drawn out of each stratum, and a within-stratum variance of 20 (somewhat low as far as Table 1 is concerned, but perhaps still too high for actual situations), then

$$V(R_P^{(t)})=\sum_{i=1}^{200}(.005)^2\,20$$

$$=.10$$

It should not be too difficult to obtain actual variance estimates to employ in such crude computations as this. For example, Adelman (*17*, Table 2) reports some variances computed within rather narrow food groups on the basis of data gathered in several food stores in the Berkeley, California area. (Her time period between quotations was 14 weeks while we are here dealing with a period of three years, and the variance will, of course, be a function of time.) Also, Staff Paper No. 2 reports some research based on Sears catalogues. Some illustrative variances were computed among three-year price relatives for men's cotton work shirts, using only items that were identical for the three-year period. One set of 10 items (1950–52) gave a variance of 33; another set of 12 (1953–55) gave a value of 15; and a third set of 15 (1956–58) gave a value of 15. These values, and those of Adelman, do not appear out of line with the value of 20 that was inserted in the preceding computation.

4. The sampling of items has been viewed here as occurring with replacement. Under certain circumstances it might be appropriate to regard it as occurring without replacement, and the effect of this would be to make the value of .63 too large. This distinction would disappear if items were stratified to the point where only a single specified-in-detail item were drawn out of each stratum, assuming, of course, that there was more than one specified-in-detail item in each stratum.

5. Taking the population of items as given, it has been necessary to leave out some sources of variation since no data were given for the "rent" and "fuel and light" strata. This would make the observed value of .63 too small.

6. The relatives reported by von Hofsten represent averages over cities and localities and over outlets within cities and localities. This would make the observed value of .63, as it refers to the sampling of commodities, too large.

Putting together all of these bits and pieces of information, it seems reasonable to guess that the variance due to the sampling of commodities of the Swedish Cost-of-Living Index as described by von Hofsten is something of the order of .1 to .6. The actual value is apt to be near the lower end of this range since most of the stated reservations appear to place the observed value of .63 on the high side. For present purposes, let us assume that $V(\hat{R}_P^{(t)}) = .2$. This means that the standard deviation of $\hat{R}_P^{(t)}$ would be approximately .5 and that a large sample, 95 percent confidence interval for $R_P^{(t)}$ would have total width of about 2.

The foregoing estimates of .2 for $V(\hat{R}_P^{(t)})$ and 2.6 for $R_P^{(t)} - R_T^{(t)}$, where t in this instance represents a period of three years, can be regarded as nothing more than crude approximations to the true values. Nevertheless, if they are fully recognized as such, it is instructive to examine their relative order of magnitude. For example, it is customary to measure the total error of an estimate by its Mean Square Error, which is defined as the sum of its variance and the square of its systematic error or bias. Thus in this example, where $E(\hat{R}_P^{(t)}) - R_P^{(t)}$ is assumed to be zero,

$$\begin{aligned} MSE(R_P^{(t)}) &= V(R_P^{(t)}) + (R_P^{(t)} - R_T^{(t)})^2 \\ &= .2 + (2.6)^2 \\ &= .2 + 6.76 \\ &= 6.96 \end{aligned}$$

The magnitude of the MSE is almost completely determined by the procedural differences and this confirms von Hofsten's previously cited observation.

But this result does not lead to the conclusion that the sampling precision of the index can be ignored. If it is assumed that the main goal of index number construction is to measure accurately the value of $R_T^{(t)}$, as opposed possibly to the measurement of time-to-time changes in $R_T^{(t)}$ (which will be discussed shortly) or to the production of indexes for subgroups of commodities, then this result strongly suggests that too great a fraction of available resources is being spent on maintaining a relatively large sample of commodities and too small a fraction on basic research aimed at reducing the magnitude of $(R_P^{(t)}-R_T^{(t)})$. For example, if the sample sizes given in Table 1 were each reduced by a factor of about two-thirds—69 foods to 23, 23 clothing items to 8, 13 shoe items to 4, and 84 miscellaneous items to 28—then $V(R_P^{(t)})$ would be increased from .63 to 1.89. Reducing 1.89 by a factor of one-half for the reasons given previously, we might expect $V(R_P^{(t)})$ to be roughly .95, or say 1.00. The MSE of $\hat{R}_P^{(t)}$ now becomes

$$\begin{aligned} MSE(\hat{R}_P^{(t)}) &= 1.00+(2.6)^2 \\ &= 1.00+6.76 \\ &= 7.76 \end{aligned}$$

The procedural error still dominates the MSE, accounting for 87 percent of its value, even though the sample of commodities has been reduced by almost two-thirds.

Naturally, it would always be possible to reduce the sample size to a point where the variance of $\hat{R}_P^{(t)}$ would become much larger than the procedural error. However, the practical problem is determining an economic balance between sampling precision and procedural error and then allocating resources so as to reduce the magnitude of the one which dominates. This can only be accomplished if "decent" estimates of $V(\hat{R}_P^{(t)})$ and of $(R_P^{(t)}-R_T^{(t)})$ are available. In this respect, there would appear to have been too much effort placed on expanding the number of specified items included in index computations (the usual procedure being to include all specified items which have more than some minimum base weight) and too little effort placed on estimating the variability of price relatives, say among specified-in-detail items within a specified item, and on estimating the value of $R_P^{(t)}-R_T^{(t)}$. Such investigations can and should be carried out and published, at least for the benefit of the scientific community.

As a final point in this discussion of $V(\hat{R}_P^{(t)})$ and $R_P^{(t)}-R_T^{(t)}$, it should be emphasized that both of these quantities are functions of time. Since all relatives are equal to 100 at $t=0$, $V(\hat{R}_P^{(t)})$ will be extremely small for values of t close to zero. Furthermore, as t increases there will be opportunity for the relatives of different items to "spread apart" and thus ordinarily one would expect $V(\hat{R}_P^{(t)})$ to be an increasing function of time. $R_P^{(t)}-R_T^{(t)}$ will also be very close to zero for values of t close to zero since there will not need to be many quality adjustments in a short period of time. However, the manner in which this procedural error changes with time is not as easy to forecast as for $V(\hat{R}_P^{(t)})$. Under most circumstances one would expect procedural "bias" to increase with time, but this is another problem that needs investigation.

Thus far emphasis has been placed on the estimation of $R_T^{(t)}$ by means of $\hat{R}_P^{(t)}$. The problem becomes slightly different if the goal is to estimate short-term changes in $R_T^{(t)}$, say to estimate $R_T^{(t)}-R_T^{(t-1)}$. Suppose that $\hat{R}_P^{(t)}-\hat{R}_P^{(t-1)}$ is employed as an estimate of this quantity. Then, using the model for the error in $\hat{R}_P^{(t)}$ and still assuming no bias in the sampling and estimation procedure, we have for the error of this estimate:

$$[\hat{R}_P^{(t)}-\hat{R}_P^{(t-1)}]-[R_T^{(t)}-R_T^{(t-1)}]=$$

$$[\hat{R}_P^{(t)}-E(\hat{R}_P^{(t)})]-[\hat{R}_P^{(t-1)}-E(\hat{R}^{(t-1)})]+$$

$$[R_P^{(t)}-R_T^{(t)}]-[R_P^{(t-1)})-R_T^{(t-1)}]$$

It seems reasonable that if the time between t and t-1 is short, say, of the order of a month, then the difference between the last two terms will be extremely small. That is, the procedural error will not change much from month to month. Thus

$$[\hat{R}_P^{(t)}-\hat{R}_P^{(t-1)}]-[R_T^{(t)}-R_T^{(t-1)}]\doteq[\hat{R}_P^{(t)}-E(\hat{R}_P^{(t)})]-[\hat{R}_P^{(t-1)}-E(\hat{R}_T^{(t-1)})]$$

Therefore the error in $\hat{R}_P^{(t)}-R_P^{(t-1)}$ will be due almost entirely to sampling error and the standard formula for the variance of a difference gives:

$$V(\hat{R}_P^{(t)}-\hat{R}_P^{(t-1)})=V(\hat{R}_P^{(t)})+V(\hat{R}_P^{(t-1)})-2\rho\sqrt{V(\hat{R}_P^{(t)})V(\hat{R}_P^{(t-1)})}$$

where ρ is the correlation between $\hat{R}_P^{(t)}$ and $\hat{R}_P^{(t-1)}$. Under these circumstances it would seem absolutely essential to have an estimate of sampling precision for the difference of $\hat{R}_P^{(t)}$ and $\hat{R}_P^{(t-1)}$ since it is not even possible to argue that this sampling precision is overshadowed by the procedural error.

An estimate of $V(\hat{R}_P^{(t)})$, when t is equal to three years, has already been obtained. The value of $V(\hat{R}_P^{(t)}-\hat{R}_P^{(t-1)})$, for a month-to-month change, can therefore be estimated if an appropriate approximation to ρ can be found. It is possible to obtain a very crude estimate of ρ from data published by the Bureau of Labor Statistics (*21*) through the following line of reasoning:

1. Let us view $\hat{R}_P^{(t)}$ as an unweighted average of a random sample of price relatives.

2. Then $\hat{R}_P^{(t-1)}$ is the unweighted average of price relatives for *exactly the same sample of items* for the preceding month.

3. The correlation between the means of two variables, each variable being measured on exactly the same random sample of elements, is the same as the correlation between the values of the variables for the individual elements in the population from which the samples are drawn.

4. Therefore the correlation between $\hat{R}_P^{(t)}$ and $\hat{R}_P^{(t-1)}$ can be approximated by the correlation between the price relatives for a sample of items in month (t–1) and month t.

5. It seemed unnecessary, at the level of approximation being discussed here, to go to the individual item price relatives and thus we have computed month-to-month correlations using the United States city average subgroup index for the following 20 subgroups: cereals and bakery products; meats, poultry, and fish; dairy products; fruits and vegetables; other foods at home; rent; gas and electricity; solid fuels and fuel oil; house furnishings; household operation; men's and boys' apparel; women's and girls' apparel; footwear; other apparel; private transportation; public transportation; medical care; personal care; reading and recreation; and other goods and services. These monthly indexes (with 1947–49 as base) are published in von Hofsten's Tables B–2 and B–3 (*18*), and the values of the correlation coefficients are given in Table 2 below. These correlations are undoubtedly overestimates of the true ρ's because of the use of grouping and also possibly because of the imputation process used when individual items are not priced each month in each city.

TABLE 2.—*Month-to-Month Correlations for 20 United States City Average Subgroup Indexes*[a]

(1947–49=100)

Months	*Correlation coefficient*
January 1947–February 1947	0.956
January 1948–February 1948	.799
January 1950–February 1950	.983
June 1950–July 1950	.983
January 1953–February 1953	.992
January 1958–February 1958	.998

[a] Original data are given in *18*, Tables B–2 and B–3.

It will be noted from an examination of this table that ρ is also a function of time. The smallest value occurs in the middle of the base period—i.e., the lowest value occurs for the comparison January 1948–February 1948 while the base period is 1947–49—and ρ increases as one moves from this base period. The reason is quite simple. As one moves from the base period, individual price relatives spread out in terms of magnitude. Yet month-to-month changes for the same specified-in-detail item are small. Therefore the greater the dispersion in price relatives, the greater will be the value of the correlation coefficient.

Returning now to the numerical example, let us consider t to be about three years. Then $V(\hat{R}_P^{(t)}) \doteq 0.2$, $V(\hat{R}_P^{(t-1)}) = 0.2$, $\rho^{(t)} \doteq 0.98$, and $V(\hat{R}_P^{(t)} - \hat{R}_P^{(t-1)}) = 0.2 + 0.2 - 2(0.98)\sqrt{0.2 \times 0.2} = 0.008$. Thus the standard error of the estimate of the difference is $\sqrt{0.008} = 0.09$, or approximately 0.1. Since a month-to-month change in the U.S. Consumer Price Index of 0.1 or 0.2 of a percentage point is ordinarily regarded as of some practical significance, at least by the newspapers and by parties to collective bargaining agreements, a standard error of 0.1 is not particularly small in this context. It would, therefore, seem important to have better estimates of the standard error of such changes than have been produced by the rough methods being used here.

Still leaving aside any discussion of interregional or intersubgroup comparisons of price indexes, there is yet a further argument that leads to the conclusion that it is absolutely essential to have a measure of sampling precision relating to the sampling of commodities. As outlined in Section II, the U.S. Consumer Price Index involves not only the sampling of commodities but also the sampling of cities and the sampling of retail outlets within cities. (Other indexes, such as those prepared by the Agricultural Marketing Service, do not have the BLS emphasis on cities but the same problems arise in other ways.) Just as there must be a balance between the procedural error of the index and the error due to the sampling of commodities, so also must there be a balance between these errors and the errors due to the sampling of cities and of retail outlets. Again it is not possible to discuss such a balancing operation unless some attempt is made to measure these components of error.

The next section of this report will present some computations which suggest that the variance of the U.S. Consumer Price Index, due to the sampling of cities and retail outlets, and for a month some three years after the base period, is something of the order of 0.01. Thus we have, using previous estimates:

Procedural bias squared	6.76
Variance due to sampling of commodities	.20
Variance due to sampling of cities and retail outlets	.01

These results suggest that not only is the sampling error due to the sampling of commodities overshadowed by the procedural bias, but that this sampling error in turn completely dominates the sampling error arising from the sampling of cities and of retail outlets. The efficient allocation of resources, as far as the overall U.S. Consumer Price Index is concerned, would therefore call for a reduction in the size of city sample and size of retail outlet sample and the assignment of these resources to work on the procedural error. But again this cannot be done unless "decent" estimates of error are available.

The preceding discussion of the sampling of commodities for a consumer price index, where the index is constructed on the basis of a fixed market basket of goods and services, has set forth the argument that it is possible and necessary to define and estimate the sampling precision of an index determined on such a basis. In concluding this discussion, we should like to mention a few points which have been touched on lightly or omitted entirely.

1. The relationship between the sampling of commodities and the adjustment procedures for quality change and new items has been discussed in extremely general terms. Under these circumstances the only satisfactory approach to the measurement of sampling precision would appear to be through the use of two or more independent samples of commodities. However, if these adjustment procedures are defined in a somewhat more restrictive fashion, then it should be possible to apply standard sampling theory more or less directly to the problem. For example, suppose that one starts out at time zero with a population of N items, where the i-th item has weight w_i. Furthermore, let us suppose that this list of items and their associated weights remains unchanged throughout the period for which the index is to be constructed. The price relative for a particular item at time t, $R_i^{(t)}$, will reflect quality changes in the original item, or may even take into account the fact that the original item has disappeared from the market and that a new item has been substituted for it.

(The only types of situations which are excluded are those in which an original item disappears without a direct substitute appearing, and those in which a new item appears which is not a direct substitute for a previous item.) Then any probability mechanism used at time zero to select a sample of commodities can also be viewed as having selected a sample from the population of price relatives $R_i^{(t)}$ as it exists at time t. Standard sampling theory can thus be used to determine the precision of the estimate made at time t. The estimates of sampling precision obtained at different times are of course correlated since they are based on the same sample of commodities, but this is another problem.

2. One of the terms in the components of error model has essentially been ignored in the preceding discussion, namely the term $E(\hat{R}_P^{(t)}) - R_P^{(t)}$. This is the bias arising from the sampling and estimation procedure. There is no satisfactory way of estimating the magnitude of this component from empirical data derived from repeated applications of a single nonprobability model sampling procedure, although conceivably it could be as large as, or larger than, the procedural error if the judgment approach used in the selection of specified-in-detail items were badly at fault. The only real way of controlling this error is to use some form of probability sampling in the original selection of items for the index, whether or not estimates of sampling precision are to be obtained by independent samples or through the use of the probability model, or to estimate the magnitude of the error through experimental studies.

3. It has been assumed that the quality change and new item adjustment procedure, designated by P, can be set forth in such detail that any two individuals or organizations who start with the same sample of commodities at time zero and who independently follow these procedures through successive time intervals will arrive at time t with indexes that are identical in all respects. In actual practice, it is probably impossible to achieve this uniqueness. There will always be cases where borderline decisions are required which could sometimes go one way and sometimes another. The effect of this lack of uniqueness would be to add still another component of random error to the model used in this section, and the only way to evaluate the magnitude of such an error would be through some type of empirical investigation. It could even happen that one might wish to build certain elements of randomness into the rules of procedure. For example, if it were impossible or too costly to decide among, say, three alternative ways of treating a certain quality adjustment problem, then one might choose to use each procedure one-third of the time. The choice on any particular occasion would be made on the basis of some random device.

4. As a final point, we emphasize again that the discussion has been directed at the error in an overall index. If one is concerned with city, or regional, or subgroup indexes, or with comparisons among such indexes, then it is still necessary that one define, study, and measure the components of error for each such index. However, it may be that requirements on accuracy at this level produce, as a byproduct, greater accuracy than is actually needed at the level of the overall index.

VI. Estimates of Sampling Error Arising From the Sampling of Cities and Retail Outlets for the U.S. Consumer Price Index

As was noted in Section II, the sampling of commodities is only one of the many sampling problems which must be faced in index number construction. In particular, it is necessary to select a sample of localities in which current prices are to be collected and, within these, a sample of retail outlets from which these prices will actually be obtained. In the case of the U.S. Consumer Price Index, localities are synonomous with cities, but the same problems exist whether the emphasis is on cities, on counties, or on some other type of local unit. The error in the final index will be partially determined by the manner in which these sampling problems are resolved. All of the reasons set forth in the preceding section concerning the necessity for measuring the error arising from each of the several sources apply equally well here, and we shall now describe an empirical investigation concerning the combined sampling error in the U.S. Consumer Price Index due to the sampling of cities and retail outlets.

In recent years the U.S. Consumer Price Index has been based upon a national sample of 46 cities. (Reference *8*, pp. 70–71, lists these 46 cities. Complete pricing in one of these cities, Ravenna, Ohio, was discontinued in 1956.) The Bureau of Labor Statistics made available to the Price Review Committee monthly indexes (for all items and for a number of subgroups) for each of these cities for the period 1953–59 with 1953 equal to 100. These city indexes were reported only for those months in which the full list of goods and services was priced in a given city. Thus all-item indexes were available each month for the twelve cities in the largest size class, every third month for the eighteen cities in the next two size classes, and either every fourth month or every third month (1957–59) for the fifteen cities in the smallest size class. These are the basic data that will be used in this section.

The present sample of 46 cities was selected as a preliminary to the 1950 Consumer Expenditures Survey (*22*). Cities were first stratified into four size groups. All cities in the largest size group were drawn into the sample, while the samples in each of the other three size groups were selected by application of a so-called Latin square design. No formal analysis of this sampling design has been published by the Bureau and no attempt will be made here to develop such an analysis. Rather, we shall, as an approximation, view the sample as the result of a much more straightforward type of design, namely, as the result of selecting a single city with probability proportionate to size from each of 34 strata, the 12 largest cities being self-representing.

Before actually presenting the design and results of the present empirical investigation, it is of interest to examine briefly the formal properties of the sampling design just mentioned since they illuminate some of the results that have already been given in Section III and serve as a guide to the estimation procedure. Suppose one has a population of N cities which are divided into L strata where the h-th stratum contains N_h cities. For the i-th city in the h-th stratum, let

$R_{hi}^{(t)}$ be the city index at time t,[2] W_{hi} be the fraction of the total population contained in this city. Thus

$$\sum_{h=1}^{L}\sum_{i=1}^{N_h} W_{hi}=1$$

Let V_{hi} be the cost or value of this city's market basket of goods and services in the base period.
Then the all-item, all-city index is given by

$$R^{(t)}=\frac{\sum_{h=1}^{L}\sum_{i=1}^{N_h}(W_{hi}V_{hi})R_{hi}^{(t)}}{\sum_{h=1}^{L}\sum_{i=1}^{N_h}(W_{hi}V_{hi})}$$

This is the same as

$$R^{(t)}=\frac{\sum_{h=1}^{L}\sum_{i=1}^{N_h} W_{hi}\cdot(\text{cost of market basket in city } hi \text{ at time } t)}{\sum_{h=1}^{L}\sum_{i=1}^{N_h} W_{hi}\cdot(\text{cost of market basket in city } hi \text{ at time } 0)}$$

or, essentially the ratio of the cost of all market baskets at time t to the cost of all market baskets at time 0.

The foregoing expression for $R^{(t)}$ can be expressed in terms of the strata indexes $R_h^{(t)}$ as

$$R^{(t)}=\sum_{h=1}^{L}\left(\frac{\sum_{i=1}^{N_h} W_{hi}V_{hi}}{\sum_{k}\sum_{j} W_{kj}V_{kj}}\right)R_h^{(t)}$$

but the above expression cannot be used for the estimation of $R^{(t)}$ since the strata weights will not be known. That is the value of V_{hi} will be known only for those cities that are actually drawn into the sample. What must be done is to estimate separately the numerator and denominator of the original expression for $R^{(t)}$.

With the foregoing stratification setup, the most reasonable approach would appear to be to select n_h cities with probability proportionate to size, i.e., W_{hi}, and with replacement from the h-th stratum.

[2] In Section III the subscripts following $R^{(t)}$ identified items and groups of items. In this section it will not be necessary to indicate indexes for items and groups of items and so subscript positions following $R^{(t)}$ will always identify cities.

Then

$$\hat{R}^{(t)}=\frac{\sum_{h=1}^{L}\left(\sum_{j=1}^{N_h}W_{hj}\right)\frac{\sum_{i=1}^{n_h}V_{hi}R_{hij}^{(t)}}{n_h}}{\sum_{h=1}^{L}\left(\sum_{j=1}^{N_h}W_{hj}\right)\frac{\sum_{i=1}^{n_h}V_{hi}}{n_h}}$$

If each $n_h=1$, as would ordinarily be the case in practice, this becomes very simple, namely,

$$\hat{R}^{(t)}=\frac{\sum_{h=1}\left(\sum_{j=1}^{N_h}W_{hj}\right)V_{hi}R_{hi}^{(t)}}{\sum_{h=1}^{L}\left(\sum_{j=1}^{N_h}W_{hj}\right)V_{hi}}$$

where the subscript hi now represents the single city drawn from the h-th stratum. This is the form of estimate that was given at the end of Section III, where the quantity

$$\left(\sum_{j=1}^{N_h}W_{hj}\right)V_{hi}\Big/\sum_{h=1}^{L}\left(\sum_{j=1}^{N_h}W_{hj}\right)V_{hi}$$

was symbolized by W'_i. These quantities are evidently the "relative cost-population weights Dec. 1952" given in Table 1 of BLS Bulletin No. 1168 (*8*).

Let us now take these observed city or stratum weights as approximations to the true stratum weights. That is

$$W'_h=\frac{\left(\sum_{j=1}^{N_h}W_{hj}\right)V_{hi}}{\sum_{h=1}^{L}\left(\sum_{j=1}^{N_h}W_{hj}\right)V_{hi}}\doteq\frac{\sum_{j=1}^{N_h}W_{hj}V_{hj}}{\sum_{h=1}^{L}\sum_{j=1}^{N_h}W_{hj}V_{hj}}$$

Then

$$\hat{R}^{(t)}=\sum_{h=1}^{L}W'_h\hat{R}_h^{(t)}=\sum_{h=1}^{L}W'_h\hat{R}_{hi}^{(t)}$$

where, as before, the subscript i represents the one particular city in the h-th stratum that was drawn into the sample. Finally,

$$V(\hat{R}^{(t)})=\sum_{h=1}^{L}W'^2_hV(\hat{R}_{hi}^{(t)})$$

In order to estimate this quantity it is necessary to obtain estimates of $V(\hat{R}_{hi}^{(t)})$.

The variance of $\hat{R}_{hi}^{(t)}$, as an estimate of $R_h^{(t)}$ for a fixed sample of commodities, depends upon the variability among indexes for cities in the h-th stratum and upon the sampling precision of the estimates of the average prices for commodities within cities, i.e., upon the within-city samples of retail outlets. Since the design under discussion assumes that only a single city is drawn from each stratum, it is impossible to obtain a direct estimate of this within-stratum variance. However, an overestimate of this variance can be obtained by the method of "collapsed strata," as described by Cochran (*15*, pp. 105–106), Hansen, Hurwitz, and Madow (*14*, pp. 399–401), or Sukhatme (*23*, pp. 339–404). Roughly speaking, one takes two strata which are as nearly alike as possible, "collapses" these two into a single stratum, estimates the variance in this stratum from the two observations, and then uses this variance estimate for each of the two original strata.

The foregoing procedure was applied to the 46 cities for which BLS supplied monthly indexes. Nothing could be done about the 12 largest cities that were drawn into the sample with certainty, but the remaining cities were paired within size classes as nearly as possible by geographic closeness. These pairings are given in Table 3, together with the values of W'_h. Many of these pairings are of necessity far from ideal, but the effect of this should be to inflate further the variance estimates. Note that the 46th city, Ravenna, Ohio is also included in this table. Even though monthly all-item indexes were not provided for this city, it can be treated just like the other "unpaired" cities as far as its weight is concerned.

TABLE 3.—*Pairings of Cities for the Empirical Variance Computations*

Paired Cities	*Values of W'_h*	
Size Class B:		
Kansas City, Mo., and Minneapolis, Minn	0.024,	0.025
Portland, Oreg., and Seattle, Wash	.024,	.027
Houston, Tex., and Atlanta, Ga	.024,	.021
Cincinnati, Ohio, and Youngstown, Ohio	.022,	.021
Scranton, Pa. (unpaired)		.021
Size Class C:		
Canton, Ohio, and Charleston, W. Va	.020,	.024
Lynchburg, Va., and Huntington, W. Va	.022,	.019
Evansville, Ind., and Middletown, Conn	.020,	.025
Madison, Wis., and Newark, Ohio	.023,	.019
San Jose, Calif. (unpaired)		.024
Size Class D:		
Grand Forks, N. Dak., and Rawlins, Wyo	.011,	.012
Madill, Okla., and Shawnee, Okla	.010,	.011
Camden, Ark., and Grand Island, Nebr	.009,	.011
Garrett, Ind., and Laconia, N.H	.013,	.010
Anna, Ill., and Shenandoah, Iowa	.010,	.011
Glendale, Ariz., and Lodi, Calif	.012,	.015
Middlesboro, Ky., and Pulaski, Va	.008,	.010
Sandpoint, Idaho (unpaired)		.010
Ravenna, Ohio (unpaired)		.012

For a particular pair of cities and for a month in which the all-item index is available in each city, the foregoing procedure leads to the following estimate of variance for each of the strata from which the cities were drawn

$$\hat{V}=\frac{1}{2}(\hat{R}_1^{(t)}-\hat{R}_2^{(t)})^2$$

where $\hat{R}_1{}^{(t)}$ is the index for the first city of the pair and $\hat{R}_2{}^{(t)}$ is the index for the second city. This assumes that the strata are of the same "size." This is not quite the case here, but no attempt was made to use a more precise form of estimate since the present way of viewing the sampling procedure is only a very rough approximation to the true situation and since $\hat{V}$ is known to be an overestimate of the true variance, even if all the proper assumptions did hold. As an example of the application of this formula, in January 1958 (with 1953=100) the index for Cincinnati was 107.2 and the index for Youngstown, Ohio, was 108.5. Therefore

$$\hat{V}=\frac{1}{2}(107.2-108.5)^2$$

$$=\frac{1.69}{2}=0.845$$

It should be clearly recognized that this estimate of the within-stratum variance includes not only the effect of the sampling of cities but also the effect of the sampling of retail outlets within the cities. It does not include any appreciable effect due to the sampling of commodities since essentially the same sample of commodities is used in each of the cities.

Two difficulties were encountered in applying this procedure to the cited data. First, because the quarterly pricing cycle was not the same for all cities, it was sometimes necessary to use the index for one city in a pair with the other city's index for either the preceding or succeeding month. This would have a tendency to inflate the variances. Second, no computations could be made for the unpaired cities. In this instance, the average of the variance estimates obtained from pairs of cities in the same size class was arbitrarily assigned to these unpaired cities.

The outlined computations were performed for each of either three or four months in the years 1953–59, and the resulting between-two-cities estimates of variance were combined in accordance with the formula

$$\hat{V}(\hat{R}^{(t)})\doteq\sum_{h=1}^{34} W_h'^2\hat{V}(\hat{R}_{hi}^{(t)})$$

The values obtained are given in Table 4. These values are the contribution to the variance of $\hat{R}^{(t)}$ of the 34 cities in the B, C, and D size class strata, representing some 58 percent of the total strata weight. The remaining 42 percent is allocated among the 12 cities in the largest size class. Since these cities are self-representing, their contribution to the variance is only in terms of the within-city variance and it is not possible to estimate this with the paired-city approach.

TABLE 4.—*Between-Two-Cities Estimate of the Variance of $\hat{R}^{(t)}$, Ignoring the Within-City Contribution from the Twelve Cities in the Largest Size Class (1953=100)*

Month:	$\hat{V}(\hat{R}^{(t)})$	Month—Continued	$\hat{V}(\hat{R}^{(t)})$
January 1953	0.0018	January 1957	0.0086
April	.0004	April	.0076
October	.0011	July	.0054
January 1954	.0015	October	.0106
April	.0012	January 1958	.0143
October	.0037	April	.0214
January 1955	.0038	July	.0140
April	.0107	October	.0157
October	.0038	January 1959	.0192
January 1956	—	April	.0249
April	.0079	July	.0255
July	.0034	October	—
October	.0084		

As has already been noted, there are a number of factors which tend to make these values overestimates of the true variances, and a single major factor (neglect of the within-city component of variance for the 12 largest cities) which tends to make them underestimates. For present purposes we shall simply regard these as counteracting effects and take the computed values as being roughly of the correct order of magnitude. It should be noted that these estimates are themselves subject to large and unknown sampling fluctuations.

There are two features of these data which stand out. First, there is a definite tendency for the values to increase over time and this is to be expected. The price relatives for all items in all cities essentially start out at 100 in the base period and there are increasing opportunities for them to spread out as the time period under study deviates from the base period. This effect was mentioned in connection with the sampling of commodities, but illustrative data were not presented at that point. Second, the actual magnitudes of these variances are small, particularly in comparison with the estimates given in the last section for the procedural error and for the sampling error due to the sampling of commodities. This comparison was made in Section V and its implications for the U.S. Consumer Price Index were discussed at that point. (The value of 0.01 used for the variance due to sampling of cities and retail outlets was obtained by rounding up the variance figures given in Table 4 for 1956, some three years after the base period.)

The analyses of this section have been carried out with two goals in mind. The first was simply that of obtaining a crude estimate of sampling error due to the sampling of cities and the sampling of retail outlets within cities, which could then be compared with and added to the estimates obtained in the preceding section for procedural error and for the sampling error arising from the sampling of commodities. The second goal was that of indicating an approach to the sampling of cities that would lead to a relatively easy way of estimating sampling variability, recognizing, of course, that the original sample of cities was not selected in accordance with this scheme. These analyses could have been extended to subgroups of commodities in the U.S. Consumer Price Index (e.g., food), but such extensions were deemed outside the purview of this investigation. Although further comments concerning choice of a city sample will be found in the next section, we should like to close this discussion with the observation that the selection of the city sample should be in accordance with some form of probability model in order that no systematic error or bias enter the all-item all-city index from this source.

VII. The Rough Outlines of a Sample Design for Estimating the Total Sampling Error of the U.S. Consumer Price Index

The analysis of the preceding section had many shortcomings, among which were: (1) the original sample of cities was not selected in accordance with the design that dictated the analysis; (2) the estimate of error contained no component for the sampling of retail outlets within the twelve strata of self-representing cities; and (3) the estimate of error contained no component for the sampling of commodities. Nevertheless, this analysis did provide an indication of the magnitude of the error due to the sampling of cities and to the sampling of retail outlets and it did illustrate the type of design that might be expected to lead to "simple" estimation of the total sampling error. The necessity for designing a complex sampling operation so that "simple" estimates of error can be obtained has long been recognized and has been discussed by many authors (e.g., *14*, p. 440, and *17*, pp. 220–229) under such titles as "replicated samples," "ultimate clusters," and "random groups." This need becomes overwhelming in the case of a price index where the number of commodities entering the index is large and where the quality adjustment procedure makes it difficult to apply variance estimating procedures derived from sampling theory to all components of the design. Furthermore, these estimates have to be made more or less continuously since the sampling errors can be expected to increase with the length of time from the base period. Some of the considerations that might apply in this instance will now be outlined.

Since the present emphasis of the Consumer Price Index is on a city sample approach (and some comments on this will be made in the next section), cities will be regarded as the ultimate clusters and the discussion will be built around this city sample. The most appropriate type of design would appear to be that outlined in the preceding section where the cities are first grouped into strata—probably on the basis of size and geographic location and possibly on the basis of additional variables—and then one or more cities are drawn with probability proportionate to size and with replacement from those strata containing more than one city. We are not here concerned with the details of this operation, but do assume the following: (1) that the relationships between city indexes and strata indexes and between strata indexes and the U.S. index are clearly specified in formal terms, and (2) that a probability model be used to select cities within strata which is consistent with the specified form of index, which provides unbiased or "nearly" unbiased estimates of the stratum and U.S. indexes, and which permits a within-strata estimate of variance either by the drawing of two or more cities within each strata or through the use of collapsed strata.

As was emphasized in the preceding section, this type of approach provides no contribution to the variance estimate from the sampling of commodities if the same sample of commodities is used in each sample city. It would seem therefore that it is absolutely imperative that the index be based upon at least two—and this is probably also the maximum number that would be considered—independently selected samples of commodities. These two samples would be selected at the time of index revision and, in accordance with present practice, would be followed through time with the best possible quality and new item adjustment procedures. The manner in which these samples would be chosen would be a matter for technical investigation, but we might make the following general observations:

1. The fact that two samples are to be selected does not mean that each must be equal in size to the desired overall sample. Rather, one would probably make each of them one-half the size of the desired overall sample. Thus a total sample of some 300 commodities would be drawn as two independent samples, each consisting of some 150 items.

2. As was argued in Section V, one would attempt insofar as possible to draw these samples in accordance with known probability models. This would probably mean that items would be highly stratified, most likely into 150 strata, and that two independent drawings would be made in each stratum with probability proportionate to weights provided by the Consumer Expenditure Surveys, and with replacement. The strata could, of course, be defined by making use of every available bit of information about substitutability, similarity of price movements, and the like, and the suggestions offered by Adelman (*17*) and Banerjee (*16*) should be thoroughly studied in making these selections from within strata. The very least that one might expect is that two groups operating in a completely independent fashion each choose a sample of 150 items from the defined strata.

3. As a final point we observe that these two samples would undoubtedly have items in common. In particular, if some strata were defined to have only a single specified-in-detail item, then this item would, of necessity, be in both samples. We shall henceforth refer to these two commodity samples as C_1 and C_2.

Now consider the two cities, say A and B, which are drawn out of a single stratum or out of the two strata which are to be collapsed into a single stratum for variance computations. There is nothing in the present procedure of combining city indexes into the U.S. index which necessitates having the same sample of commodities in each city. Let us therefore assign sample C_1 to A and sample C_2 to B and thus obtain estimates of these two city indexes, say $\hat{R}_A^{(t)}$ and $\hat{R}_B^{(t)}$, in the ordinary manner. Then an estimate of the within-stratum variance which is based upon a comparison of $\hat{R}_A^{(t)}$ and $\hat{R}_B^{(t)}$ will be influenced not only by the sampling of cities and the sampling of retail outlets within cities, but also by the sampling of commodities, and this influence will remain when one combines variance estimates across strata.

It is assumed that the sample of retail outlets in a city is chosen in accordance with a known probability model. There appears to be no reason why this cannot be done, and the mere fact that such a sample may be small is no reason for not using an appropriate probability model approach. This is the only way that one can guarantee an unbiased estimate of average prices or of average price relatives for a city.

This "half sample" approach does provide an overall estimate of the within-stratum variance, including a contribution for the sampling of commodities. It does not, however, permit one to estimate the components of this variance. If it is possible to use both samples of commodities in each city—and this will have to be recommended for the self-representing cities in the sample—then it should be possible to separate these components. For example, consider a stratum made up of an extremely large number of cities of equal weight from which two, say A and B, are selected. In each city an index estimate is prepared using commodity sample C_1 and a separate estimate using C_2, where an independent sample of retail outlets is used for each of the four indexes. The results can then be presented in a fourfold table:

		City A	City B
Commodity Sample	C_1	$\hat{R}_{1A}^{(t)}$	$\hat{R}_{1B}^{(t)}$
	C_2	$\hat{R}_{2A}^{(t)}$	$\hat{R}_{2B}^{(t)}$

A particular index, say $\hat{R}_{1A}^{(t)}$, can now be viewed as

$$\hat{R}_{1A}^{(t)} = R^{(t)} + c_1^{(t)} + s_A^{(t)} + e_{1A}^{(t)}$$

where $R^{(t)}$ is the true stratum index, $c_1^{(t)}$ is an effect due to this particular sample of commodities, $s_A^{(t)}$ is an effect due to city A, and $e_{1A}^{(t)}$ is the effect due to a particular sample of retail outlets. This is essentially an analysis of variance, random effects model, for a two-way classification without interaction. Therefore one can easily estimate from the data not only the variance of the stratum sample index, but also σ_c^2, which is the variance due to the sampling of commodities, σ_s^2, which is the variance due to the sampling of cities, and σ_ϵ^2, which is the variance due to the sampling of retail outlets within cities. It would appear that the integration of some such simple design features as this into the ongoing operations of the Consumer Price Index would provide a large amount of data concerning the accuracy of the index at relatively low cost. These estimates will naturally be subject to a large amount of sampling variability, each being based on only a single degree of freedom, but it might be possible to combine them across strata or across time periods and thus improve their reliability.

As a final point, we turn to those cities which are self-representing. Estimates of sampling error can now be obtained only by replication within each of these cities. Thus suppose that indexes are obtained from each of the two samples of commodities, C_1 and C_2, where an independent sample of retail outlets is used for each sample of commodities. Then a comparison of the two resulting indexes, $\hat{R}_1^{(t)}$ and $\hat{R}_2^{(t)}$, will provide an estimate of the variance of the city index which would be the average of these two indexes. In this instance it would not be possible to estimate the components of variance due to the sampling of retail outlets. This could only be accomplished by further replication, say by using at least two independent samples of retail outlets for each of the two samples of commodities.

The contents of this section have not been aimed at giving a detailed program of sample design for the index. Rather, they have been given as illustrations of the fact that it should be possible to obtain easily estimates of error and of the components of this error by appropriately choosing the various samples on which the index is based, without increasing the size of any of these samples.

VIII. Some Further Suggestions for Consideration

This report has taken the present form of the U.S. Consumer Price Index more or less for granted and has then argued that it is both possible and necessary to obtain and publish estimates of sampling error for the various components of the sample design, as well as for the overall U.S. index. Crude estimates of the various components of error suggest that, as far as the level of the overall U.S. index is concerned, too much effort is being expended on obtaining relatively large samples of commodities, cities, and retail outlets and too little effort on the evaluation of procedural error. Furthermore, as between commodities and other sources of sampling error, too much effort is devoted to the sampling of cities and the sampling of retail outlets within cities. But definite conclusions on these matters can come only from a program of research carried out parallel with, and yet separate from, the actual day-to-day operations of index construction.

Not only would one expect to obtain firm estimates of error from an investigation of this kind, thus leading to better allocation of resources among the components of the present design, but such an investigation might also lead to recommendations for major changes in the construction of the Consumer Price Index. Two areas which seem worthy of special attention are the following:

1. Index numbers of the Laspeyres type have traditionally been based upon a market basket of commodities which remains essentially unchanged between major weight revisions, except for adjustments which are made to account for the changing quality of items in the market basket. As noted in Section IV, Adelman has advocated drawing a completely new sample of commodities at fixed intervals, together with a chain approach for obtaining comparisions over longer periods of time, but this approach seems unlikely to be adopted by the producers of index numbers. It should, however, be possible to effect a compromise between these two extremes and thus gain some of the advantages of each. Thus one could set up a rotation schedule so that each item remains in the index for some fixed period of time, say, one, two, or three years, and so that a fixed fraction of the items are replaced each month, quarter, or year by newly selected items. This type of sampling has been successfully applied to situations where the same population is sampled on successive occasions—Coch-

ran (*15*, pp. 282–290) and Hansen, Hurwitz, and Madow (*14*, pp. 490–503)—and it might well be adaptable to commodity sampling for index numbers. In particular, this would give "new" items (i.e., not in existence at the time of the original selection) a chance to come into the index without giving up all the features of a Laspeyres index, and would also give "old" items a chance of being dropped before they became entirely obsolete.

In attempting to adapt partial replacement to the sampling of commodities for an index number, there are many problems and points to be kept in mind. Among these are the following: If a population is fixed and the goal is to estimate month-to-month changes, then the "best" procedure is to keep the same sample. However, if the goal is to estimate the actual level, then the "best" procedure is usually to replace some fraction of the sample. In the case of index numbers, the real goal is probably a mixture of the two and a compromise would be required. Replacement procedures would also depend upon cost considerations and, in view of specification problems, it would probably always be more expensive to replace an item than it would be to retain it. Furthermore, it might be necessary to make some changes in the Laspeyres concept to take account of the fact that it would be difficult to obtain base period prices and specifications for items brought in some years after the base period.

2. The Consumer Price Index is basically city-oriented. That is, indexes are computed for each city in the city sample, and these indexes are weighted to obtain the U.S. index. This emphasis on city indexes does not appear to be the most efficient way of obtaining the U.S. index. If one views the index in terms of U.S. average weights and average prices, then it is clear that quite a different sample should be used, for example, to obtain a "good" estimate of the average price of a newspaper than would be used to obtain a "good" estimate of the average price of a used car or of a woman's coat. In other words, the size of the "best" city sample for an item depends upon the cost of obtaining a price quotation and upon the variability of the item's price from city to city, and thus the size of the "best" city sample will differ considerably from item to item. It is recognized that aggregation according to a Laspeyres index calls for price quotations to be weighted in proportion to population and to value, and that a complete set of value weights could not possibly be obtained for all cities in which one would be able, for example, to collect newspaper prices. This difficulty might be overcome, for example, by deriving the Consumer Expenditure weights for the population of cities in a region rather than for a number of individual cities in the region. An added benefit of such a change in emphasis might well be that it would become more feasible for the BLS to employ selected data from other sources in the index computations, e.g., from the Monthly Retail Trade Report of the Bureau of the Census.

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STAFF PAPER 5

INDEX NUMBERS AND THE SEASONALITY OF QUANTITIES AND PRICES

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I. THE PROBLEM: ITS SETTING AND ITS HARD CORE

1. INTRODUCTION

Each of the major U.S. price indexes covers many commodities that are subject to substantial seasonal fluctuations in quantities consumed or sold.[1] These seasonal changes in quantities are often associated with seasonal fluctuations in prices although they are not the only important source of price seasonalities. The intrayear variation in consumption presents a vexing problem in the construction of indexes designed to measure consistently the movement of prices from month to month and from year to year.

Seasonal changes in quantities and prices may be due to conditions of supply, for example, the short harvest seasons of perishables such as fresh fruits and vegetables or the heavy marketing of cattle and sheep at the end of the grazing season. Or they may be due to conditions of demand, e.g., in the summer the consumption of ice cream is at its peak and that of sweets at its seasonal trough, some meats are considered "heavy" but more is spent on poultry, etc. Much of the variability of food prices in the CPI (and, as a group, foods move faster than any other group within this index) reflects the high seasonality of so many food products. But seasonal influences are also quite substantial among commodities other than foods. In the soft-goods group, apparel is obviously and inevitably subject to such influences, with seasons for new spring and fall lines in clothing being accompanied by higher, and summer and post-Christmas sales by lower, prices. Among the durable goods which include automobiles, furniture, TV, radio, and various household appliances, model changes

[1] We are referring to the Consumer Price Index (CPI) and the Wholesale Price Index (WPI) of the U.S. Bureau of Labor Statistics and to the indexes of Prices Received and Paid by Farmers of the Agricultural Marketing Service (U.S. Department of Agriculture). Of course, since these indexes measure different things and serve different purposes the implications of the seasonal problem for them are by no means alike. Our concern in some parts of this study will be primarily with the CPI.

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anticipated and introduced in the final months of the year constitute a strong seasonal factor. It is only in the group of services that the seasonal elements are generally weak, in contrast to the above commodity categories.

The timing of the seasonal peaks and troughs, expansions and contractions, varies greatly among the component price series, however, so that these movements offset each other to a large extent, leaving only relatively small seasonal changes in the index as a whole.[2] Nevertheless, seasonal influences may and at certain times did dominate the short-run behavior of a comprehensive measure of average price changes such as the Consumer Price Index. That is, they can temporarily offset or even outweigh the influence of other, primarily cyclical, changes in business conditions. (To be sure, at other times seasonal factors may work in the same direction as cyclical factors, thus reinforcing the effect of the latter.) One illustration is provided by the 1929 developments when the CPI held firm, showing only the normal seasonal changes in foods, while the cyclically sensitive economic activities such as industrial production had already experienced considerable declines.[3]

It would seem that for some purposes, in particular for the analysis of longer-term movements in prices, the solution of the seasonal problem lies in the elimination of seasonal price variation. Techniques for such adjustments are well known and criteria are available according to which the quality of the results can be judged. But even the best seasonal adjustment will not, of course, remedy the shortcomings of the raw (unadjusted) time series to which it is applied. In the present case, the real problem is how to make the index reflect properly the seasonal variation in prices, taking into account the seasonal variation in consumption; it is not how to get the seasonal element out again once it has been adequately measured. In short, the important and difficult issue here is that of proper index measurement, an analytical as well as a practical problem, not the logically subordinate question of technical deseasonalization.

2. SEASONAL WEIGHTS, CHAIN INDEXES, AND THE PROPORTIONALITY CRITERION

To isolate the seasonal problem in price index construction and to simplify the analytical situation, let us assume that the "seasons" can be represented by months of the calendar year and that all change in consumption is seasonal only (no change in annual consumption). Then there would be 12 monthly "market baskets" applicable, respectively, to the Januaries, Februaries, etc., of the successive years. Thus the market baskets would not be constant in the consecutive monthly periods, although they would be constant in the same months or "seasons" of each year. To complete this simplest type of seasonal model, let the price change, too, be of exclusively seasonal nature and such that prices would vary only from month to month but be equal in the same months of each year.

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[2] This applies to each of the price indexes reviewed. The overall sensitivity to seasonal factors of the Wholesale Price Index seems to exceed somewhat that of the CPI, while the Indexes of Prices Received and Paid by Farmers (especially the latter) appear to be less subject to such influences. (For a statistical documentation of these statements, see Part III of this paper.)

[3] Cf. Ewan Clague, "The Consumer Price Index in the Business Cycle," *Monthly Labor Review*, LXXXI, No. 6 (June 1958), 616–620. Among the "economic characteristics" of the CPI emphasized by Clague, seasonal factors have indeed a prominent place.

One point, at least, is clear under these hypothetical conditions, namely, that the price index for the current month, P_t, should equal the index for the same month a year ago, P_{t-12}. This follows from the so-called "proportionality" requirement, which underlies one of the tests that Irving Fisher first proposed in *The Purchasing Power of Money* (1911). That an index number of prices should agree with each of the price relatives from which it is derived, if all of these relatives agree with each other, is a criterion that is hardly in need of much explanation or justification.[4] "Proportionality," of course, includes "identity" as a special case. In the present example, identity of prices at $(t-12)$ and t has been postulated, but it is easy to specify somewhat more relaxed assumptions (e.g., admit a steady trend in all prices as well as stable seasonals) such as would result in price level but not in price structure changes from year to year.[5]

Now, to do justice to the seasonal problem, a series of index numbers of price change should reflect as well as possible the seasonal variation in consumption. Since 1887, when Marshall first advanced the chain system and Edgeworth seconded it, many students of index numbers have come to look upon the chain index as the standard statistical solution to changing weights. But careful consideration must be given to the question of how well chain indexes can be applied to the seasonal weight changes with whose specific features they were surely not designed to cope.

It is easy to demonstrate that a chain index with varying weights does not fulfill the test of proportionality (or identity). Table I illustrates this by means of a numerical example in which, for simplicity and space economy, only two commodities and four quarterly seasons are recognized.[6] These hypothetical data embody the assumption that both p' and p'' (that is, "all prices") doubled between periods 0 and 2. Three fixed-base indexes employing different weight systems are shown to satisfy the proportionality test in that each of them has the value of 200 (percent) in period 2 (period 0=100). Of the three corresponding chain indexes with seasonal weights, none passes the test. Again, Table I is based on the assumption that prices and quantities are the same in the same "seasons" (here, quarters) of each year. Thus, on the identity test, the indexes for the same seasons should be equal, too, but they are so only for the fixed-base, not for the chain, formulae.[7]

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[4] Fisher regarded this test as "really a definition of an average" (*The Making of Index Numbers*, Cambridge, Mass., 3d ed., 1927, App. I., p. 420). Bortkiewicz pointed out that the requirement is an "obvious consequence" of an even broader concept of a statistical average than that used by Fisher (Ladislaus v. Bortkiewicz, "Zweck und Struktur einer Preisindexzahl," *Nordisk Statistisk Tidskrift*, III, 1924, p. 218; quoted in literal translation).

[5] Then, given the relation $p^k{}_t = \gamma\ p^k{}_{t-12}$ where γ is a constant proportionality factor and p^k is price of any k-th item, the condition to be satisfied by the price index would be $P_t = \gamma\ P_{t-12}$ (in the exclusively seasonal model introduced before, $\gamma = 1$).

[6] This example bears a general resemblance to a short numerical illustration given in Bortkiewicz, op. cit., p. 218, but our model has been developed to emphasize the seasonal aspects which are here of primary interest.

[7] The criterion of proportionality will not be satisfied, except under a special assumption, even by the most sophisticated version of the chain index, the Divisia formula. This approach assumes that prices and quantities change over time by infinitesimal steps, so that the price and quantity indexes can be defined by differential equations and converted into Divisia's "chain indexes" by integration. Divisia's index in its general form can be written as $P^D = dP/P = \Sigma adp/\Sigma qp$. See François Divisia, "L'indice monétaire et la théorie de la monnaie," *Revue d' Economie Politique*, 39 and 40 (1925–26); also separately by Librairie Sirey, Paris. That the Divisia index satisfies the said criterion only if the utility functions are homogeneous was shown by J. Ville, "Sur les conditions d'existence d'une ophélimité totale et d'un indice du niveau des prix," *Annales* de l'Université de Lyon, A 3, 1946 (Engl. translation, 1951, in the *Review of Economic Studies*, Vol. XIX).

TABLE I.—*Selected Measures of Price Change Applied to a Simple Seasonal Model*

Period No	0	1	2	3	4	5	6
Year	1	1	1	1	2	2	2
Quarter	I	II	III	IV	I	II	III
A. ASSUMED DATA							
Item 1:							
Price (p')	3	5	6	4	Same as for periods 0, 1, 2, . . .[1]		
Quantity (q')	40	20	10	30	Do.[1]		
Item 2:							
Price (p'')	1	4	2	3	Do.[1]		
Quantity (q'')	25	5	15	10	Do.[1]		
B. INDEX NUMBERS*							
(a) Binary comparisons:							
Laspeyres	100.0	206.9					
		100.0	108.3				
			100.0	94.4			
				100.0	66.7		
					100.0	[2] 206.9	(3)
Paasche	100.0	184.6					
		100.0	81.8				
			100.0	75.0			
				100.0	61.7		
					100.0	[2] 184.6	(3)
Fisher ("ideal")	100.0	195.4					
		100.0	94.1				
			100.0	84.2			
				100.0	64.1		
					100.0	[2] 195.4	(3)
(b) Fixed-base indexes (named by corresponding binary formula):							
Laspeyres	100.0	206.9	200.0	162.1	100.0	[2] 206.9	(4)
Paasche	100.0	184.6	200.0	150.0	100.0	[2] 184.6	(4)
Fisher	100.0	195.4	200.0	155.9	100.0	[2] 195.4	(4)
(c) Chain indexes based on formulas by:							
Laspeyres	100.0	206.9	224.1	211.7	141.1	[5] 292.0	[5] 316.3
Paasche	100.0	184.6	151.0	113.3	69.9	[5] 129.0	[5] 105.6
Fisher	100.0	195.4	184.0	154.9	99.3	[5] 194.1	[5] 182.7

[1] That is, we assume that $p'_t=p'_{t+4}$; $q'_t=q'_{t+4}$; $p''_t=p''_{t+4}$; and $q''_t=q''_{t+4}$ (using the subscript t to denote periods as numbered in the first line of the table and listing the variables in the order they appear in the four lines of Section A of the table).

[2] This index for period 5 is equal to the corresponding index for period 1.

[3] The index for period 6 (on base period 5) is equal to the corresponding index for period 2 (on base period 1). The general relation $P_t=P_{t+4}$ holds.

[4] The index for period 6 (on base period 0) is equal to the corresponding index for period 2 (on same base). The general relation $P_t=P_{t+4}$ holds.

[5] These indexes for periods 5 and 6 are not equal to the corresponding indexes for periods 1 and 2, respectively. The relation $P_t=P_{t+4}$ does not hold.

*Formulae used in Section B of the table:

(a) Binary comparisons:

$$\text{Laspeyres } P_{ij}^L=\frac{\Sigma p_j q_i}{\Sigma q_i p_i};$$

$$\text{Paasche } P_{ij}^P=\frac{\Sigma p_j q_j}{\Sigma p_i q_j}$$

$$\text{Fisher ("ideal") } P_{ij}^F=\sqrt{P_{ij}^L \cdot P_{ij}^P}$$

(c) Fixed-base indexes (names indicate correspondence to method of binary comparisons):

$$\text{Laspeyres } P_{0j}^L=\frac{\Sigma p_j q_0}{\Sigma p_0 q_0};$$

$$\text{Paasche } P_{0j}^P=\frac{\Sigma p_j q_j}{\Sigma p_0 q_j}$$

$$\text{Fisher } \tilde{P}_{0j}^F=\sqrt{P_{0j}^L \cdot P_{0j}^P}$$

(d) Chain indexes based on formulae by:

$$\text{Laspeyres } \tilde{P}_{0t}^L=P_{01}^L \cdot P_{12}^L \cdot P_{23}^L \ldots P_{ij}^L \ldots P_{t-1,t}^L$$

$$\text{Paasche } \tilde{P}_{0t}^P=P_{01}^P \cdot P_{12}^P \cdot P_{23}^P \ldots P_{ij}^P \ldots P_{t-1,t}^P$$

$$\text{Fisher } \tilde{P}_{0t}^F=P_{01}^F \cdot P_{12}^F \cdot P_{23}^F \ldots P_{ij}^F \ldots P_{t-1,t}^F$$

where $t=0, 1, 2, \ldots$; $i=$any t; and $j=i+1$.

The major objection to the chain index encountered in the literature is that it will not equal the result of a direct comparison between the first and the last of the periods it covers, except in the trivial case of constant weights. Our criticism of the chain index in the seasonal context does not refer directly to this so-called circular test but is founded on the proportionality criterion. To be sure, the latter when applied to more than two periods can be viewed formally as included in the broader circular criterion, yet the two are certainly not the same. Moreover, the historical controversy about chain indexes and the circular test was primarily concerned with long-term comparisons based on annual data—a very different perspective from our short-run, seasonal view. There is certainly much force in the familiar argument against the circular test and in favor of chain indexes as far as such longtime comparisons are concerned.[8] It is also clear why writers who were thinking in terms of long developments in annual values could and did disregard the proportionality test; economic change over years is complex and relative prices vary continuously, without ever returning to their past constellations. But to ignore the proportionality criterion in dealing explicitly with the seasonal problem would just as surely be wrong, for it is the essence of seasonal movements that they recur from one year to the next in similar patterns which for the most part change only gradually over a number of years.

There are, however, important differences between the various chain formulae with respect to the magnitude and character of the divergencies of these indexes from the values expected under the proportionality test. The Laspeyres chain typically exhibits a marked systematic upward "drift" over time; the Paasche chain, an analogous downward drift. These tendencies are vividly illustrated in Table I. With regard to recurrent seasonal fluctuations, such trends are seriously disturbing.[9] Even when the exaggeration involved in this highly simplified example is heavily discounted, it seems clear that the drifts are too strong for the formulae that produce them to be acceptable.[10] It is true that these drifts are not inherent in the working of the formulae, that is, the latter will produce them under certain,

[8] Briefly restated, the argument is that direct comparisons limited to the price and quantity data for two distant years must contain large errors because they disregard the changes in living standards, habits, etc., that accumulate over time. Binary (year-to-year) comparisons are the most accurate and as the distance in time increases the quality of index measurement deteriorates; by making a chain index out of the annual links, information on prices and quantities in all intervening years is utilized most completely and the inevitable error of the long-distance comparison is minimized. On this view, then, the circular test is not valid theoretically in that it implies the reverse of the above reasoning, namely that the direct comparison P_{0t} (and even the backward direct comparison P_{t0}) is a more accurate measure than the result of a complete, forward-oriented and irreversible as historical time itself, chain of annual links, $\tilde{P}_{0t}$.

[9] There is reason to stress the specific and material nature of the argument behind the above statement. As Ragnar Frisch pointed out, the mere fact of "drifting" does not necessarily imply that the chain method is "wrong" (and the direct index "right"); this issue cannot be resolved by "formal considerations." Cf. R. Frisch, *Econometrics*, Vol. IV, 1936, p. 9.

[10] A few statistical tests and experiments are available, which suggest that the drifts of the chain indexes due to seasonal fluctuations may well be quite pronounced. Erland von Hofsten, *Price Indexes and Quality Changes*, Stockholm, 1952, p. 14, refers to Leo Törnquist. "Finlands banks konsumtionspris index", *Nordisk Tidskrift for Teknisk Ökonomi*, Köbenhavn, 1937, as having demonstrated that a week-to-week chain index for food was after 3 years 20 percent higher than a direct comparison. The present author had unfortunately no access to Törnquist's study. Recently, considerable experimentation with seasonally weighted chain indexes and other formulae has been performed at the Bureau of Labor Statistics; its results are summarized in Doris P. Rothwell, "Use of Varying Seasonal Weights in Price Index Construction," *Journal of American Statistical Association*, March 1958, pp. 74–77. Here the 3-year divergence between the Laspeyres chain and direct indexes was similar but slightly larger (close to 26 percent).

not all, circumstances. But it is precisely in the seasonal context that the conditions assuring the occurrence of the drifts will be most often fulfilled (see Section 3b below).

Chain indexes based on some compromise method of crossing formulae or weights will miss the proportionality test much more narrowly, following, as would be expected, an intermediate course between the Laspeyres and the Paasche chains. The Fisher chain in Table I shows some downward drift and other more realistic test calculations also indicate the presence of such slow drifts both in this cross formula and in the Marshall-Edgeworth cross weight chain.[11] But it is likely that under conditions pertinent to the practice of index measurement—a sufficiently large number of component items in the index, less violent period-to-period movements in these data—divergencies such as those yielded by the Fisher chain will not prove seriously disturbing, at least not over a period of a few years at the end of which a revision of the index might be used to "rectify" matters. One must also remember that the stringent seasonality assumptions of the test will not often be closely approximated in practice. After all, seasonal fluctuations are in reality overlaid by trends and cyclical and erratic movements and they are not always well-defined or very regular in themselves.

Thus, on the strength of the charge of "drifting" alone, a strong case can be made against the Laspeyres and Paasche chain formulae, but not against the Fisher chain. The main merit of a chain series, which is that each of the links in the chain uses only those price and quantity changes that belong to the same period and are directly associated with each other, is of course pertinent in the seasonal context as it is in other applications. Hence it is important to ask whether a chain index faces still other difficulties that would tend to offset its admittedly important theoretical advantage.

There is one basic difficulty here that becomes important in connection with seasonal quantity changes, but this difficulty is shared by the chain series with all other conventional price indexes. This concerns the so-called "unique" commodities—items found only in one of the two commodity lists of a binary (two-period) comparison but not in both. Chain indexes of the standard type, like other index numbers computed by averaging price relatives, imply a given list of commodities in two successive pricing periods; that is, they retain in a binary comparison what for fixed-base indexes is true for a number of comparisons (over longer periods of time), namely, that the "market basket" is constant. But the main complication introduced by the seasonal change is precisely that the market basket is different in the consecutive months (seasons), not only in weights but presumably often also in its very composition by commodities. This is a general and complex problem which will have to be dealt with separately at later stages of our analysis.

Finally, turning to the very different matter of practical difficulties associated with the application of the chain method to short-run data with seasonal characteristics, two possibilities must be distinguished.

[11] A 4 percent downward drift over a period of 10 years (in annual data) was found experimentally for a Fisher chain by Warren M. Persons ("Fisher's Formula for Index Numbers," *The Review of Economic Statistics*, March 1921, p. 110). Recent tests at the Bureau of Labor Statistics reveal a similar drift from year to year in a monthly Marshall-Edgeworth chain with seasonal weights. Cf. Doris P. Rothwell, op. cit., Fig. 77B.

If the seasonal weight patterns are essentially stable from year to year (Table I presents the extreme case where they are constant), then the chain method, which does not take advantage of this stability but rather faces a difficulty in it (the "drift" problem), is of questionable efficiency. If, on the other hand, the intra-annual weight distribution varies considerably over time, then it would seem overzealous to attempt to reflect in the index these numerous short-run changes in weights, many of which are likely to be minor and unsystematic. A monthly or even a quarterly chain index with current weights poses maximum data requirements whose continuous fulfillment can hardly be realistically expected. To try to get reasonably accurate seasonal quantity weights on a current basis would most likely prove an exercise in futility.

3. IMPLICATION OF PRICE-QUANTITY RELATIONSHIPS

a. *Indexes of Price Change and of the Cost of Living.*—The theoretically ideal cost-of-living index may be defined in purely formal terms as the ratio of two money expenditures $V_j = \Sigma p_j q_j$ and $V_i = \Sigma p_i q_i$ which are "equivalent" in the sense that the "typical" consumer in the group to be covered by the index is just as well off at j (spending V_j) as he was at i (spending V_i).[12] Clearly, such an index implies a complete solution to the seasonal problem, as to any other "problem" in cost-of-living measurement. By definition, V_i and V_j are household budget expenditures on equivalent market baskets which will be as similar or as different as required to provide "equal real incomes of utility" (Keynes); this takes care of seasonally motivated as well as any other necessary adjustments in the basket. Given any indicator of equal "well-being," μ or ν (e.g., an indifference function), the index $V_j(\mu,\nu \ldots)/V_i(\mu,\nu \ldots)$ fulfills the proportionality test and the circular criterion in general, identically in μ,ν or any other such indicator.[13]

The theory of cost-of-living measurement acknowledges that the "true" index V_j/V_i is not known. It proceeds from an analysis of the relationship between the two available basic measures of average price change, the Laspeyres and the Paasche indexs (in our notation,

$$P_{ij}^{L} \text{ and } P_{ij}^{P}$$

respectively), in an effort to establish how these are related to the true cost-of-living indexes.

Assume two "cross combinations" of conditions for our group of consumers: (*a*) their real income level is still as of period i but they face now a changed structure of prices, that of the next period j; (*b*) they are confronted with relative prices of period i but their real incomes are those of period j. Let $\bar{q}_i$ denote the quantities that would have been purchased in the first, and $\bar{q}_j$ those that would have

[12] See A. A. Konüs, "The Problem of the True Index of the Cost of Living," *Econometrica,* Vol. 7, No. 1, January 1939, p. 10 (translation of a paper published in Russian in 1924). Definitions which coincide with that given above are also employed in the writings of Gottfried Haberler, *Der Sinn der Indexzahlen,* Tübingen, 1927; A. L. Bowley, "Notes on Index Numbers," *The Economic Journal,* Vol. 38, 1928, pp. 216–237; J. M. Keynes, *A Treatise on Money,* New York, 1930, Vol. I; R. G. D. Allen, "On the Marginal Utility of Money and Its Application," *Economica,* May 1933; Hans Staehle, *International Comparisons of Cost of Living,* International Labour Office, Studies and Reports, series N, No. 20, Geneva, 1934; and Ragner Frisch, op. cit., pp. 10–13.

[13] Frisch, op. cit., p. 13.

been purchased in the second of these hypothetical situations. Then, in accordance with the definition given above, there would be two "true" cost-of-living indexes for the real income levels of i and j, respectively, with formulae much like those of Laspeyres and Paasche except for the crucial substitution of the barred for the simple q's in two instances. These not directly measurable expressions are

$$P^I_{ij}=\frac{\Sigma p_j\bar{q}_i}{\Sigma p_i q_i} \text{ and } P^J_{ij}=\frac{\Sigma p_j q_j}{\Sigma p_i \bar{q}_j}$$

There are now also two inequalities:[14]

$$P^L > P^I \text{ and } P^J > P^P$$

which are due entirely to changes in the price structure and the response to them of consumers' buying.[15] Implicit in the Laspeyres index is the assumption that demand for any commodity is completely price-inelastic. Because it thus neglects to take into account the adjustments of consumption in favor of items that have become relatively cheaper, the numerator in P^L is too large and P^L exceeds P^I which by definition is free from that error. And again because it implies inelasticity of demand, the denominator in P^P is too large so that P^P is less than P^J which, too, is by definition error-free.

Defining $D_p=(P^L-P^I)+(P^J-P^P)$ and $D_r=P^I-P^J$, we obtain as their algebraic sum the total difference between P^L and P^P, $D_t=D_p+D_r$. If there were no change in real income between periods i and j, D_r would be zero and the difference between P^L and P^P would equal D_p alone, which means that it would be dependent only on the effects of changes in the relative prices and as such be strictly positive. If there is also a change in real income affecting the structure of consumption, then D_r will be non-zero and D_t will depend on the sign and magnitude of D_r as well as on the size of the positive D_p.

A simple yet not ineffective way to evaluate D_r consists in taking a close look at P^J and P^I to compare their relative magnitudes under certain specified conditions. Thus if the group covered by these indexes experiences a net rise in their real incomes between periods i and j, then one would expect that $\Sigma p_j q_j > \Sigma p_i q_i$ but also that $\Sigma p_i \bar{q}_j > \Sigma p_i q_i$. In other words, both the numerator and the denominator of P^J would then be larger than the corresponding components of P^I. If the difference between the numerators were larger than that between the denominators, P^J would exceed, and in the reverse case it would fall short of, P^I. There does not seem to be any reason for either of these eventualities to have a higher probability of occurrence than the other; and the parallelism of the two inequalities works to make the difference between P^J and P^I small. Analogous considerations apply to the case of a net decline in real incomes between periods i and j, where the expected relations are $\Sigma p_j q_j < \Sigma p_j q_i$ and $\Sigma p_i \bar{q}_j < \Sigma p_i q_i$. The inference to be drawn in each case is that the differences, D_i, between the cost-of-living indexes P^I and P^J, or between their fixed-base equivalents, are likely (*a*) to bear signs that do not vary systematically over time, and (*b*) to be small and, on the aver-

[14] For simplicity, the subscripts of the indexes are henceforth omitted.

[15] Cf. Melville J. Ulmer, *The Economic Theory of Cost of Living Index Numbers*, New York, 1949.

age, zero. Hence the total difference $D_t = P^L - P^P = D_p + D_i$ would tend to have the general order of magnitude and the sign (+) of D_p. These conclusions are consistent with the available evidence.[16]

Changes in real incomes are primarily a cyclical and a trend phenomenon, and presumably of relatively little importance in the shorter run. In the seasonal context, in particular, changes of relative prices and of quantities consumed can be expected to dominate the scene. Table I shows this in a highly exaggerated form[17] but without falsifying the direction in which these factors work on most (although by no means on all) occasions.[18] The model assumes a negative correlation between the price and quantity relatives. It yields Laspeyres indexes consistently exceeding the corresponding Paasche indexes (see the section "binary comparisons" in Table I).

b. *Correlation and Dispersion of Price and Quantity Relatives.*—Another instructive approach to the analysis of the relation between P^L and P^P has been developed by Bortkiewicz and applied in empirical work on international cost-of-living comparisons by Staehle. For convenient notation, define

$$x = \frac{P_j}{P_i},\ y = \frac{q_j}{q_i},\ \text{and}\ w = p_i q_i$$

Then we can write (omitting the subscript ij in the index symbols)

$$P^L = \frac{\Sigma wx}{\Sigma w};\ P^P = \frac{\Sigma wxy}{\Sigma wy};\ \text{and}\ Q^L = \frac{\Sigma wy}{\Sigma w}$$

where the last expression is a *quantity* index (Laspeyres). By their definitions, the weighted coefficient of correlation between x and y (r_{xy}) and weighted variances of these variables (σ^2_x and σ^2_y) are

$$r_{xy} = \frac{\Sigma w(x - P^L)(y - Q^L)}{\sigma_x \sigma_y \Sigma w};\ \sigma^2_x = \frac{\Sigma w(x - P^L)^2}{w}$$
$$\text{and}\ \sigma^2_y = \frac{\Sigma w(y - Q^L)^2}{\Sigma w}$$

The following equation can be shown to hold[19]

$$\frac{-D_t}{P^L} = \frac{P^P - P^L}{P^L} = r_{xy} \cdot \frac{\sigma_x}{P^L} \cdot \frac{\sigma_y}{Q^L}$$

[16] See M. J. Ulmer, op. cit., pp. 55–58, where some annual retail price data for 1929–40 are shown to yield very low positive values of D_t. (They are based on a fixed-weight Laspeyres and a variable-weighted Paasche index, average 0.3 percent of either of these measures, and seem to show a slight positive cyclical pattern.)

[17] This has two reasons: (1) The assumed fluctuations in prices and quantities are very large, as are the implied movements in the relative prices and expenditure weights, and (2) there are only two items in the example. Cf. Fisher, op. cit., app. II, "The greater the number of commodities in an index number of prices, the less is the index number affected by a change in weights, or in price relatives" (p. 450). About the empirical effects of different scales of coverage and types of weighting, see also Wesley C. Mitchell, *The Making and Using of Index Numbers*, U.S. Bureau of Labor Statistics, pt. I, of Bulletin 173, 1915, reprinted as Bulletin 656, 1938 (secs. IV5 and 156).

[18] See Section 3d below.

[19] Derived by Bortkiewicz, op. cit., pp. 13–14. An earlier version of this analysis is given in Bortkiewicz's first article in *Nordisk Statistisk Tidskrift*, II, 1922, pp. 374–379.

Thus the divergence between P^L and P^P, standardized in terms of P^L, is found to depend on three factors: (1) the coefficient of correlation between the price and quantity relatives, p_j/p_i, and q_j/q_i, and (2, 3) the coefficients of variation of these relatives (each of these coefficients being weighted by means of $w = p_i q_i$).

The ratio σ_y/Q^L applied to two seasons i and j would measure the extent to which the structure of consumption differs between these periods for households with specified characteristics. The ratio σ_x/P^L would similarly measure the divergence between the i-th and the j-th relative price systems. Either ratio could theoretically be zero (if q_j were proportional to q_i, or p_j to p_i, for all commodities, i.e., if $q_j/q_i=$const. or $p_j/p_i=$const.). Actually, either can be expected to be positive, of course, but most likely less than one. The distribution of consumption in periods i and j would have to be very asymmetrical—associated with a very large dispersion of the quantity relatives y—in order for σ_y to reach values exceeding Q^L. The case of $\sigma_x/P^L > 1$ is still less probable: that ratio would more likely than not be smaller than σ_y/Q^L, although the two may not be widely different.

Since both σ_x/P^L and σ_y/Q^L are positive, the sign of the total difference $D_t(=P^L \; P^P)$ must be opposite to the sign of r_{xy}. Thus in the case of a negative correlation between price and quantity relatives, which is the assumption we have been making so far, D_t will be positive. The analysis also suggests that D_t/P^L, when based on a large number of common consumption items, should not be large: its value is the *product* of three factors each of which is a proper fraction. Still, its value might be quite respectable as shown by the following, perhaps not implausible, example: assuming r_{xy}, σ_x/P^L, and σ_y/Q^L are, respectively, -0.6, 0.3, and 0.4, the resulting D_t/P^L would be 0.072 or somewhat more than 7 percent.

A similar analysis may be used to explain the relation between chain comparisons and the corresponding direct comparisons, say $\tilde{P}^L_{ot}$ and P^L_{ot}. Restricting the chain to a single link of two indexes without loss of generality and defining

$$x_k = \frac{p_k}{p_j},\ y_j = \frac{q_j}{q_i},\ \text{and } w_j = q_i p_j$$

(i, j, and k denoting three successive periods), we have

$$\frac{P^L_{ij} \cdot P^L_{jk}}{P^L_{ik}} = 1 + \frac{r'_{xy}\sigma'_x\sigma'_y}{\bar{x}_k \bar{y}_j}$$

Here r'_{xy} is the coefficient of correlation between x_k and y_j, $'_x$ and σ'_y are the respective standard deviations of these variables, and $\bar{x}_k$ and $\bar{y}_j$ are their means, all of these expressions being weighted with w_j.[20] It is evident that if r'_{xy} is positive, the left-hand expression will

[20] The above equation seems to convey the analytical situation and its implications somewhat more directly than the original version given in Bortkiewicz, *Nordisk Statistisk Tidskrift,* III, p. 211. In the present notation, the Bortkiewicz relations reads

$$P^L_{ij}P^L_{jk} - P^L_{ik} = \frac{r'_{xy}\sigma'_x\sigma'_y P^L_{ij}}{Q^P_{ij}}$$

That the two versions are equivalent is easily verified, once it is realized that

$$\bar{x}_k = P^L_{ik}/P^L_{ij} \text{ and } \bar{y}_j = Q^P_{ij}$$

be larger than one, i.e., the chain Laspeyres ($P^L_{ij} \cdot P^L_{jk}$) will give a higher result than the direct Laspeyres (P^L_{ik}). By the same token, a negative r'_{xy} would make $P^L_{ik} > P^L_{ij} \cdot P^L_{ik}$.

Now the former of these two eventualities has on occasion been presented as an unqualified rule.[21] Actually, a sweeping generalization to this effect cannot be made, since the outcome will depend on the conditions of the case, for example on the length of the unit period of the comparisons.[22] However, as far as short-run seasonal elements of price and quantity movements are concerned, there are some good reasons, as well as empirical evidence, to expect that $P^L_{ik} < P^L_{ij} P^L_{jk}$ would indeed prove to be the dominant tendency in practice. Two points must be made: (1) We can assume that taking "the season" as a unit period, the correlation between price and quantity relatives on a simultaneous basis is likely to be negative for a large number of products. (2) Seasonal variations may be conceived as deviations from an annual average, so that they imply a "normal": rises above and falls below that level will tend to succeed each other in compensatory sequences over the year for both the price and the quantity relatives. Now the combination of (1) and (2) makes it probable that when these relatives are taken with a *lag*, which is the case here where we consider q_j/q_i and P_k/P_j, their correlation, as measured by r'_{xy}, would be positive. This is the situation represented in Table I which implies an association between the price relatives and the quantity relatives that meets the above conditions. It is because of this that the resulting index numbers show the familiar "drifts."

c. *Unique Commodities.*—Can the analysis of the previous section help us in dealing with the problem of "unique" commodities? It has been observed that the sequence of seasons produces substantial changes not only in the amounts of the same goods purchased at different times of the year but often also in the variety of the goods purchased. For many items the supply (or demand) is heavily concentrated in certain seasons; for some items it is entirely confined to this or that part of the year. Is it possible, e.g., to have the expression σ_y/Q^L cover two sets of commodities that include some items encountered only in one but not the other of the compared periods? And, if so, what might be learned from such a measure?

For any item that appears in the i-th but not in the j-th basket, the quantity relative q_j/q_i is zero. The Laspeyres quantity index Q^L can be computed for a situation in which some of the q_j are zero, either as a weighted average of quantity relatives, $\Sigma(q_j/q_i)\,q_i p_i/\Sigma q_i p_i$, or as a ratio of aggregates, $\Sigma q_j p_i/\Sigma q_i p_i$. The two forms are here equivalent, just as they are in the normal case of index-making practice where only positive (reported or estimated) q_j are used.

For any item that appears in the j-th but not in the i-th basket, the quantity relative q_j/q_i, and consequently Q^L as a weighted average of such relatives, cannot be computed. Where q_i is zero there is no corresponding market price p_i, so that the aggregative form $\Sigma q_j p_j/ \Sigma q_i p_i$ cannot be extended beyond the intersection of the two sets of commodities either (unless hypothetical instead of actual market prices are

[21] See Ragnar Frisch, "Annual Survey of General Economic Theory: The Problem of Index Numbers," *Econometrica*, Vol. IV, 1936, p. 9.
[22] This dependence was noted, without further elaboration, by Bortkiewicz, op, cit., p. 219.

used for p_i). But a Paasche quantity index can be obtained from the formula $Q^P = \Sigma q_j p_j / (q_i/q_j) q_j p_j$, where some of the relatives q_i/q_j are now zero; and the analysis of the difference D_t can be worked out in terms of the Paasche as well as the Laspeyres indexes.[23]

The weighted relative variance of the quantity ratios is

$$\sigma_y^2 = \frac{\Sigma w(y-Q^L)^2}{\Sigma w} = \frac{\Sigma w.y^2}{\Sigma w} - (Q^L)^2,$$

where $y = q_j/q_i$ and $w = q_i p_i$. The case of $q_j = 0$ is here again very simple. Such an item contributes a zero y to $Q^L = \frac{\Sigma wy}{\Sigma w}$ in the second part of the above expression and similarly a zero y^2 to the first part of it. For $q_i = 0$, the "Laspeyres-type" variance σ_y^2 cannot be computed but the "Paasche-type" variance $\sigma_{y'}^2$ (see footnote 23) can. The latter can be written as $\Sigma w'(y')^2/\Sigma w' - (1/Q^P)^2$, where $Q^P = \Sigma w'/\Sigma w'y'$. For each item with $q_i = 0$ $(q_j > 0)$, $y' = q_i/q_j$ will equal zero.

The situation with respect to price relatives and price indexes is different. In our first case ($q_i > 0$; $q_j = 0$), the price of the commodity is positive at i, nonexistent at j. It is not possible simply to parallel the treatment on the quantity side and include the price relative p_j/p_i for this item at the value zero in the computation of the Laspeyres index P^L. To do so would clearly involve a logical error (absence of a market price is not identical with the existence of a zero price) as well as a distorted measurement of the average price change (disappearance of an item from the market does not per se lower the index and should not be permitted to have this effect). The same consideration applies *mutatis mutandis* to the case of $p_j > 0$ and p_i nonexistent ($q_i = 0$). It is valid for the Paasche as well as for the Laspeyres price index. There is simply no escape from the truism that any comparison of two magnitudes such as p_i and p_j requires that both of them be actually given. If either is not directly observable, then, under the method of item-by-item comparisons, it must be estimated or else the item concerned must be omitted from the index altogether, and not just from that part of the index relating to the period for which p is not available. Being true generally for the price relatives and their aver-

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[23] Define $x' = \frac{p_i}{p_j}$, $y' = \frac{q_i}{q_j}$, and $w' = p_j q_j$. Then

$$\frac{1}{P^P} = \frac{\Sigma w'x'}{\Sigma w'}; \frac{1}{Q^P} = \frac{\Sigma w'y'}{\Sigma w}; \text{ and } \frac{1}{P^L} = \frac{\Sigma w'x'y'}{\Sigma w'y'}$$

We get $$\sigma_{x'}^2 = \frac{\Sigma w'\left(x' - \frac{1}{P^P}\right)^2}{\Sigma w'}; \sigma_{y'}^2 = \frac{\Sigma w'\left(y' - \frac{1}{Q^P}\right)^2}{\Sigma w'}; \text{ and}$$

$$r_{x'y'} = \frac{\Sigma w'\left(x' - \frac{1}{P^P}\right)\left(y' - \frac{1}{Q^P}\right)}{\sigma_{x'}\sigma_{y'}\Sigma w'}$$

The equation for the relative D_t has now the form:

$$\frac{-D_t}{P^L} = \frac{\frac{1}{P^L} - \frac{1}{P^P}}{\frac{1}{P^P}} = \frac{P^P - P^L}{P^L} = r_{x'y'} \cdot \sigma_{x'} \sigma_{y'} \cdot P^P \cdot Q^P.$$

ages, the conventional price indexes, this argument is of course also applicable to variances of price relatives such as $\sigma_x^2 = \frac{\Sigma w(x-P^L)^2}{\Sigma w}$ (where $x = p_j/p_i$ and $w = p_i q_i$). This expression, too, cannot be extended to cover heterogeneous aggregates, i.e., different through overlapping sets of commodities, except through the use of some hypothetical prices.

In view of the above, one must conclude that the Bortkiewicz analysis of D_t cannot as a whole be consistently applied to commodity sets that include unique goods. This imposes a considerable limitation upon its value for the treatment of the seasonal problem. Of those parts of the analysis that retain interest for the case of unique commodities, the ratio σ_y/Q^L is the most important. This expression can be regarded as a measure of the difference in the structure of consumption between the two situations or periods computed. It may be written as

$$\frac{1}{Q^L}\sqrt{\frac{\Sigma w(y-Q^L)^2}{\Sigma w}} = \sqrt{\left(\frac{1}{Q^L}\right)^2\left[\frac{\Sigma wy^2}{\Sigma w} - (Q^L)^2\right]} = \sqrt{\frac{\Sigma q_i p_i \Sigma q_j p_i\left(\frac{q_j}{q_i}\right)}{(\Sigma q_j p_i)^2} - 1}.$$ [24]

The value of this Laspeyres-weighted coefficient of variation is obviously an increasing function of the dispersion of the quantity relatives q_j/q_i from their weighted average Q^L. But it is thus implicitly also an increasing function of the importance of those commodities that appear in the i-th but not in the j-th "market basket." With each replacement of a positive by a zero q_j, Q^L is lowered and σ_x raised. On both counts, then, the value of the relative variance or standard deviation of the quantity relatives is increased. The accompanying tabulation provides a simple hypothetical example.[25]

Data							Results		
Variable	Items					Model	σ_x	Q^L	$\frac{\sigma_x}{Q^L}$
	1	2	3	4	5				
p_i	3	2	1	5	4				
q_i	4	5	6	2	1	I	1.014	1.119	0.906
q_j	2	3	4	3	4				
q_j	0	3	4	3	4	II [1]	1.118	0.976	1.145
q_j	0	0	4	3	4	III [1]	1.195	0.833	1.434

[1] p_i and q_i as in model I.

Where instances of $q_i = 0$ ($q_j > 0$ occur,

$$\sigma_y^2 = \frac{\Sigma w'(y')^2}{\Sigma w'} - \left(\frac{1}{Q^P}\right)^2$$

is the expression to be evaluated (see footnote 23). This is the weighted relative variance of the quantity relatives q_i/q_j. The ratio

[24] For the definitions of the symbols used, see Part I, Sections 3b and 3c.

[25] Its results are, of course, again greatly exaggerated, for reasons analogous to those noted before in connection with Table I (see Part I, Section 2a and footnote 17). In realistic cases σ_x/Q^L would be expected to be much lower than one. The presence of unique commodities would indeed work strongly to raise the value of that ratio, but there will be relatively few such items in representative market baskets.

corresponding to σ_y/Q^L in the analysis of the Laspeyres terms is here $\sigma_{y'}/(1Q^P)$. Where cases of $q_j=0$ occur along with those of $q_i=0$, both the Laspeyres- and the Paasche-type measures would be needed. The analysis, then, would consist of two parts, and for an appraisal of the total change the results of the two should be combined. It should also be instructive to have the above expressions computed in two variants, one inclusive and the other exclusive of the unique commodities. This would permit separate estimation of the influence of the factors of dispersion and nonhomogeneity.

The analysis of differential consumption structures has been put to some interesting empirical uses with little concern for the difficulties discussed in these pages. Minimization of the difference between the structures of consumption in two different price situations has been proposed as a method of ascertaining "equivalent" income levels whose ratio approximates the theoretical cost-of-living index.[26] Let a series of "incomes" in the base situation be distinguished—values of $\Sigma q_i p_i$ for various q_i, baskets, and the corresponding prices—and let each such value be compared with a series of incomes for the j-th situation, or different combinations for $\Sigma q_j p_j$. For each pair of these aggregates, a value of σ_z/Q^L (or Δ, see footnote 26) can be calculated. Empirically, a tendency was found for each of such series of comparisons to yield a fairly well-defined minimum value for these measures of dissimilarity of the quantities consumed. The lowest of the minima were used by Staehle in his international comparisons as means of selecting pairs of incomes regarded as most nearly equivalent in terms of living standards. Staehle's results were found encouraging, although further studies are needed to reach firmer conclusions on the usefulness of his method. The possibility of applying the latter in an approach to the task of constructing an index with seasonal weights is contemplated later in this paper (see Part II, Section 9 below).

The existence of commodities that are marketed only at certain times of the year (the "unique goods" in the seasonal context) dramatizes the index number problem posed by the seasonality of quantities sold. No conventional price index formula can handle a situation in which the "market basket" varies between two consecutive periods. This is the hard core of the seasonality problem. To make real sense economically, the solution of this problem must seek an approximation to constant-utility indexes through the use of seasonal goods complexes that approach equivalence in the eyes of the representative consumer or producer.

d. *Seasonal Shifts in Demand and Seasonal Indifference Curves.*[27]—Much of the preceding discussion was related to seasonalities whose

[26] Hans Staehle, op. cit.; see also articles by the same author in *Archiv für Sozialwissenschaft*, June 1932, *Econometrica*, January 1934, and *The Review of Economic Studies*, June 1935. Staehle uses as his measure of "dissimilarity" between the quantity complexes q_i and q_j the expression

$$\Delta=\frac{\Sigma w|y-Q^L|}{\Sigma w}\cdot\frac{1}{Q^L}$$

He notes that Δ bears a close family relationship to the Bortkiewicz measure

$$\sqrt{\frac{\Sigma w(y-Q^L)^2}{\Sigma w}}\cdot\frac{1}{Q^L}.$$

Staehle's Δ can vary between 0 and 2 (and Frisch, op. cit., p. 30, observes that it will equal 2 only when none of the q_j goods occur in q_i). The values of Δ for our models I, II, and III are 0.652, 0.846, and 1.101, respectively.

[27] The author is indebted to Professor Martin Bailey (University of Chicago) for helpful criticism and suggestions relating to this section.

source lies on the supply side. This category is indeed particularly important in practice. Thus, production of many foods undergoes pronounced intra-annual fluctuations. The relation between the monthly price and quantity ratios is negative because changes in supply cause movements along essentially stable demand functions.

In some cases, however, seasonal variation is due primarily to demand rather than supply changes. For example, the demand for gasoline increases considerably during the summer when cars are used more extensively, but crude petroleum is produced and refined continuously throughout the year with little seasonal change. In this category there is no reason for an inverse association between quantities and prices over the course of the seasons, but instead there are the possibilities of (a) positive correlation or (b) no correlation. If production does increase at the time of the seasonal rise in demand and if this is accompanied by rising marginal costs, then the price can be expected to go up in the demand season. This, then, is the positive correlation case (a). But if the supply curves for the given product(s) are highly elastic over the pertinent range of demand variation or if the peak seasonal demand is met at no substantial additional or specific costs from stock of output produced in, and carried over from, the low-demand season, then the price need not increase at all at the time when sales do. In these situations, the price-quantity correlation over the seasons would be zero or close to it (b).

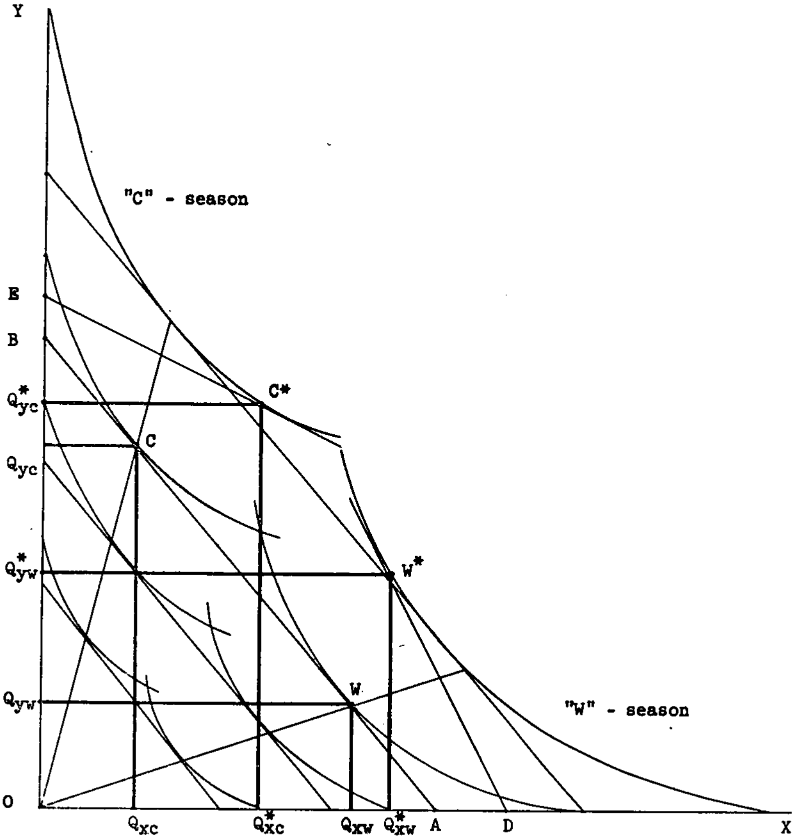
It is believed that case (b) is more important in practice than case (a), i.e., that there are relatively few examples of large *positive* correlation between price and quantity seasonally.[28] Thus we expect the following to be the dominant conditions: (1) negative correlation, which may often be quite substantial; (2) absence of any significant, or some low positive, correlation. The former, since it incorporates a stable system of demand functions, can be handled by the familiar constant-indifference-map method of index numbers analysis; the latter, since it presupposes shifts in the demand patterns, cannot. We submit that one logical and plausible way of looking at some situations that are here involved is to assume a seasonal rotation of indifference curves or the existence of different sets of such curves characteristic of the different seasons.

Figure 1 refers to a simple two-goods, two-seasons case. Suppose the year is about evenly divided into a "warm" and a "cold" season, *W* and *C*. Let *X* be an article used primarily in the *W* season, e.g., a light suit, and *Y* an article used primarily in the *C* season, e.g., a heavier suit, both items being sufficiently well defined and measurable in some standardized units.

There are now two sets of indifference curves, one for the *C* and one for the *W* season. The *C* curves start from the *Y* axis and decline markedly at first but then flatten off sharply, indicating that a sufficiently large quantity of the commodity *Y* can replace *X* entirely in this season and that some quantity of *Y* will be purchased in any

[28] In some instances, the existence of positive correlation appears to make little sense, but even there, of course, there is no point in ignoring its possibility. Thus discounts may be offered in off-season months on goods providing seasonal consumption services, e.g., on air-conditioners in the winter, and yet, despite the durability of the product, only a small proportion of the annual air-conditioner sales may be made during the cool-weather part of the year. In other instances, there may be more logical justification for a positive price-quantity correlation, as when some significant storage or inconvenience costs are incurred by the off-season buyer (e.g., coal purchases for domestic heating purposes in the spring) or a restriction exists on choice (e.g., swimming suit purchases in autumn).

FIGURE 1



event—no increase in X can balance off a decrease in Y below that amount, so that the latter represents a minimum seasonal quantity demanded of Y. Thus it is only within a certain range of the Y-quantities that X can be substituted for Y as shown by the indifference patterns. The same applies *mutatis mutandis* to the W-set of the curves. These, of course, start from the X axis and the "flattening" takes here the form of a gradual approach to verticality. The roles of the two items are reversed: there is a minimum for X below which no substitution of Y for it is possible.

Let us suppose that the ratio of the price of X to the price of Y is the same in the two seasons despite the seasonality of demand; production along a horizontal segment of the marginal cost curve in each of the firms making X or Y throughout the year would exemplify the possibility of such a situation. Thus the slope of the budget line, such as the line AB in Figure 1, is given and constant. The set of indifference curves representative of the W-season is so placed in the consumer's preference field that the equilibrium (tangency) solution consists in a combination of a large quantity purchased of X and a small quantity purchased of Y (compare $0Q_{xw}$ and $0Q_{yw}$ in Figure 1).

Analogously, the position of the C-season indifference curves is such that, even with the relative prices of X and Y unchanged, little is bought of the former and much of the latter product (cf. $0Q_{xc}$ and $0Q_{yc}$).

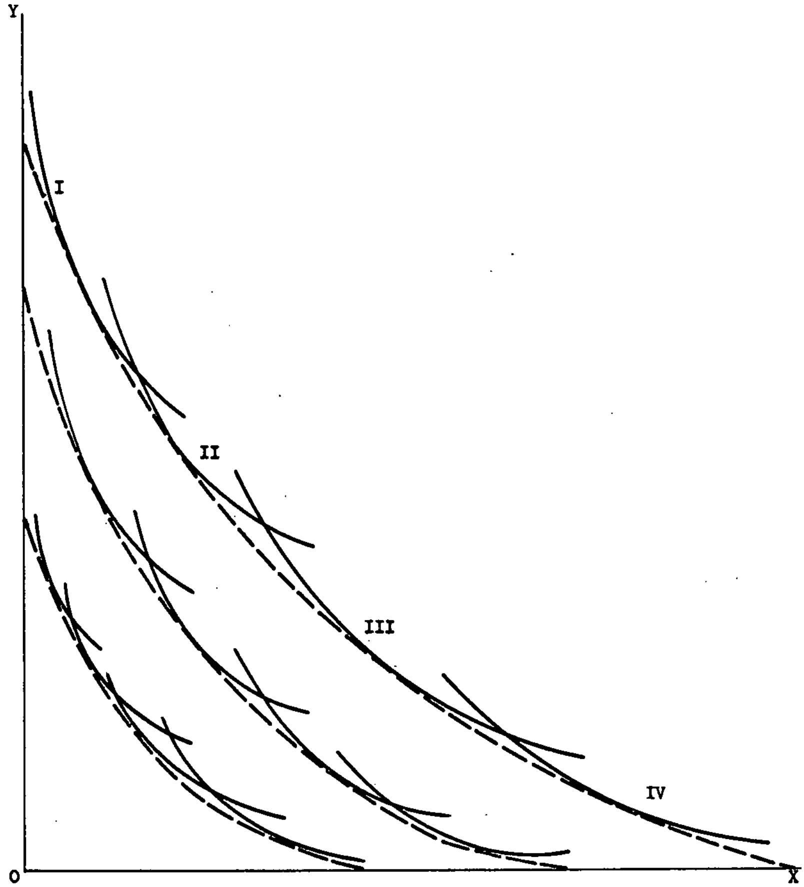
The other possibility is that of seasonal shifts in relative prices in favor of the item experiencing the slack, off-season demand. Thus let the price of X relative to the price of Y be lower in the C than in the W season. The slope of the budget line, which is equal to the price ratio px/py, would then be less in the former in the latter season, as illustrated by the lines EC^* and DW^* in Figure 1. Compared to the constant price-ratio case (applied to the same pair of seasonal indifference curves), the normal result here will be, of course, an increased quantity demanded of the off-season item and a decreased quantity demanded of the in-season item. Comparisons in time between the seasons will show a positive quantity-price correlation: more X is demanded at a higher price in W than in C (and conversely more Y is demanded at a higher price in C than in W).

In the case of a few sharply distinguished seasons, as in our two-season model, annual indifference curves are apt to be mere average constructs with little, if any, analytical significance. But if the interseasonal shifts are more frequent and continuous, the seasonal patterns may be conceived as superimposed upon a conventional indifference map representative of the consumer's preference system in longer time periods. Such a situation is illustrated in Figure 2 where the longer-term indifference curves are shown in broken, the seasonal curves in solid, lines.

For comparability with the latter, the former curves are reduced in scale, from "per annum" to "per season" units. Four seasons are distinguished explicitly, but a similar picture for a larger number of seasons with still less interseasonal discontinuity can be easily imagined. The diagram simply follows the notion, which ought to be often true, that the possibilities for substitution will be greater in the longer time periods than in the very short run.

In Figures 1 and 2 we have assumed that X and Y are good substitues over broad quantity ranges in each season. But in some cases the substitutability range may be very narrow, e.g., as short as AB or CD in Figure 3. In the extreme event of zero substitutability, X only would be demanded in the W season and Y only in the C season. The map would then consist of straight lines rising upward from, and perpendicular to, the X-axis and running to the right from, and perpendicular to, the Y-axis (such as AA, $A'A'$ . . . and CC, $C'C'$ . . . in Figure 3). Viewed from their intersection points upward and rightward, these lines form a set of angular "indifference curves" such as are known from the analysis of the relationship of perfect complementarity (see AIC, $A'I'C'$, etc., in Figure 3). But here again caution is needed lest one concentrate on annual patterns that may be spurious or misleading at the expense of seasonal patterns that have real significance. Thus whether the seasonal components of the "map" are of the initially curved sort (BIA, $B'I'A'$ . . . and DIC, $D'I'C'$ . . .) or straight lines throughout (AIA, $A'I'A'$ . . . and CIC, $C'I'C'$ . . .), the same angular patterns—AIC, etc.—are obtained in either case in the annual, two-

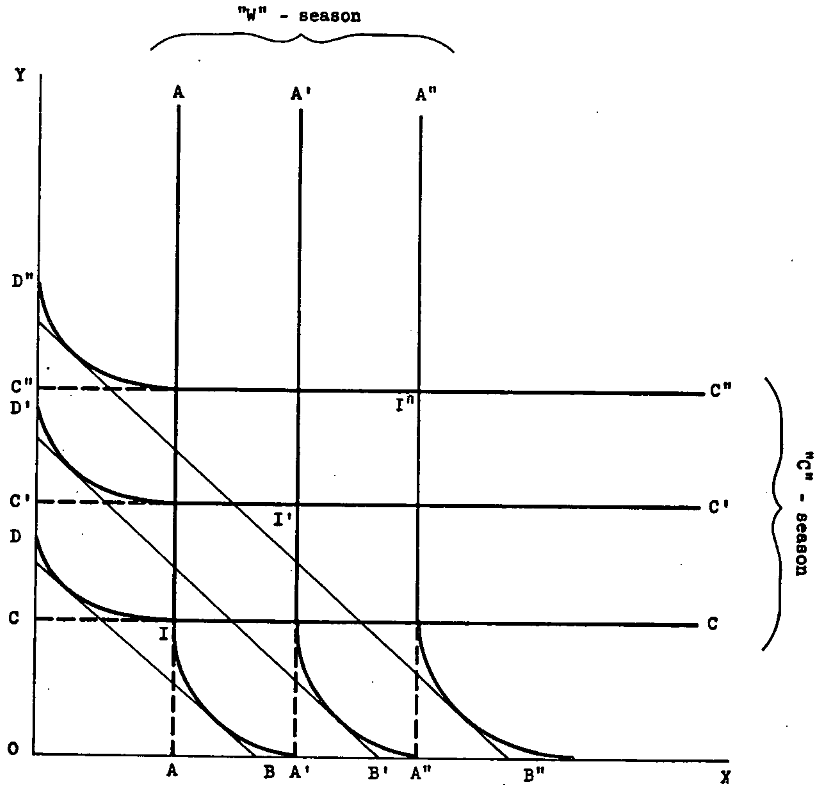
FIGURE 2



season view. But obviously the two cases are in fact quite different: the former allows some substitutions similar to those shown in Figure 1 (see the budget lines in Figure 3), while the latter allows no substitutions whatsoever.

A comment may be added here on the interpretation of the seasonal indifference maps. They formalize different patterns of consumer preferences but this type of variation does not indicate any basic changes in tastes and habits. The taste systems of individuals and families reflect, among other things, the established seasonal patterns of living, but they are not appreciably or systematically altered by the short-run and periodic changes in the natural or social environment that constitute the complex "seasonal factor." The role of the latter is thus seen as static rather than dynamic. Seasonal variation in quantities consumed merely represents a periodic variation in the means whereby people satisfy the same wants over the course of the year. The ends themselves can be viewed as definite, known, and seasonally invariant. Basically, the seasonal problem does not in-

FIGURE 3



volve either really "new" products or "new" wants. In short, the concept of the "taste system" includes a provision for the regular seasonal variation; the system itself is not regarded as changing from one season to another. (Tastes do change over time, of course, but as a rule gradually, under the influence of more enduring, long-term factors.)

Turning from analysis to index measurement, it must be noted that the model in which only quantities undergo seasonal change presents no problems for the conventional price index formulae. Table II illustrates a case where the relative valuation of the component items remain unchanged over the seasons while the quantity relations vary, so that prices and quantities are not correlated in their interseasonal movements. As shown in this example, the formulae of Laspeyres and Paasche (and thus also their "crossing," as represented by the Fisher index) give identical results here. Moreover, chaining the binary comparisons results in this case in the same time series as that obtained by the fixed-base approach. The series satisfies, among others, the proportionality test. The two methods, then, are equivalent here and either is, in terms of the traditional criteria, satisfactory.

TABLE II.—*Selected Price Index Measures for a Model with Seasonal Change in Quantities and Stable Relative Prices*

Period no.	0	1	2	3	4	5	6
Year and quarter (in parentheses)	1(I)	1(II)	1(III)	1(IV)	2(I)	2(II)	2(III)
A. ASSUMED DATA							
Item 1:							
Price (p')	3	3.6	4.8	6	Same as for periods 0, 1, 2 . . .[1]		
Quantity (q')	40	10	10	40	Do.[1]		
Item 2:							
Price (p'')	1	1.2	1.6	2	Do.[1]		
Quantity (q'')	25	50	50	25	Do.[1]		
B. INDEX NUMBERS[2]							
(a) Binary comparisons (Laspeyres, Paasche, Fisher).[3]	100.0	120.0					
		100.0	133.3				
			100.0	125.0			
				100.0	50.0		
					100.0	[4] 120.0	([5])
(b) Fixed-base indexes[3]	100.0	120,0	160.0	200.0	100.0	[4] 120.0	([5])
(c) Chain indexes[3]	100.0	120.0	160.0	200.0	100.0	[4] 120.0	([5])

[1] That is, we assume, that $p'_t=p'_{t+4}$; $q_t=q'_{t+4}$; $p''_t=p''_{t+4}$; and $q''_t=q''_{t+4}$ (using the subscript t to denote periods as numbered in the first line of the table).

[2] The formulae used in this table are the same as those used in Table I. See footnotes to Table I for identification of the formulae.

[3] The formulae of Laspeyres, Paasche, and Fisher all give the same results for this class of indexes.

[4] This index for period 5 is equal to the corresponding index for period 1.

[5] The index for period 6 is equal to the corresponding index for period 2. The general relation $P_t=P_{t+4}$ holds.

On the other hand, difficulties of the same kind as those encountered in dealing with the model in which prices and quantities are negatively correlated (the basic situation illustrated in Table I) also attach to the case of positive correlation between prices and quantities, as exemplified in Table III. In both models systematic differences obtain between the results of the formulae of Laspeyres and Paasche, but the indexes reverse their roles in the two situations. In the familiar case of Table I, the Laspeyres indexes exceed the corresponding Paasche indexes throughout, and the Laspeyres chain has an upward, and the Paasche chain a downward, drift. In Table III, the Paasche indexes are larger than the Laspeyres indexes, and it is the Paasche chain that shows an upward, and the Laspeyres chain that shows a downward, drift.

TABLE III.—*Selected Price Index Measures for a Model in Which Prices and Quantities Are Positively Correlated Over the Seasons*

Period no. / Year and quarter (in parentheses)	0 1(I)	1 1(II)	2 1(III)	3 1(IV)	4 2(I)	5 2(II)	6 2(III)
A. ASSUMED DATA							
Item 1:							
Price (p')	5	2	3	5	Same as for periods 0, 1, 2 . . . [1]		
Quantity (q')	40	10	20	40	Do.[1]		
Item 2:							
Price (p'')	4	8	6	4	Do.[1]		
Quantity (q'')	25	50	35	25	Do.[1]		
B. INDEX NUMBERS [2]							
(a) Binary comparisons:							
Laspeyres	100.0	93.3					
		100.0	78.6				
			100.0	88.9			
				100.0	100.0	(3)	
Paasche	100.0	168.0					
		100.0	84.4				
			100.0	111.1			
				100.0	100.0	(3)	
Fisher ("ideal")	100.0	125.2					
		100.0	81.4				
			100.0	99.4			
				100.0	100.0	(3)	
(b) Fixed-base indexes:							
"Laspeyres"	100.0	93.3	90.0	100.0	100.0	(3)	
"Paasche"	100.0	168.0	112.5	100.0	100.0	(3)	
"Fisher"	100.0	125.0	100.6	100.0	100.0	(3)	
(c) Chain indexes:							
Laspeyres	100.0	93.3	73.3	65.2	65.2	[4] 60.8	
Paasche	100.0	168.0	141.8	157.5	157.5	[4] 264.6	
Fisher	100.0	125.2	102.0	101.3	101.3	[4] 126.9	

[1] That is, we assume that $p'_t=p'_{t+4}$; $q'_t=q'_{t+4}$; $p''_t=p''_{t+4}$; and $q''_t=q''_{t+4}$.
[2] The formulae used in this table are the same as those used and identified in Table I.
[3] The index for period 5 is equal to the corresponding index for period 1. The general relation $P_t=P_{t+4}$ holds.
[4] These indexes for period 5 are not equal to the corresponding indexes for period 1. The relation $P_t=P_{t+4}$ does not hold.

4. AN OVERALL VIEW OF THE PROBLEM AND THE NEXT STEPS

The elements of the index number problem posed by the seasonality of consumption can now be collected. A point-by-point account reveals an analytical and statistical dilemma on each of the few levels on which some conventional solution to the problem may be sought.

1. In the United States as in other countries (with only very few partial deviations from the common practice), price indexes employ annual rather than seasonal weights. The individual component series of such indexes are price series, each of which would ordinarily reflect the seasonal variation in the given item, except in instances of seasonal discontinuity in pricing when estimates are used instead of reported price quotations. But the weights that serve to combine these series fail to reflect the seasonal variation in quantities consumed or sold. If all intra-annual quantity movements were exclusively seasonal, use of annual weights would be equivalent to the use of seasonally adjusted monthly weights. This, of course, is an extreme and very unrealistic assumption but it nevertheless helps to show that the current price indexes employing annual weights come much closer to being seasonally adjusted than unadjusted so far as quantities are concerned. These indexes, therefore, are of a hybrid

sort in this respect, since the price series of which they are composed are definitely "unadjusted." However, it can also be said that a monthly price index using strictly and exclusively annual weights cannot properly reflect the total seasonal element in the month-to-month change of the average price level precisely because it cannot take account of the existent seasonal fluctuations in quantities.

In the important case of negative price-quantity correlation over the seasons, annual weights may cause some upward bias relative to what would be obtained by application of the proper seasonal weights. For if the price of a commodity is typically lower and its volume traded larger in season than off season, then the average annual quantity weight will understate the importance of price movements during the season (when the price falls to its relatively low levels) and overstate it during the rest of the year (when the price rises to its annual peak levels). This might be regarded as a seasonal variant of the familiar upward bias of Laspeyres indexes (holding true generally in the negative-correlation model). However, such error as may be contributed by the use of annual weights is essentially restricted to monthly within-the-year values and is not expected to distort the series of annual averages; in this, it is different from the year-to-year constant-weight bias which is cumulative.[29]

2. The fixed-base, annual-weight indexes in current use assume a constant "market basket" over a period of time comprehending many seasons—several years. And all conventional price index formulae, including the chain indexes, assume a constant market basket for at least the binary comparison, such as a month-to-month or "inter-seasonal" comparison, since they are designed to measure the change in price of a given household budget supposed to represent a specific level of living. Yet the market basket is not constant from month to month and the existence of commodities that can be priced only in certain parts of the year—the "unique" goods in the seasonal context—makes this fact clear in a particularly forceful way.

3. The Laspeyres and the Paasche chain indexes also fail to satisfy the proportionality criterion which acquires importance in short-term serial comparisons precisely because of the existence of periodic seasonal fluctuations (Section 2 above). Indeed, these basic chain formulae exhibit certain systematic "drifts" over time. By using the Fisher method of crossing the two formulae, it is possible to cope rather effectively with this particular difficulty. But the exceedingly high data requirements posed by all monthly chain indexes with currently changing weights represent a very serious practical handicap.

4. The alternative to the application of varying sets of seasonal weights from year to year (the chain method) is to use a standard

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[29] Hence, assuming that the price-quantity relationships are similar in both contexts, there is no doubt that the "type bias" is more serious in its year-to-year than in its temporary, intra-annual form. Since the former error is generally tolerated in the prevailing Laspeyres-oriented practices of index making, it might seem incongruent to make an issue of the latter, noncumulative error. But this is not a very convincing argument. In this writer's view, the size of the error in either form can be only empirically determined. The year-to-year bias, if serious, should not be ignored and neither should the seasonal bias which, even though restricted in time, need not necessarily be negligibly small. Thus it is possible that the negative price-quantity correlation is often more pronounced in the seasonal than in the longer view where cyclical shifts in the demand functions become more important.

Empirical evidence bearing on the issue of the seasonal bias due to the use of annual weights is largely lacking, but some support for the argument in the text above appears in the experiments by Doris P. Rothwell, op. cit., Chart 77A, described on pp. 74–75. This chart shows an index of retail prices for fresh fruits and vegetables showing seasonal movement only and computed by the standard formula with annual weights and by the Rothwell formula with seasonal weights (see Part II, Section 5d). The curve based on the Rothwell formula runs at a significant distance below the annual-weight series during that part of the year when the price is declining and low.

base-year set of seasonal weights over a number of years—as long as the set seems sufficiently realistic. This is a sort of fixed-base approach to the problem of using seasonal weights in price index construction. Such an index presents no insuperable data requirements. Its usefulness, however, depends on how stable the seasonal weight pattern is from year to year. If the intra-annual weight distribution varies considerably over time, the use of a constant set of seasonal weights will result in errors which could possibly offset much of the advantage of having seasonal rather than annual weights.

On the theoretical level, criticism of the present approach centers on the meaning of month-to-month movements in the resulting index series. Since different sets of weights are assigned in this method to each month of the calendar year, comparisons between indexes for different months involve different quantities of the same commodities and even "unique" commodities which are found in one season but not in the other. If a formula that can produce meaningful comparisons of this kind can be devised, it would have an important advantage over the traditional price index measures, including the chain series, which cannot deal with quantitatively and qualitatively different market baskets within a binary comparison. But can such a formula be devised in an operationally as well as conceptually satisfactory way? We shall seek an answer to this question in a comprehensive and systematic survey of methods which constitutes Part II of this study. Meanwhile, let us note that the measurement of the month-to-month change, just like the measurement of the year-to-year change for the chain indexes with seasonal weights, represents the main difficulty for the fixed-base seasonal indexes using a standard set of monthly market baskets. It is already clear that the traditional price index formulae cannot offer a full solution to the seasonal problem, that is, they cannot accomplish simultaneously the following two things: (1) use changing seasonal weights within a year to do justice to the fact that market baskets vary between months (seasons), and (2) provide satisfactory comparisons between the same months of successive years when the market basket (assuming all change to be of the stable-seasonal variety) is constant.

Nevertheless, it would be rash to conclude that the situation is a complete impasse. A critical review of the various possible approaches to the seasonal problem, which is the task we assign ourselves next, should help to identify the possibilities for partial improvements in meeting the problem instead of insisting on a complete solution. It may be anticipated that the familiar types of index formulae will provide some room for such improvements. But in order to make them do so, it will be necessary at certain points to build bridges between the price indexes of the practice and the concepts of the economic theory of cost-of-living indexes. No necessity is seen to accept the contrary view—which seems distinctly unhelpful—that the differences between these two categories are unbridgeable.[30]

[30] There is, of course, nothing new about this position which was often found to be the only logical one to take by students of related index number problems. Thus M. J. Ulmer (op. cit., p. 66) says, in connection with the problem of how to treat new and disappearing goods, that "it is necessary to recall that the fixed budget priced under Laspeyres' formula must be regarded as an approximation to a bundle of goods providing a fixed real income of utility rather than a bill of goods of physically identical commodities. Indeed the very problem of environmental change with which we are dealing testifies that the goal of a physically identical bundle of goods is literally impossible as well as theoretically incorrect."

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The full treatment of the problem would require, in addition to these analytical parts, a quantitative estimation of (1) any errors involved in the present procedures; (2) the prospective size of any achievable improvement; and (3) the cost of any improvement. This is too large a program to be carried out with the data and resources available, but Part III of this study will present a considerable amount of materials bearing on some of these issues.

II. Practices and Methods of Dealing With the Seasonal Problem

1. A survey of the principal approaches

Perusal of the literature, including descriptions of various price index statistics and suggestions of new procedures, reveals a variety of ways in which problems of seasonality are or can be approached. However, it is possible to bring order into this variety and it will prove helpful to do so. Table IV presents a classification of those practices and methods available for dealing with seasonal variation in consumption that can be represented by, or used in connection with, the conventional price index formulae.[31] The few more drastic departures from the "conventional" are not included in the table, but are treated later in the text. However, the tabulation does include some procedures that are known from other applications but deserve attention for the possibility of being used in the present context, viz., the "substitution" methods (items I, 1 (c), (d), and (e) in Table IV). It also contains two recent proposals designed specifically to cope with the seasonal problem (items II, 1 (b) and (d) in Table IV).

For simplicity, Table IV includes no references to the source of any of the methods or, with respect to the methods used currently or in the past, to the index statistics in which they are or were applied. All this, as well as any other explanation that seemed necessary, is relegated to the text discussion.

The procedures listed in Table IV fall naturally into two groups, those using annual quantities and those using seasonal quantities in weights. Within either group a distinction can be made between the fixed-base and the chain indexes. Fixed-base indexes employing annual quantity figures in their value weights are of course severely restricted in their ability to make any allowances for the seasonality of consumption. Yet if they include any items that are "out-of-season," i.e., that are not traded, during any part of the year, then they must also involve some ways of dealing with such items. These ways may be merely devices to circumvent the seasonality problem but they will not avoid having some implications of their own regarding the behavior or the meaning of the index. It will be shown that these implications vary considerably depending on the nature of the device used. Of course, for a fuller recognition of seasonal variation,

[31] Table IV relies on verbal description rather than on formulae, for two reasons: (1) Formulae would fail to indicate some of the differences between the methods, since the latter may vary only with respect to their treatment of out-of-season items, a matter often considered "outside of the index formulation" (this applies, e.g., to the price indexes of the BLS). (2) Formulae differ according to the precise system of weighting chosen (e.g., Laspeyres, Paasche, etc.) but these are features that need not be specified for the purposes underlying Table IV.

TABLE IV.—*Treatment of the Seasonality Problem in Price Index Numbers: A Conspectus of Methods and Their Implications*

I. ANNUAL QUANTITIES USED IN WEIGHTS

A	B	C
1. Fixed-base indexes:		
(a), (b): Two methods of estimating price changes for the out-of-season (OS) commodities.	(a) Prices of OS items held constant in off-season period.	Seasonal variation in the market basket (SMB) effectively disregarded.
	(b) Price change for OS items assumed equal to that of related year-round items.	Some SMB implied by treatment of OS items.
(c), (d), (e): Methods of substituting items available in the given season (IS) for and transferring to them the weight of, the OS items.	In these procedures, differences in quality or utility per unit of the substitute items may be: (c) ignored, as when the new priced (IS) item is given the quantity weight of the OS item; (d) assumed to be measured by relative prices of the substitute items, as when the expenditure weight is held constant at the time substitution is made; (e) estimated on the basis of some independent quantitative criteria, e.g., caloric contents of food items.	Attempt to allow explicitly for SMB by item substitution, while holding constant the basic annual weights allotted to certain groups or types of commodities.
2. Chain indexes with annual base period quantities used in weights.	Price change for OS items from the end of one pricing season to the beginning of the next is not reflected in the index.	Attempts to allow explicitly for SMB by linking in and out the seasonal items.

II. SEASONAL QUANTITIES USED IN WEIGHTS

A	B & C	D
1. Fixed-base indexes:	Seasonal quantities are used throughout. Hence, out-of-season items are eliminated from the indexes for the times of the year when they disappear from the market, and the seasonal variation in the market basket is reflected in the indexes.	
(a) Prices for a given month (season) compared with those of same month of the base year. Quantities of the latter period used in both numerator and denominator of the index.		Month-to-month change in this index is of questionable meaning (it is equal to the ratio of cost of the market baskets in given and previous month of the current year, divided by a corresp. ratio for the base year).
(b) Similar to (a) but cumulative: indexes for January, Jan.–Feb., first quarter, etc., are obtained to measure, within any year, the change in the cumulating influence of the seasons. Basic index annual.		No monthly index is provided by (b).
(c) Prices for a given month and quantities for the same month of the base year used in numerator; expenditures in base year used in denominator of the index.		Month-to-month change in (c) is simply the current ratio of cost of the market baskets.
(d) Prices for a given month and quantities for same month of the base year used in numerator; base period annual average prices and same quantities (i.e., those for the proper month of the base year) used in the denominator of the index.		Month-to-month change in (d) is the current cost ratio divided by a seasonal quantity index.
2. Chain indexes with seasonal base period quantities used in weights.	Seasonal items are linked in and out as they appear and disappear from the market. Index reflects seasonal variation in the market basket.	Year-to-year changes in these indexes give unrealistic results (cf. the proportionality test and drift arguments in text).

Key: A—General description of the indexes and procedures.
B—Method of handling the out-of-season (OS) items.
C—The implications or effects of the method with regard to the seasonal variation in the market basket (SMB).
D—The implications of the method with regard to the measurement of month-to-month or year-to-year changes in price levels.

weights appropriate to the compared seasons must be used, and Part II of the table identifies a number of methods employing such weights.

The individual practices and methods summarized in Table IV will now be discussed in a series of critical appraisals. We begin with two procedures used in the principal U.S. price index series and represented by the first two entries in Table IV (items I, 1(a) and (b)).

2. CURRENTLY PREVALENT PRACTICES

a. *Holding Out-of-Season Items Constant.*—Prior to January 1953 the procedure adopted by the Bureau of Labor Statistics with respect to goods which are not sold in certain months of the year (or for which prices are not available at certain seasons even though some trade in them does take place) was to carry such items during these "off-season" periods at the same prices at which they have last been reported. The price change during the off-season months was thus assumed to be zero for any such item; the price was held constant until a new quotation became available in the next season. At this first pricing of a season, the full price change for the given item from the end of the previous season was reflected in the current month's relative and index. The basic nature of the BLS indexes (Laspeyres' fixed base, in our notation $P^L_{0j} = \Sigma p_j q_0 / \Sigma p_0 q_0$) was not affected by the above procedure. Since 1953, the BLS partially discontinued this practice in favor of an imputation method which will be described in the next section (b) of this review. But the procedure of holding out-of-season items constant is still followed by the Agricultural Marketing Service (AMS) in all instances of effective seasonal disappearances among the prices received and paid by farmers.

The argument in favor of this procedure is that it does not pretend to do anything that an index using annual quantity weights is not designed to do. Such an index, it may be argued, cannot properly take account of the effects of the seasonal variation in consumption. Efforts to allow for such effects nevertheless, which must resort to some technical devices that would let some of the seasonal elements "slip in through the back door," can at best have only partial success and may be seriously misguided. Hence the best way, if an annual-weight index is used, is to make minimum assumptions in regard to the out-of-season items (which must be dealt with somehow) and to avoid steps which would influence the behavior of the total index in any major or systematic fashion.

Incidentally, the specific difficulty posed by the out-of-season commodities would, of course, be completely avoided if such items were altogether omitted from the market basket; and indeed the practice of excluding them was followed frequently by index makers in various countries, particularly before World War II.[32] However, such omissions obviously reduce the representativeness of an index to an extent which varies for different index measurements but seems in general large enough to be disturbing.

The strongest criticism that has been leveled against the "constant-off-season-price" estimation procedure asserts that the method introduces into the index fictitious prices. The price attributed to an item

[32] Cf. International Labour Office, "Cost-of-Living Statistics, Methods and Techniques for the Post-War Period," report prepared for the Sixth International Conference of Labour Statisticians (Montreal, 4–12 Aug., 1947), ILO Studies and Reports, new series, no. 7, part 4, Geneva, 1947.

included in the index (but not actually traded) in, say, June (e.g., a winter overcoat or leather jacket) may in fact be a February or March quotation.[33]

The charge is harsh but it is only partially true. If the price in June is nonexistent or unknown or entirely unrepresentative and thus unusable, then, given the concept of an index which requires that some price be used for each component of the (unchanged) market basket, there is no escape from estimation of some sort which may be viewed as containing elements of fictitiousness. But keeping its off-season price constant serves to hold down to the minimum the contribution of the given item to the change in the index as a whole. In fact, the method makes this contribution nil in the off-season estimation period and so the question here is really whether this does not overstate temporarily the stability of the index. The answer to this question, however, depends on the prevalent direction of change in prices of possible substitutes for the passive off-season items, which in turn is likely to depend on the general price movement in the given period.

The issue actually gave rise to a complaint about the practical implication of the "constant off-season-price" method. In Congressional hearings conducted under the fresh impact of the strong inflationary movement during the first year of the Korean War, a labor representative pointed out that "in periods of generally rising prices this practice introduces a downward bias into the index. The weight of the seasonal items carried at constant prices exercises a dragging effect on the index so that it does not adequately reflect the rise in prices which is taking place on items being purchased. This downward bias is accentuated by the fact that seasonal merchandise is frequently sold at abnormally low prices at the end of the season. Consequently the constant price at which such goods are carried in the index during the off-season is unrepresentative of the price generally paid by workers during the previous seasons."[34]

Seven years earlier, the Mitchell Committee report of 1944 expressed the belief that "the use of uniform weights for all seasons has tended to cause a downward bias in the index during the past few years." But it continued with the comment that "The introduction of seasonal weights might not be worth the trouble they would involve. . . ."[35]

Again, however, a warning is in order not to overestimate the importance of this point. The just noted "bias" of the index due to the practice of holding the off-season prices constant should be recognized as (a) dependent on the general price movements (if the error is in a downward direction during inflations, it is also in an upward direc-

[33] For a categorical criticism of this type, see Bruce D. Mudgett, "The Measurement of Seasonal Movements in Price and Quantity Indexes," *Journal of the American Statistical Association,* March 1955, p. 93. Mudgett also stresses the inappropriateness of annual weights in the same connection. The argument that weights involving annual quantities do not measure the importance of the index components in the successive seasons is of course right, but we must remember that it applies to annual indexes generally and not specifically to the estimation method now under discussion.

[34] Consumers' Price Index, *Hearings before a Subcommittee of the Committee on Education and Labor,* House of Representatives, 82nd Congress, 1st Session, Statements appended to testimony by Solomon Barkin on behalf of the CIO, U.S. Government Printing Office, Washington 1951, p. 261.

[35] Office of Economic Stabilization, *Report of the President's Committee on the Cost of Living, Appended Report IV* (an appraisal of the BLS index of the cost of living by a committee consisting of W. C. Mitchell, chairman, S. Kuznets, and M. G. Reid, June 15, 1944), U.S. Government Printing Office, 1945, p. 289. The statement quoted at the end of the paragraph in text appears to reflect merely a general impression of the committee; according to our information, no empirical study of the dimensions of the seasonal problem has been undertaken for the 1944 Mitchell report.

tion during deflations); (b) transitory in either case, since the record for any of the affected commodities will always be "rectified" at the first pricing of the given item in its new season. Moreover, this is a procedural effect attributable only to the "seasonal disappearances" which are diffused and not so numerous. Hence any error due to it is likely to be small and overshadowed by other larger and more systematic errors (including the intra-annual upward bias due to the use of annual rather than seasonal quantity weights, which is independent of the direction of the general price-level movement; cf. Part I, Section 4 above).

When the item that has vanished for its off-season period returns to the market, the actual price quotation for it is introduced and the series may undergo a sudden and abrupt shift upward or downward (more likely upward, since in the first month of the new season many items are still scarce and have high prices which then rapidly decline). But this difficulty is shared by the present procedure with its alternative to be discussed next.

b. *Imputing Out-of-Season Items to the Group.*—The current method used in the Consumer Price Index since its revision in 1953 is to assume that the price change for each out-of-season item in a commodity group is equal to the average monthly change in prices of the in-season components of the group (or, in some cases, of its year-round components). For example, the price change for strawberries or peaches from one winter month to another is taken to equal the average price change, in the same monthly interval, of all "fresh fruits" then available. Thus the change of all priced items in the group serves as a basis for estimation of the prices of items out of season. At the first reported pricing of the new season, however, the price change for any item that has just prior to that been so estimated is computed from the end of its previous pricing season. The weight applied to this price change is then also the corresponding end-of-season value. By this means a correction of the previous (off-season) months' estimates is taken and reflected in the current month's index.

An index maker who aims at measuring simply price changes in constant market baskets will describe this procedure as just another "practical solution"—a device to handle the problem of out-of-season commodities within the framework of an index using constant annual quantity weights. This way of viewing it is, of course, perfectly legitimate. However, it is possible to see behind this practical method a principle which can be given an interpretation that is less technical and more economic, less formal and more substantial.

To explain, suppose the rule is adopted that items which fall out of season cease to enter into the calculations but that their (annual quantity) weight is distributed proportionately over the remaining items within the group. It is easy to show that the results thus obtained are the same as those of the imputation procedure described before.[36] These then are two equivalent interpretations of one and the same method. But the second interpretation makes it particularly clear that, while the total weight carried by the group containing the seasonal items remains constant throughout the year, the number of items priced within that group and consequently their effective weights undergo a certain amount of intra-annual variation. When an item such as strawberries becomes unavailable or at least very scarce and

See footnote 36 on p. 261.

expensive, other commodities, say all the fresh fruits not in short supply, are substituted for it. If an intragroup substitution relationship of this kind were empirically established, this would provide a strong rationale for the method in question.[37]

Under the straightforward interpretation of the present procedure as "imputation," there is not much that can be said about it in the way of a general critique. However, if an out-of-season commodity does not disappear completely from the market, yet its price is not available, this should as a rule indicate a pronounced shortage of the given item. The average price change for goods belonging to the same group but available in normal supplies would presumably be a poor indicator of the price change for a good in such short supply. But then to include an item at its very high off season price and its average annual quantity weight (rather than at its much smaller off-season weight) would probably amount to an even worse distortion, which we would certainly wish to avoid. All of which, of course, merely illustrates the basic inadequacy of constant annual weights for combining price changes at different seasons.

This method, too, will often result in large and abrupt price changes at the beginning of a new season when a transition is made from the imputed price to the actual quotation for the "reappearing" item (see Part III, Section 6a below for some numerical illustrations). To be sure, difficulties on this point of transition are unavoidable, since the true situation here involves the presence of "unique" goods which, as was shown before, cannot be handled by any of the customary price index techniques.

If the interpretation of the method as an intragroup "weight-transfer" or substitution is adopted and the assumption of a complete temporary disappearance of the out-of-season items is made, then the

[36] Consider the following illustrative data:

	Annual quantity weight	Prices in period	
		"1"	"2"
Year round items:			
A	45	5	7
B	30	3	4
Seasonal item: *S*	25	6	0

The price index for *A* and *B* is $P^L_{A,B}=\frac{7(45)+4(30)}{5(45)+3(30)}\times 100=138.1$

The price index for *A*, *B*, and *S*, according to the "first interpretation", is

$$P^L_{A,B,S}=\frac{7(45)+4(30)+6(25)P^L_{A,B}}{5(45)+3(30)+6(25)}\times 100=P^L_{A,B}=138.1$$

$$\left(\text{In general: If } P^L_{A,B}=\frac{a}{b},\text{ then } P^L_{A,B,S}=\frac{a+\frac{a}{b}c}{b+c}=\frac{a}{b}\right)$$

According to the "second interpretation," *S* disappears from the index for period "2" since its quantity and price are then both zero, and the weights of *A* and *B* become, respectively, $45+\left(\frac{45}{45+30}\right)25=60$ and $30+\left(\frac{30}{45+30}\right)25=40$

The index calculation is now:

$$\frac{7(60)+4(40)}{5(60)+3(40)}=P^L_{A,B}=P^L_{A,B,S}=138.1$$

[37] To be sure, the method has not in fact been given any such basis. The index maker did not seek to do this; moreover, if he did, he would have come up with some other combination of substitutes closer to reality, since the simple intragroup relation implied is not really plausible.

analytical situation is in principle clearer. Ideally, one would want to find one or more (i.e., a combination of) perfect substitutes for any item that drops out and transfer to them the weight of the item, taking proper account of the relative amounts of "utility" or service provided per unit of the substitute commodities. It is obvious that this is merely a conceptual standard of perfection which cannot even be closely approximated in practice, let alone attained. Substitutes are virtually always more or less imperfect, and the degree of substitutability eludes measurement. Even so, a careful, explicit attempt to use selected plausible combinations of substitutes would not be unlikely to lead to an appreciable improvement over an implicit substitution procedure via weight transfer within a single narrowly defined group. Thus, the current BLS practice of imputation uses only fresh fruits as, in effect, a group of substitutes for each of the seasonal fruits such as grapes or watermelons (there are five such items in the CPI). But there is no reason why canned and frozen fruits should be excluded from the role of substitutes for seasonal fresh fruits, where one would expect them to be, on the contrary, quite important.[38]

3. METHODS OF SEASONAL SUBSTITUTION

Seasonal changes in the composition by commodities of the market basket can to some extent be handled explicitly even within the rigid structure of a fixed-base index using annual quantity weights. Common to the methods that fall under this heading is the central idea of seasonal substitution, which has already been introduced in the preceding section's discussion of the weight-transfer procedure.[39]

a. *Direct Replacement of One Price Series by Another.*—In this approach, which in Table IV is listed under the category I, 1 as item (c), the current month's price of a new article B is directly compared with the previous month's price of the article A that is being replaced. The quantity allotted to B is the same as that previously allotted to A.

[38] For evidence supporting this expectation, see Part II, Section 4 below. The above suggestion concerning canned fruits has a counterpart in the practice currently adopted in Britain for the new Index of Retail Prices of the Ministry of Labour and National Service, which replaced a postwar "interim" index as from January 1956 (except that there the substitutes are fresh and canned vegetables; the same role was proposed for fruits, but presently the British index includes no fruits that are not priced throughout the year). Cf. Great Britain, Ministry of Labour and National Service: (1) Cost of Living Advisory Committee, "Report on the Working of the Interim Index of Retail Prices," Cmd. 8481 (March 1952), p. 31, § 78; (2) "Method of Construction and Calculation of the Index of Retail Prices," Studies in Official Statistics: No. 6, London, H. M. Stationery Office, 1956, pp. 13–14.

It may be noted that otherwise the U.K. practice with respect to the out-of-season commodities is in effect the same as that currently used in the U.S. Consumer Price Index. While the U.S. method is interpreted as an "imputation," the U.K. method is interpreted as a "weight transfer," but as we have seen these are two readings of the same procedure. The official description of the British procedure (see ref. 2 above) is cast in technical terms and does not refer to any theoretical considerations regarding substitution between the seasonal and the year-round commodities. It does point out that some intra-annual variation in "effective weights" results from the application of the method, but stresses that the latter is designed as a practical device for "adhering as closely as possible" to the conception of pricing a fixed market basket during periods of temporary unavailability of some of the items included in the index. This position is analogous to that taken by the U.S. index makers.

[39] Substitutions are used in price index measurements primarily in connection with changes in the quality of goods produced and consumed at different times. The methods discussed in this section have all been so employed, in either some regularly published or some proposed index series. Although the seasonal problem differs from the quality problem in several respects, the two do have certain features in common and it will be instructive to review these methods with reference to their applicability to the issue of seasonal variation in the market basket.

The two are simply treated as if they were one and the same item; any differences between them in quality or "utility" are disregarded. The ratio p_2^B/p_1^A measures the price development at the time of the substitution assumed to occur between the periods 1 and 2.

The method is used by the BLS only for substitutions within narrowly defined specification ranges. A less restricted form of employing it, with rather different implications, would consist in direct comparisons of the *average prices* of a number of varieties of a product; this is a procedure designed to handle changes in the available assortment of such varieties, which often reflect changes in the product's quality.[40] But it is clear that, even in its most relaxed form, this method is largely inadequate in the seasonal context, since the goods substituted for each other because of seasonal changes in the demand and/or supply conditions differ in various ways, and the differences between them are as a rule too large to be neglected. We know of only one instance in which a variant of this method is applied to a seasonality problem, namely, the case of tobacco in the Index of Prices Received by Farmers. There an average price is computed each month for the types of tobacco that are actively being sold and the most recent season average for types not currently sold.

b. *Price Ratios as Measures of Relative Utilities.*—In this approach, price relatives, p_2^A/p_1^A and p_3^B/p_2^B, are used as measures of price change from period 1 to 2 and from 2 to 3, respectively, and their product is the measure of the price development between the periods 1 and 3. This method presupposes that *A* and *B* are available for sale and priced simultaneously at least during one unit period. The technical consideration behind it is that the movement of the index in either the 1–2 or the 2–3 interval will not reflect any differential in price that is due to differences in quality between the two articles, only the price change proper in either *A* or *B*. But this, while pertinent, is clearly not a sufficient argument in favor of the method. The shift from *A* to *B* is not a mere technicality and it will hardly fail to influence the behavior of the index.[41] The really important consideration, then, is what is used to replace what and when.

The method implies that at the time the substitution is made the consumer spends the same sum of money on *B* that he or she used to spend on *A*. The consumer may be presumed to derive equal utility per dollar from either purchase. This means that the relation between the qualities of the substitute goods is taken to be measured

[40] The price development would here be measured by a ratio of the form p_2/p_1, where the bars refer to the averaging operations and the superscripts to the combinations of the varieties included. (For example, p''_2 may be the average in period 2 of prices of *A*, *B*, *C*, and *E*; p'_1 the average in period 1 of prices of *A*, *B*, *C*, and *D*.) The procedure may work well with regard to certain product categories for which optimum specification ranges can be found. These should be broad enough to include all varieties of the product that are close substitutes in terms of the pertinent quality standards. If there are enough such varieties, the number and quality of price quotations for them may be adequate to yield stable and representative averages to be used in the calculation of the price relatives. But such favorable situations are probably not very frequent even in the content of quality changes for which the method has been considered. The specification ranges may be too narrow to provide useful averages; or it may prove impossible to restrict them properly without application of more refined methods because of their multidimensional nature (cf. Andrew T. Court, "Hedonic Price Indexes With Automotive Examples," *The Dynamics of Automobile Demand,* General Motors Corporation, New York, 1939, pp. 103–105).

[41] Suppose that *A* is still available for pricing in periods 3, 4, etc., then the index would presumably move differently if it continued to carry the old article instead of the new item *B*; and its behavior would be different again if the substitute were *C* rather than *B*.

by the ratio of their prices. If *B* has *g* times the quality of *A*, then implicitly the quality ratio *g* is assumed to equal p_2^B/p_2^A.[42]

It is of course an elementary proposition of the demand theory that the equality of the corresponding price ratios and marginal utility ratios, or marginal rates of substitution, defines the maximum (equilibrium) position of the consumer. This makes the present approach, which implies that the price ratios tend to reflect the *g*-values (taken to express the "relative qualities" of the substitute goods as seen by the consumer), highly appealing on *a priori* grounds in all those situations in which consumer choice can be viewed as generally free and informed and in which the market mechanism can be assumed to enforce the necessary adjustments of relative prices at some time during the transition from one variety or set of items to another. By the same token, where the above conditions are *not* fulfilled, the method lacks its theoretical basis. This is clearly the case when the transition from one product to another is sudden rather than successive, decreed by authorities or imposed on households by some external factors rather than due to voluntary actions of consumers under market influences.

A few factors can be listed in favor of applying this method (listed as item I, 1(d) in Table IV) to the seasonal problem. Transition to other products from items that have become seasonally scarce is as a rule gradual; seasonal goods do not disappear from and reappear on the markets overnight but rather their availability decreases or increases successively over a number of weeks or a few months at certain times of the year. Substitutions due to seasonal change are expected and essentially "voluntary." The element of the new and as yet unfamiliar, which is often a complicating factor in the quality context, is here negligible.

On the negative side, it is not so much any inherent unfavorable features of the problem that stand out as a likely source of difficulties but rather certain technical limitations of the method in its practical use. It is natural to think of the present method as applicable primarily to *paired* substitutes. But in the approach to the seasonal problem, as in many other applications, restricting the substitution to two commodities at a time strikes one as artificial and scarcely satisfactory. Relatively few goods have single specific substitutes; most by far have several or many partial substitutes which, moreover, need not be restricted to any easily defined commodity group. Thus decreased consumption of strawberries in the winter may be replaced by increased consumption of, say, pudding or jellies as well as of apples or bananas.

In principle, the situation can be dealt with by forming groups of related goods and making the substitutions within such groups; in practice, to be sure, this task would be far from easy. However, if we can judge it from the present contents of the principal U.S. indexes, the items that effectively disappear from the market at certain seasons

[42] As applied to quality changes, this procedure will usually not directly affect the level of the index. In practice, prices of strictly specified articles are not frequently changed; rather such price variation as occurs here typically accompanies the introduction of a new brand, make, or model of the product. The above method will then amount in effect to a multiplication of two price relatives which, however different their components, are each equal to one (i.e., since $p_1^A = p_2^A$ and $p_2^B = p_3^B$, $p_2^A/p_1^A \times p_3^B/p_2^B = 1$). Thus Hofsten (op. cit., pp. 49 ff.) treats this method as if it always gave an index equal to unity. In connection with seasonality problems, however, it is well to remember that either or both price relatives involved may differ from one and so may, consequently, the result of this substitution procedure.

are not very numerous or complex, so that specific substitution schemes to deal with the special problem of these disappearances might prove practical. In fact, the imputation procedure currently used by the BLS (item I, 1(b) in Table IV discussed in Section 2b above) has all the formal characteristics of the group substitution method just referred to. It does, however, differ from that method in one material respect: as was argued before, the BLS device is "substitution" more by implication than by design. A full-scale attempt to apply the present method explicitly would have to involve careful studies designed to determine (1) in what areas of the index groups of related items should be distinguished for purposes of seasonal substitution; (2) what items should be included in any such group, so as to minimize the intergroup dependence and substitution; and (3) what is the optimal timing for any substitution to be made.[43]

c. *Independent Estimation of Relative Utilities.*—It has been suggested that criteria other than relative prices be applied to comparisons of the substitute goods. In this view, the previously introduced "quality ratio" g should be measured "objectively" on the basis of the serviceability of the goods in question, leaving out of consideration "factors which are not of real utility."[44] But it is clear that for many products "quality" as a sum of objective properties of a given article, as distinct from its subjective valuation, is not a very pertinent concept so far as our problem is concerned. For example, caloric content measures are available for foods, but any food item has properties other than caloric content that are important to consumers and hence cannot be disregarded. Quality itself is usually a composite, and so it might be argued that the solution lies in taking proper account of all of its essential elements rather than selecting arbitrarily one, such as, for a food product, its caloric value. But the basic difficulty here is not so much with the *number* of the relevant characteristics of a given good as with their *nature*. It is likely that closer relationships will be found between the prices and the objective quality characteristics for certain complex items of machinery than for many simple food or apparel products, simply because, in the evaluation of the former, objective measurable properties play a decisive role while, in the evaluation of the latter, individual subjective taste factors are particularly important. Now for those products with close and stable price-quality relations the problem of dealing "objectively" with quality differences is, of course, in principle manageable, even though it may be in practice highly complex because of its multidimensionality.[45] But as it happens, few of the seasonal goods seem to belong to this category and many to the other one that does not favor the "objective" approach. The usefulness of the latter in regard to seasonal substitutions is therefore believed to be very limited.

[43] Certain simple rules could be tentatively adopted in these empirical inquiries. For example, dovetailing consumption seasonals might be taken as *prima facie* evidence of a significant seasonal substitution. Months of extremely low consumption may be excluded or at least avoided in the selection of the proper timing for the linking-in operations.

[44] E. v. Hofsten, op. cit., p. 120. It may be noted that some of these arguments (Hofsten's approach is a good example) seem to be based on questionable generalizations which lack firm analytical support: views that the commodity world has grown so complex that consumers can have no adequate knowledge of "articles for sale," that advertising often persuades the public to buy goods that will fail to give them the satisfaction which they expected, etc. If the consumer is not irrational or ignorant, then he is the best arbiter of the values to himself of the commodities or services acquired; if he is, then how is anyone else to tell what the "true" values for him are?

[45] An ingenious approach to this problem was suggested in 1939 by Andrew T. Court, op. cit.

An interesting example of a "quality" adjustment that is being made in the seasonal field is offered by the new British Index of Retail Prices. In this index, the difference in price between new potatoes and old potatoes (from the previous year's crop) is considered to reflect in a certain degree a change to a higher-quality article. To allow for this change, 5½ lb. of new potatoes are taken as equivalent to 7 lb. of old potatoes in July. In mid-August the ratio used is 6 : 7, and in mid-September 6½ : 7; thereafter no further adjustment is made.[46] The decline in the ratio apparently reflects the fact that as the season progresses the "newness" of the current year's potatoes wears off: they become more plentiful and less expensive relative to the old crop which they soon replace. Thus the adjustment is not based merely on objective quality differentials, which remain constant during the transition period, although the official description of the index stresses the fact that new potatoes generally involve less wastage and possess a higher nutritive value than old ones. Rather, the procedure has the merit of taking into account, to some extent, the changing market positions of the two items.

4. CHAIN INDEXES WITH ANNUAL BASE PERIOD QUANTITIES IN WEIGHTS

No conventional index formula employing basically *annual* weights can be really satisfactory in dealing with the seasonal problem. This applies also to the "chain method" insofar as the latter retains base period weights (item I, 2 in Table IV). This is not a "true" chain because it is based on fixed period weights rather than on changing weights for the months being compared. It is, however, not identical with the corresponding index series calculated by the fixed-base method because we conceive this chain as being confined to items common to the two successive months being compared, so that the price change for out-of-season items from the end of one pricing season to the beginning of the next one would not be reflected in the index. But if seasonal disappearances occur, then this principle is sure to introduce such differences between the successive links of the chain as to make the chain series diverge from the corresponding fixed-base series. In this case, our chain index will fail the proportionality test just as any true chain index would, and, as shown in Part I, this is a serious weakness as far as the seasonal problem is concerned; and at the same time we will not even have the advantage that a full-fledged chain index would give us, for we will not have utilized all the information on the weights for the successive months or seasons. Hence no gain is seen in this rather halfhearted use of the chain method.

5. FIXED-BASE INDEXES WITH SEASONAL QUANTITIES USED IN WEIGHTS

It is natural to seek a more complete and satisfactory solution to the seasonal problem by devising methods involving seasonal weights and working out their implications. There is of course no difficulty in measuring the average price change between the same months of successive years, if a month is our unit "season," and if a constant seasonal market basket can be used, for traditional methods of price index construction can be applied in such comparisons. For each month of the year, a list of commodities representative of consumption in the given month would have to be made up, specifying the quantities

[46] For more detail, see pp. 12–13 in the Ministry of Labour 1956 pamphlet cited in footnote 38.

purchased of each item. The resulting 12 seasonal market baskets for the Januaries (J), Februaries (F), etc., may be represented by as many column vectors of quantities $\{Q\}_J$, $\{Q\}_F$, . . . Q_D. The current dollar value of, say, $\{Q\}_J$ in the "first" year (to be denoted by the subscript 1) would be $[P]_{J1}\{Q\}_J$, where $[P]_{J1}$ is a row vector of appropriately dated prices of items included in the January market basket. The expression for the year-to-year change (say, between the Januaries of years "1" and "2") can now be written in two equivalent forms, first using the simpler vector notation and then using the traditional notation, to read

$$\frac{[P]_{J2}\{Q\}_J}{[P]_{J1}\{Q\}_J} \text{ and } \frac{\Sigma p_{J2}q_J}{\Sigma p_{J1}q_J}=\frac{\Sigma \frac{p_{J2}}{p_{J1}} p_{J1}q_J}{\Sigma p_{J1}q_J}.$$

This is in itself a satisfactory formula for a "binary comparison" on a seasonal basis, judging by standards of the classical or orthodox price index theory, which are widely accepted in index making. The basis for the seasonal quantities could be changed, if it were so desired, to satisfy a Paasche-type or some other formula. While all this is simple enough, the real difficulty that must now be faced is how to construct an index on the base period which would (a) be consistent with the above form for year-to-year comparisons and (b) imply also an acceptable measure of the average price change from month to month. It will be shown that these requirements cannot be easily or completely satisfied.

a. *Comparisons with Same Month of the Base Year.*—The procedure that suggests itself most readily is to compare the prices for a given month with those for the same month of the base year, using quantities for the latter period in weights (see item II, 1(a) in Table IV). Let us use the subscript j to denote a given month of the year and the subscripts 1,2, . . . to denote the years 1,2. . . . Using 0 to identify the base year, the index on the base period for the month j of, say, year 2 is then

$$\frac{[P]_{j2}\{Q\}_{j0}}{[P]_{j0}\{Q\}_{j0}} \text{ or } \frac{\Sigma p_{j2}q_{j0}}{\Sigma p_{j0}q_{j0}}=\frac{\Sigma \frac{p_{j2}}{p_{j0}} p_{j0}q_{j0}}{\Sigma p_{j0}q_{j0}}.$$

This formula differs from that given previously for the year-to-year comparison only in that the price vector in the denominator refers now, not to the same-month year-ago period, but to the same-month-of-the-base-year period. (The subscripts of the quantity terms are here $j0$ because the base period and the weight period are taken to coincide; they would also apply to the previous formula under the same construction.)

By dividing the above index number into that for the next month, the measure of the month-to-month change implicit in the present formula is shown to be

$$\frac{[P]_{j+1,2}\{Q\}_{j+1,0}}{[P]_{j+1,0}\{Q\}_{j+1,0}} \div \frac{[P]_{j2}\{Q\}_{j0}}{[P]_{j0}\{Q\}_{j0}}=\frac{[P]_{j+1,2}\{Q\}_{j+1,0}}{[P]_{j2}\{Q\}_{j0}} \div \frac{[P]_{j+1,0}\{Q\}_{j+1,0}}{[P]_{j0}\{Q\}_{j0}}.$$

This result, especially in its second form, has a meaning that can be verbalized. But this meaning is not simple; the formula does not represent a direct measure of the average price change between the two months, and translating it into words cannot, of course, change this fact. What the formula offers is really a comparison of two cost ratios: (1) the ratio of the cost of the market basket assigned to month $(j+1)$ at current prices to the cost of the market basket assigned to month j at last month's prices, and (2) the ratio of the expenditures in month $(j+1)$ of the base year to expenditures in month j of that year (i.e., the original cost ratio for the two baskets).

b. *A Cumulative Within-the-Year Index.*[47] In his 1955 article in the J.A.S.A. (see reference in footnote 33) B. D. Mudgett proposed an index using seasonal weights which would differ from the formula just discussed essentially in that it would employ a process of intra-annual cumulation of the monthly value aggregates. In Mudgett's notation, the index on the base period (year 0) for, say, February of some given year i reads

$$P_{0 \cdot i2} = \frac{\sum_{j=1}^{2} \sum_{t=1}^{N_{aj}} p_{ij} q_j}{\sum_{j=1}^{2} \sum_{t=1}^{N_{aj}} p_0 q_j}$$

where j (months)$=1,2, \ldots 12$; t (commodities)$=1,2, \ldots N$; N_{aj}=number of commodities in list for month j of the weight year a; P_0=base year average price of commodity t.

This index, unlike the previous one, uses in its denominator the average annual prices, rather than the seasonal prices, of the base year. Assuming again, for simplicity, that the weights of the base year are used $(a=0)$, the only other difference between the two indexes results from Mudgett's use of the cumulation device, which is a specific feature of his formula. Thus, from February of any year on, the formula refers, not to a single month, but to periods of 2, 3, . . . 12 months. The cumulated values are the products of our P and Q vectors for the successive months within each year.

It is easily seen that in Mudgett's formula the December index for any year, as an end result of the intra-annual cumulation process, is identical with the given year's index. The yearly index is the basic index and is of the conventional sort; in the expository formulae of Mudgett's paper it is presented as a fixed-weight aggregative but, as noted by the author, it could be easily rewritten to give the formula of Laspeyres or Paasche, etc. Neither would the question of whether to use a fixed-base index or a chain of annual indexes be prejudged by Mudgett's method of dealing with the monthly changes.

Mudgett claims that his monthly within-the-year indexes "can give an accurate measure of the cumulative influences of price change . . . throughout the months of the year, compared to the corresponding months of the year chosen as base; and this is done with the complete realism that is associated with the disappearance of some commodities

[47] Listed as item II, 1(b) in Table IV.

at some seasons and their reappearance at others."[48] But his method has neither a better nor a worse claim of this sort than has the simpler method described in the preceding subsection (a), except that here the word "cumulative" is in order and there it is not. Actually, neither method provides us with a monthly price index proper. If anything, the meaning of the monthly change in Mudgett's index (evaluated as usual in terms of the ratio of two adjoining index numbers, $P_{0.i,j} \div P_{0.i,j-1}$) seems to be less clear than the meaning of the corresponding measure for the other index. This is due to the cumulation procedure adopted by Mudgett, which does anything but help in the already difficult task of interpreting monthly changes in an index with monthly varying market baskets and weights. It is true that this procedure has its own rationale in that it establishes a link between the monthly index numbers, which are treated as subsidiary, and the annual index, which is regarded as being of central importance. But while some link between the monthly and the annual indexes is certainly necessary, it is not at all obvious that it must have this particular form, i.e., that cumulation cannot be avoided and a more regular time series of monthly price indexes with seasonal weights cannot be constructed. And since monthly measures of average price change, if reasonably satisfactory, can be really useful and are undoubtedly an object of public demand, a proposal that does not provide for such measures is definitely at a disadvantage vis-à-vis others that would improve them.

c. *An Index of Seasonal Variation in Expenditure.* The Canadian Consumer Price Index, 1949 to date, which was introduced in 1952 to replace the old Cost-of-Living Index, uses a particular formula with seasonal weights for a subgroup of food items (item II,1(c) in Table IV).[49] Let P_{ji} be the seasonal food index for month j of year i; year 0 be the base and weight period, and N be the number of commodities (t) on the list for the period indicated by a subscript. Then the formula is

$$P_{ji} = \frac{\sum_{t=1}^{N_{ji}} p_{ji} q_{j0}}{\frac{1}{12} \sum_{j=1}^{12} \sum_{t=1}^{N_{j0}} p_{j0} q_{j0}}$$

The numerator of this expression is equivalent to that of the first index reviewed in the present section, which can be seen directly by rewriting it as $[P]_{ji}\{Q\}_{j0}$. The denominator is the sum of the value aggregates $[P]_{j0}\{Q\}_{j0}$ over the twelve months of the base year, divided by 12. This summation and averaging account for the entire difference between the two indexes. (It will be recalled that in our first seasonal index the denominator was the aggregate $[P]_{j0}\{Q\}_{j0}$ for the appropriate month.)

If the index P_{ji} is divided into the next month's index $P_{j+1,i}$, the denominators of the two, which are equal, cancel each other and the

[48] Bruce D. Mudgett, op. cit., p. 98.

[49] Government of Canada, Dominion Bureau of Statistics, Department of Trade and Commerce, *The Consumer Price Index, January 1949–August 1952* (including an explanatory statement), Ottawa, 1952, pp. 14–15. The group of seasonal foods is composed of fresh and canned fruits and vegetables, fats, eggs, and meats, and poultry. It accounts for 61 percent of all foods.

resulting ratio, a measure of the monthly change implicit in the present formula, may be written as

$$\frac{\overset{N_{j+1,i}}{\Sigma} p_{j+1,i} q_{j+1,0}}{\overset{N_{ji}}{\Sigma} p_{ji} q_{j0}} \quad \text{or} \quad \frac{[P]_{j+1,i}\{Q\}_{j+1,0}}{[P]_{ji}\{Q\}_{j0}}$$

This is again the ratio of the cost of the market basket appropriate for month $(j+1)$ at current prices to the cost of the market basket appropriate for month j at that month's prices. As such it is identical with the first half of the corresponding measure for our first seasonal index (see text and formula in Section 5a above). In that measure the current cost ratio was taken in relation to the ratio of market basket expenditures for the corresponding months of the base year; here it stands by itself. These two formulae, then, are rather similar, but the explicit reference to the "base season" in the first of our seasonal indexes can be regarded as a point in its favor.[50]

It may be added that seasonal weights are applied only within a single group of foods in the Canadian index, and that this group as a whole, like all the other groups in the index, is assigned a constant annual weight. In this case, then, an internal distribution of weights is being varied from month to month during the year in such a way that seasonal declines in the importance of some items are always exactly balanced off by seasonal increases in the importance of other items, with the combined weight of both categories remaining constant. This can be regarded as a group substitution similar in principle but, to be sure, much more complex in practice than the substitution with proportional weight redistributions discussed earlier in Section 3 of this survey.[51]

d. *Value Ratio Deflated by a Seasonal Quantity Index.*—Recently a new seasonal index method (listed as item II, 1(d) in Table IV) was developed by Doris P. Rothwell in her article in the March 1958 issue of the *J.A.S.A.* to which we have already referred. Rothwell's index on the base period, in the conventional and vector notation, respectively, is appealingly simple:

$$\frac{\Sigma p_{ji} q_j}{\Sigma \bar{p}_0 q_j} \quad \text{and} \quad \frac{[P]_{ji}\{Q\}_j}{[\bar{P}]_0\{Q\}_j}$$

Here again j is a given month of the year, i is a given year, and 0 is the base year (if base and weight periods coincide, the subscripts of the quantity terms are $j0$).

[50] D. P. Rothwell, op. cit., p. 69, describes the Canadian index as "actually a ratio of expenditures, in which the numerator is the product of monthly quantities and monthly prices and the denominator is 1/12 the annual value weight (or 1/12 the sum of monthly expenditures) in the base year." This is partly incorrect as the quantities in the numerator of the Canadian index refer to the j-th month of the base, not of the current year (cf. the formulae given in the Canadian source identified in footnote 49 above and in the Rothwell article). Nevertheless, Rothwell is right in saying that "some of the month-to-month fluctuation is due to differences in physical quantities" but only provided that the differences referred to are those between the monthly market baskets on which the index is based.

[51] The Technical Committee appointed in 1956 to make recommendations for the new British Index of Retail Prices considered the desirability of internal weight distributions for the fruit and vegetables sections of that index but concluded that these variations in weighting would have little effect and did not advise the use of such a method. Instead they did advise the simpler substitution procedure to which reference was made in Part II, Section 2b (for source see footnote 38).

The value $\bar{p}_0$ is the annual average price in the base year, obtained by weighting the monthly prices by seasonal quantity weights. $[\bar{P}]_0$ is the vector of these p_0 values.

The formula has the merit of yielding the logical measures of price change between the same months of successive years (the measure presented early in this section). But all of our seasonal-weight indexes have this advantage; any index of this type will have it, provided that for a given month its base period calculated denominator is the same in any year.

The Rothwell index also shares with the other indexes some other points that have been advanced in its favor, such as the ability to use the proper seasonal weights and changing commodity lists. Its further advantage is that a weighted average of its monthly values for any given year yields a proper annual index for that year, but again this is not a unique feature of this index.[52]

Decisive for the evaluation of this as well as other seasonal-weight, fixed-base indexes is how they measure the month-to-month change in prices, for this is where the main difficulty for these indexes lies. The ratio of base period indexes for two consecutive months in terms of the Rothwell formula provides an expression for the monthly change that has a particular meaning. We can write it in our two notations as

$$\frac{\Sigma p_{j+1,i}q_{j+1}}{\Sigma p_{ji}q_j} \div \frac{\Sigma \bar{p}_0 q_{j+1}}{\Sigma \bar{p}_0 q_j} \text{ or } \frac{[P]_{j+1,i}\{Q\}_{j+1}}{[P]_{ji}\{Q\}_j} \div \frac{[\bar{P}]_0\{Q\}_{j+1}}{[\bar{P}]_0\{Q\}_j}.$$

Rothwell says that "In this form, the price index is an expenditure ratio divided by the quantity index calculated for the base year, or adjusted for the difference in quantities in the two periods." [53]

Since the q-terms refer, not to the actual quantities marketed in the given months of the given year, but to fixed quantities used as weights, the first of the two expressions used in the division is not really an observable "expenditure ratio" but rather a ratio of costs, in the given and the previous month, of certain predetermined baskets of goods. The second expression is a true seasonal index of quantities with average base year prices used as fixed weights. There will be as many such "seasonal adjustment factors" as there are "seasons" distinguished, e.g., 12 in the case of an index with monthly seasonal weights. Thus it is believed that the notion of an adjustment for the seasonal change in quantities fits Rothwell's measure better than her other notion, that of a ratio of an expenditure index to a quantity index. This is better than if the reverse were true, because a division of a value ratio proper by a quantity index need not in all cases yield an acceptable price

[52] The weights that will give the desired result for the Rothwell index are quantity indexes of seasonal consumption $\Sigma q_j \bar{p}_0 / \Sigma q_0 \bar{p}_0$. The annual index obtained can be written as

$$\sum_{j=1}^{12} \sum_{i=1}^{N_{ji}} p_{ji} q_j \Big/ \sum_{i=1}^{N_{j0}} \bar{p}_0 q_0.$$

(The value q_0 in these expressions is the annual base quantity weight or the sum of the monthly seasonal weights.) By applying to the monthly values of our first seasonal index the ratios between the base period calculated seasonal and annual values, $\Sigma q_j p_{j0} / \Sigma q_0 \bar{p}_0$, the same annual index can be computed.

[53] Rothwell, op. cit., p. 72.

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index.[54] But then what is being accomplished by the Rothwell adjustment method is itself open to question, too. It may be argued that, while seasonal weighting is used in the formula, the effect of it is largely canceled again by the adjustment, so that the measure we get does not really reflect the influence of the consumption seasonals or does so only to some unknown but presumably small extent. This indeed may explain why the results of an experimental application of the Rothwell formula differed but relatively little from the results obtained by applying, to the same body of test data, conventional annual-weight methods such as those now and previously used to deal with the seasonal problem at the Bureau of Labor Statistics.[55]

6. CHAIN INDEXES WITH SEASONAL BASE PERIOD QUANTITIES USED IN WEIGHTS

These indexes (item II, 2 in Table IV) have been given sufficient attention in Part I of our study. It will be recalled that the major objection to these formulae is that they tend to produce errors in the range of the year-to-year comparisons.

7. INDEX NUMBERS BUILT FROM SEASONALLY ADJUSTED PRICES AND QUANTITIES

The methods discussed so far did not use any explicit adjustments for the seasonal variation in prices or quantities but aimed at the construction of improved *unadjusted* index numbers. (The resulting series could, of course, be subjected to some seasonal correction procedure.) A treatment of seasonal commodities which would require estimation of the seasonal variation in prices has recently been suggested by Richard Stone.[56]

The method involves the assumption that normal seasonal patterns in prices appropriate to the base year exist and can be expressed by sets of seasonal multipliers, one set for each commodity. A multiplier for the j-th season, say s_j, would thus satisfy the relation $p_j = s_j p^*_j$, where p_j is the actual price of the given item in the j-th season and p^*_j is its corresponding adjusted price. The adjustments must, of course, cancel out over the entire seasonal cycle, i.e., normally over a year; if there are m seasons, then

$$\sum_j^m s_j/m = 1 \text{ and } \sum_j^m p_j = \sum_j^m s_j p^*_j = \sum_j^m p^*_j.$$

[54] Rothwell (ibid., pp. 71–72) states that the "basic idea [of deriving a price index by dividing a value index by a quantity index] is inherent in the formula proposed by the German mathematician, M. W. Drobisch, in 1871 for measurement of changes in exchange values:

$$\frac{I_2}{I_1} = \frac{\Sigma q_2 p_2}{\Sigma q_1 p_1} \cdot \frac{\Sigma q_1}{\Sigma q_2}.$$

This, however, contains the unrealistic condition that the quantities must be expressed in the same units so as to be additive."

The Drobisch formula is indeed a poor precedent, especially as far as the requirements of the seasonality problem are concerned, and not just because of the additivity issue. As noted in Bortkiewicz, *Nordisk Statistick Tidskrift,* III, 1924, pp. 510–512, the Drobisch formula does not satisfy the proportionality and identity tests. It is at least questionable whether it should be regarded as a price index proper. Let us add that the unweighted quantity index, $\Sigma q_1 \Sigma / q_2$, can be replaced as the divisor in the above formula by a weighted quantity index, e.g., $\Sigma q_1 p_0 / \Sigma q_0 p_0$ *or* $\Sigma q_1 p_1 / \Sigma q_0 p_1$. In these cases, the results are simply a Paasche or a Laspeyres index, respectively.

[55] See D. P. Rothwell, op. cit., pp. 74–75, and Chart 77B on p. 77 (also the statistical tables in the appendix available upon request to the author).

[56] R. Stone, *Quantity and Price Indexes in National Accounts,* Organization for European Economic Cooperation, Paris, 1956, Chapter VI, particularly pp. 74–77.

Stone then suggests that the adjusted quantity measure in terms of which different seasons can be compared is $q^*_j=s_jq_j$. For any given good, then, the seasonal multiplier for quantity is the reciprocal of the corresponding seasonal multiplier for price. This can be viewed as an implicit assumption of unitary elasticity of demand in the seasonal context: if in an off-season month the price is, say, 10 percent higher than it is on the average during the year, the quantity consumed is presumed to be 10 percent less than its mean annual per-month rate. Alternatively, one may regard this treatment as a substitution for the physical quantity units of a system of measurement in what may be termed the "equivalent-seasonal-value" units. For example, one may decide that "a product quantity of the December variety should be reckoned as equivalent to twice as much of the June variety." [57] In contrast, physical units such as pounds or barrels are said to be not comparable between the seasons because they do not take into account the "seasonal quality differences." [58]

In these terms, Stone's formulation of an annual Laspeyres quantity index for a single commodity with several "seasonal varieties" is simply

$$\sum_j^m q^*_{j1}p^*_{j0}\Big/\sum_j^m q^*_{j0}p^*_{j0}=\sum_j^m q_{j1}p_{j0}\Big/\sum_j^m q_{j0}p_{j0},$$

where the subscripts 0 and 1 denote, respectively, the base and the current year. The equivalence of the two expressions reflects the fact that price and quantity adjustments are in this approach designed to cancel out for each season, leaving the values unchanged ($p_jq_j=p^*_jq^*_j$). The formula

$$\sum_j^m q_{j1}p_{j0}\Big/\sum_j^m q_{j0}p_{j0}$$

could also be obtained by treating the supplies of a product that are available in different seasons as different commodities and averaging the quantity changes between the base and the current year for each season separately, using as weights the proper seasonal expenditures.[58]

By defining the mean adjusted price and the mean adjusted quantity in the base year, respectively, as

$$\bar{p}^*_0=\sum_j^m p^*_{j0}q^*_{j0}\Big/\sum_j^m q^*_{j0} \text{ and } \bar{q}^*_0=\sum_j^m q^*_{j0}/\text{m},$$

Stone derives another formula for an annual base-weighted quantity index, viz.,

$$\bar{q}^*_1\bar{p}^*_0/\bar{q}^*_0\bar{p}^*_0=\sum_j^m q^*_{j1}\Big/\sum_j^m q^*_{j0}.$$

He accepts this index, in effect an unweighted quantity ratio, as adequate, too, on the ground that "in adjusted units the quantities of different seasons are directly comparable." [59] Accordingly, the use of these units is seen by Stone as also permitting comparisons involving individual seasons; for example, a quantity index for the j-th

[57] R. Stone, op. cit., p. 117.
[58] Ibid., p. 75.
See footnote 59 on p. 274.

season of the current ("1st") year on the base of year "0" as a whole would read

$$q_{j1}^{*}\bar{p}_0^{*}/\bar{q}_0^{*}\bar{p}_0^{*}=q_{j1}^{*}/\bar{q}_0^{*}.$$

Price indexes analogous to Stone's quantity indexes are easily identified. The annual Laspeyres formula applied to a single seasonal commodity gives

$$\sum_{j}^{m} p_{j1}^{*}q_{j0}^{*}/\sum_{j}^{m} p_{j0}^{*}q_{j0}^{*}=\sum_{j}^{m} p_{j1}q_{j0}/\sum_{j}^{m} p_{j0}q_{j0}.$$

Given our previous definition of the weighted averages

$$\bar{p}_i^{*}\ (i=0,1\ldots),$$

the result would be identical had the formula

$$\bar{p}_1^{*}\bar{q}_0^{*}/\bar{p}_0^{*}\bar{q}_0^{*}(=\bar{p}_1\bar{q}_0/\bar{p}_0\bar{q}_0)$$

been used instead. For the current-season-to-base-year comparison, the corresponding expression is simply

$$p_{j1}^{*}\bar{q}_0^{*}/\bar{p}_0^{*}\bar{q}_0^{*}=p_{j1}^{*}/\bar{p}_0^{*}.$$ [60]

To see how Stone's single item formulae can be applied to groups of commodities, let us write out the season-to-year price index for n items $(t=1,2\ldots n)$, omitting for simplicity the t-subscripts which would have to be attached to all the p's and q's. The index, which will be recognized as a weighted average of the $p_{j1}^{*}/\bar{p}_0{}^{*}$ terms, reads

$$\frac{\sum_{t}^{n} p_{j1}^{*}\bar{q}_0^{*}}{\sum_{t}^{n} \bar{p}_0^{*}\bar{q}_0^{*}}=\frac{\sum_{t}^{n} \frac{p_{j1}^{*}}{\bar{p}^{*}}\bar{p}_0^{*}\bar{q}_0^{*}}{\sum_{t}^{n} \bar{p}_0^{*}\bar{q}_0^{*}}=\frac{\sum_{t}^{n} \frac{p_{j1}^{*}}{\bar{p}_0^{*}}\bar{p}_0\bar{q}_0}{\sum_{t}^{n} \bar{p}_0\bar{q}_0}.$$

It would be possible to use various formulae within this framework, for example, to substitute the seasonal for the mean annual q's in the weights. The formulae thus obtained would resemble the seasonal-

[59] Ibid., p. 76. It may be noted that substitution of the weighted average

$$\sum_{j} q_{j0}^{*}p_{j0}^{*}/\sum_{j} p_{j0}^{*}$$

for the unweighted one

$$\left(\sum_{j} q_{j0}^{*}/m\right) \text{ gives } \bar{q}_1^{*}\bar{p}_0^{*}/\bar{q}_0^{*}\bar{p}_0^{*}=\sum_{j} q_{j1}^{*}p_{j0}^{*}/\sum q_{j0}^{*}p_{j0}^{*}=\sum_{j} q_{j1}p_{j0}/\sum_{j} q_{j0}p_{j0}.$$

This result, obtained by using annual mean figures, is identical with the result obtained in the previous paragraph by using the detailed price and quantity information for each season.

[60] As noted by Stone (op. cit., p. 76), these indexes satisfy the Fisher factor "reversal" test: the product of the matching formulae, $p_j{}^{*}{}_1/\bar{p}_0{}^{*}$ times $q_j{}^{*}{}_1/\bar{q}_0{}^{*}$, equals the ratio of the current season's value to the base year value. This, however, is trivial in the present case of unweighted price and quantity ratios restricted to the seasonal varieties of a single good.

weight indexes discussed previously in Section II, 5 of this study, and in several cases would actually be equivalent to them. Thus note that

$$\frac{\sum_{t}^{n} p_{j1}^{*} q_{j0}^{*}}{\sum_{t}^{n} p_{j0}^{*} q_{j0}^{*}} = \frac{\sum_{t}^{n} p_{j1} q_{j0}}{\sum_{t}^{n} p_{j0} q_{j0}} \quad \text{and} \quad \frac{\sum_{t}^{n} p_{j1}^{*} q_{j0}^{*}}{\frac{1}{12}\sum_{j}^{m} \sum_{t}^{n} p_{j0}^{*} q_{j0}^{*}} = \frac{\sum_{t}^{n} p_{j1} q_{j0}}{\frac{1}{12}\sum_{j}^{m} \sum_{t}^{n} p_{j0} q_{j0}}.$$

The first of these equations relates to simple same-month-year-ago or same-month-of-the-base-year comparisons (see Section 5a). The second relates to the seasonal index now used in Canada (see Section 5a). In these formulae, then, unadjusted prices and quantities can be replaced by the corresponding adjusted figures without affecting the results. On the other hand, conversion from unadjusted into adjusted units would not leave unchanged Rothwell's formula

$$\sum p_{j1} q_{j0} / \sum \bar{p}_0 q_{j0}$$

(see Section 5d), since the denominator of this index would not in general equal

$$\sum \bar{p}_0^{*} q_{j0}^{*}.$$

Stone illustrates his argument in favor of measurements in the adjusted unit by comparing the simple quantity indexes

$$\sum_{j}^{m} q_{j1}^{*} / \sum_{j}^{m} q_{j0}^{*} \quad \text{and} \quad \sum_{j}^{m} q_{j1} / \sum_{j}^{m} q_{j0}.$$ [61]

He assumes that in the base period the commodity in question was available in large quantities and at nonexorbitant prices only during a small part of the year, while in the current year the progress in refrigeration, development of alternative supply sources, etc., eliminated the wide seasonal differences in the supply of the product, making the latter available throughout the year at more or less similar prices. The adjusted quantity ratio will be higher than the unadjusted one, reflecting the fact that the out-of-season varieties of the commodity, which were highly valued in the base year, are now available in larger amounts.

This is an important argument supported by a realistic example but it is not sufficient to resolve some serious doubts about this approach to the problem of seasonal commodities. The assumption of a negative correlation between the seasonal changes in price and quantity has repeatedly been made on these pages and is no doubt valid for many products (see, however, Part I, Section 3d above). But here, unlike in the other cases, it is built into the method by the device of the inverse relation between the seasonal adjustment factors for prices and quantities. It is possible to question this approach on the ground

[61] R. Stone, op. cit., p. 77.

that it in effect prejudges an issue which had better be left open in the assumptions stage of the analysis.

A secondary practical consideration is that the Stone method would presumably require separate seasonal adjustments for each component item of the index. This is a large although by no means overwhelming task in the case of a comprehensive price index, but the main difficulty here would likely be qualitative rather than quantitative: substantial shifts in the seasonal patterns of some series in the base period and the neighboring years, and the like.[62]

8. SOME RELEVANT ASPECTS OF THE SAMPLING PROBLEM IN INDEX SERIES CONSTRUCTION [63]

In a recent article on the probability sampling approach to the making of price indexes, the claim is made that this method, in contrast to the present "use of an arbitrary fixed sample," would "permit changes in products and product quality to be incorporated smoothly into a continuing index." [64] This apparently implies that the suggested sampling procedure will result in an index series for which seasonal changes (along with such other important factors as the nonseasonal weight and quality changes) would not present any major difficulty in principle.

This claim, if so interpreted, is believed to be excessive and potentially misleading. The matter deserves some attention, although it is difficult to discuss it without digressing somewhat from our main line of discourse. But first it must be emphasized that what follows is not at all intended to question the objective sampling per se or its advantages over the currently used judgment sampling.[65] The application of probability sampling to price index construction is an important task to which Adelman [66] and, before her, Banerjee [67] have made valuable contributions.

The proper use of sampling in this connection is within strata or "composite commodities," i.e., groups of items with common patterns

[62] Stone himself devotes most of his chapter on "Seasonal Variations" (op. cit., pp. 77–88), not to the treatment of seasonal commodities, but rather to the task of developing a satisfactory method of seasonal adjustments. His basic treatment of the subject as a problem in the analysis of variance is admirable, as are the further refinements of his analysis.

[63] The author is grateful to Professor Philip J. McCarthy of Cornell University for a valuable criticism of an earlier version of this section and suggestions that helped to improve it.

[64] Irma Adelman, "A New Approach to the Construction of Index Numbers," *The Review of Economics and Statistics*, Vol. XL, No. 3, August 1958, pp. 240–249 (the quotations in the text are from pp. 240 and 247, respectively).

[65] On the contrary, these advantages are seen as very substantial. If worked out satisfactorily, the objective sampling procedures would provide estimates of standard errors, which are not presently available for our major price indexes, and thus also the possibility of improving the sampling precision of these indexes.

[66] Adelman, op. cit.

[67] See "A Comment on the Sampling Aspects in the Construction of Index Numbers," *The Review of Economics and Statistics*, Vol. XLII, No. 2, May 1960, pp. 217–218, and the list of the pertinent writings by K. S. Banerjee, ibid., footnote 2.

of price change (relative to the general price level movements which are taken to affect all such groups). It is not among the strata whose relative prices follow distinctly different courses over time.[68] Hence the appropriate form of sampling presupposes a satisfactory solution of an important and difficult task—the grouping of the index items into strata. The components of a stratum must meet the criterion of a reasonably close similarity of relative price change, so that they would presumably belong to a rather narrow cluster of good substitutes produced under generally similar supply conditions. One would hope that a stratification based on this criterion would not have to be revised too often over time, but the degree of stability achievable in this respect for an economy as dynamic as that of the United States might prove considerably less than the practical index maker would wish.

In the absence of any changes in the availability or quality of the goods that make up the universe to be covered by the price index, the probability sampling approach as proposed by Banerjee and Adelman would face no major theoretical difficulties. If we assume a stable division of the universe into a (presumably large) number of proper strata, an intrastratum sampling scheme consistent with the currently dominant fixed-weight type of index numbers could be adopted. In-

[68] Implied in the statistical sampling procedures is the assumption that the price change of each item can be decomposed into three independent additive parts: (1) that common to all items in the universe; (2) that common only to the items within the relevant strata; and (3) a random component. The weighted average of the elements (2) is zero for the economy as a whole, the weighted average of the elements (3) is zero for each stratum. (See Adelman, "Reply," *The Review of Economics and Statistics*, May 1960, p. 219.) As a working arrangement this is presumably acceptable, even though the real world, in which prices are interdependent and changes in their structure may affect their level (as well as vice versa), is undoubtedly very different from the above model of independent price changes (1) and (2). But the construction seems to us just strong enough to permit sampling within carefully selected groups of related items; it will not bear either sampling of the items directly in disregard of such strata or sampling among the strata.

Ideas which seem to suggest sampling beyond the range of the "composite commodities" go back to Edgeworth (1887) and are shared also in similar form by W. S. Jevons (1909) and Bowley (1928). This is the conception that any change in the general price level or in the value of money "in itself" should manifest itself in a proportional change of all prices. Monetary factors are supposed to act upon each price alike and deviations from proportionality are viewed as due to other causes; but if this is so, then such deviations can be treated as if they were errors of observations as far as the measurement of price level changes is concerned. If a sufficiently large number of observations of any individual prices is taken, their relative movements will cancel out in accordance with the law of error and the residual movement of the price level will be satisfactorily measured by the average, subject to the ordinary sampling errors, etc. The logic of this approach does not call for weighting of the price relatives sampled according to the economic importance of the goods concerned. Rather, if weights are applied they should vary with the degree of precision of the individual observations.

The principal objection to this "stochastic approach" (Frisch) is that it implies that individual prices show divergencies from the "true" average price level that are independent from each other and that their fluctuations around that (moving) level are of a random character. Monetary as well as nonmonetary factors may exert different amounts of influence on prices of different goods. "Economic" weighting of the index items is essential to impart to the price level concept a definite meaning. Extensive criticism of the "stochastic" approach along the above lines is found in J. M. Keynes, *A Treatise on Money*, Vol. I, pp. 79–88 (1st ed., 1930). Similar arguments have also been made by Welsh (1924), Gini (1924), Divisia (1925), and Frisch (1936; see his article in footnote 9 for references).

deed, schemes of this sort are provided in the Banerjee-Adelman proposals.[69]

In reality, commodity universes change continually over time, and, here as elsewhere, it is this change that creates the major problems. Variation in the assortment of goods available to or desired by the buyers will in the course of time invalidate even the most carefully implemented, detailed stratification schemes. Some of this variation can be predicted to a considerable extent, the stable elements in the seasonal change being here of particular importance. Such changes should be taken into account in the stratification design as extensively as possible, in order to make that design better and more durable. But that part of the variation which is nonrecurrent and largely unpredictable—most of the changes in quality and many of those in weights—cannot be given such an advance treatment with fair chances of success.

Apart from the stratification problem (or assuming, boldly, an enduring satisfactory solution to it), the question arises as to how frequently new samples of products should be drawn and priced in the process of producing the index series. Strict sampling considerations suggest drawing a completely new sample of items for each pricing period (month, in the major U.S. indexes), but other reasons militate against this extreme course. The operation would presumably be very costly. Moreover, it would be necessary to chain the resulting monthly links into a continuous series, a procedure which, as we know, gives rise to errors of its own.[70] To have a practical chance of being adopted and proving workable, the probability sampling method would probably have to be considerably attenuated to permit some compromise with the constant-market basket (fixed-commodity sample) principle of the price index maker.

9. BASIC CONCLUSIONS AND SUGGESTIONS

None of the various approaches that we have systematically explored is free from deficiencies, but some of these are much more

[69] Adelman suggests that each of the n items in a sample from a given stratum be assigned a probability of selection which is proportional to its weight (w_i) in the stratum; then a simple (unweighted) mean of the selected price relatives (p_i), that is

$$\frac{1}{n}\sum_{i=1}^{n} p_i,$$

will provide an unbiased estimate of the weighted average of the price relative for the entire stratum,

$$\sum_{i=1}^{N} p_i w_i$$

(where N=total number of items in the stratum). To meet the consistency requirement posed in the text, let w_i be the normalized base year expenditure weights.

It may be noted, however, that with respect to weights Adelman's position shows some affinity with the "stochastic approach," a critical summary of which was given in footnote 68. Although Adelman did use expenditure weighting in her pilot study index, she feels that this was an "arbitrary" assignment and that "just about any a priori weighting scheme would permit a reasonable evaluation of the whole procedure." Again, while following the procedure of making the number of items drawn from each stratum roughly proportional to the stratum's (expenditure) weight, she observes that this is a mere expedient: optimally, "the sampling percentage in each group ought to vary directly with the standard deviation of that group" (Adelman, op. cit., pp. 244–245). But then it should also be mentioned that these points are probably of rather marginal concern to Adelman who is well aware that her proposal "would not solve the problem of appropriate weighting" (p. 240).

[70] See Adelman (op. cit., p. 244) for an interesting variance ratio formula derived by R. Dorfman which shows that sampling errors will tend to be larger for the chained than for the fixed-base index.

serious than others. Thus it is possible to eliminate certain methods and discriminate among the remaining ones.

Two objectives may be distinguished, one limited and one comprehensive. The first is that of identifying a preferable method of dealing with "part-year" items or the effective seasonal disappearances (technically the most troublesome aspect of the seasonal problem). The second is that of finding the most satisfactory way of coping with the seasonal problem as a whole, including the issue of seasonally disappearing or unique goods.

(1) The procedure of imputing out-of-season items to their groups yields results whose quality will depend upon what precisely is imputed to what; a general unconditional prediction of how this method will work is not possible. The method can be viewed as an intragroup expenditure-weight transfer or a substitution of "year-round" or in-season commodities for "part-year" or "out-of-season" commodities. Seasonal substitutions are real and often important phenomena, but their incidence does not necessarily conform to the groupings adopted in subclassifying the price index in question. A group imputation may therefore ignore or cut across the real seasonal substitution relationships. If so, it may give poor or even perverse results, which could conceivably be inferior to those obtained by the other method applied to the problem of seasonal disapperances—the practice of holding the prices of out-of-season items constant. However, errors of application aside, the method of seasonal substitution is the logically preferable of the two, as it enables an annual weight index to give some—very limited but pertinent and opportune—recognition to the seasonal variation in consumption. But the proper application of this method presupposes a comprehensive and detailed study of the substitution relations involving seasonal commodities.

(2) If seasonal (say, monthly) quantities are used in weights, instead of annual quantities, two basic approaches are available. One is to use a standard (base year) set of seasonal weights over a number of years, as long as the set seems sufficiently realistic. The other is to use varying sets of seasonal weights from year to year to meet the changing exigencies of the particular year. This is the familiar dichotomy between the "fixed-base" and the "chain" indexes applied to the seasonal-weight measures.

Where seasonal fluctuations are pronounced and relatively stable, chain indexes, which fail to meet the proportionality test, will tend to produce errors in the year-to-year (same season) comparisons. Over a period of years, chain methods could not be properly applied without corrections for the "drifts" which would then tend to develop. Under these conditions, the use of a base year set of seasonal weights is preferable.[71] But, again, we know that this approach faces the critical difficulty with the month-to-month comparisons, and its more or less conventional variants (surveyed in Section II, 5 above) all fail in one way or another to provide an adequate solution to the problem.

Suppose, however, that one succeeded in ascertaining seasonal market baskets of such a composition as would give the "average consumer" approximately equal utility or satisfaction in each month of

[71] In terms of practicability and cost, this "fixed-base" approach has, of course, always a big advantage over the chain methods which presuppose a continuous collection of current seasonal weight data.

the year. (The Bortkiewicz formulae and the Staehle method of analyzing differential consumption structures, which have been reviewed in Section I, 3c above, might be profitably used in this connection.) Provided that—and as long as—the seasonal pattern of consumption remains sufficiently stable, such a set of market baskets would have to be selected only for the base year.[72] An index of this type would solve the basic difficulty of month-to-month measurements in the seasonal context; the same-month-year-ago comparisons, for which a constant market basket is assumed, have of course presented no problem to begin with and retain their conventional form.

Given the proper monthly market baskets, the simplest method of seasonal index construction can then be used, viz, comparisons of prices for a given month with those for the same month of the base year, using quantities for the latter period in weights. There would be no need to employ any of the more complicated formulae used or proposed as solutions to the seasonal problem; indeed, each of these formulae has one or another disadvantage which argues against its acceptance.

To be sure, this approach requires some departure from the strict concept of a price index in the direction of a cost-of-living index; but then some relaxation of the former concept will always be necessary if one wants to really come to grips with the seasonal problem. It is also clear that the empirical application of the method would be a task of major proportions and probably of considerable difficulty. But good results (even if obtainable only for some portions of an index which show large and sufficiently stable seasonalities) would here presumably pay off considerable investment in data collection and research.

III. Some Statistical Explorations of Seasonalities in Quantities and Prices

Knowledge of seasonal changes in each of the individual price series used in the computation of a comprehensive price index is not in itself sufficient to provide knowledge of the "true" seasonal variation in that index as a whole. This, of course, is an implication of the "seasonal weight problem" that has been given much attention in the present study. Nevertheless, measures of seasonal movements in prices of individual commodities or product classes are clearly of great interest, assuming their quality is adequate. When available for a large number of items, including those of major relative importance, such measures convey valuable insight into the dimensions of seasonal influences upon the movements of prices. How large is the proportion of the price series that show substantial seasonal fluctuations? How large and persistent are these fluctuations? What is the degree of confluence of the seasonal patterns among the various price series? These questions, whose pertinence will hardly be doubted, lend themselves to an empirical investigation, and the recently computed seasonal adjustment factors for the BLS price index series provide data that promise some progress in this direction.

[72] But the method is, of course, perfectly compatible with basic weight revisions every few years or so.

TABLE V.—*Range of Average Seasonal Indexes for Selected Groups, Subgroups, Product Classes, and Items of the Consumer Price Index, 1947–58*

Line	Group or item	Range of average seasonal index [1] (1)	Rank [2] (2)
	A. GROUPS AND SUBGROUPS [3]		
1	All items	0.7	34.5
2	All items, less food	.6	36
3	All commodities [4]	1.1	30
4	All commodities less food [4]	1.1	30
5	Durable commodities [4]	1.5	23.5
6	Nondurable commodities less food [4]	1.0	33
7	Food	2.4	19
8	Food at home	2.7	17
9	Meats, poultry, and fish	6.1	8
10	Meats	7.5	7
11	Dairy products	3.4	14
12	Fresh fruits and vegetables	15.3	5
13	Apparel	1.2	26.5
14	Housefurnishings	1.1	30
15	Appliances [5]	1.3	25
16	Private transportation	1.5	23.5
	B. PRODUCT CLASSES AND ITEMS [6] [7]		
17	Tomatoes [8]	60.3	1
18	Potatoes	25.5	2
19	Oranges	24.2	3
20	Eggs	23.1	4
21	Pork	12.4	6
22	Poultry	5.8	9
23	Beef and veal	5.2	10
24	New cars [9]	4.8	11
25	Milk, fresh (grocery)	4.7	12
26	Used cars [5]	4.5	13
27	Solid fuel—fuel oil	3.3	15
28	Bituminous coal	3.2	16
29	Fish	2.6	18
30	Fats and oils	2.3	20
31	Women's and girls' apparel	2.2	21
32	Refrigerators, electric [5]	1.6	22
33	Television [10]	1.2	26.5
34	Textile housefurnishings [10]	1.1	30
35	Gasoline [11]	1.1	30
36	Men's and boys' apparel	.7	34.5
37	Footwear	.5	37
38	Furniture [5]	.4	38

[1] Derived from average monthly seasonal indexes for 1947–58, except when a footnote to the contrary is attached to the title of the series.
[2] Based on the entries in col. 1, from the largest (rank 1) to the smallest (rank 38).
[3] Includes overall aggregates and groups containing any of the items listed in Part B below.
[4] Based on quarterly data, 1947–55; monthly data, 1956–58.
[5] Based on the average quarterly seasonal index, 1947–58.
[6] Listed according to their ranks in col. (2).
[7] Includes some groups for whose components no separate price seasonals are available (see note 3).
[8] Based on the average monthly seasonal index, 1953–58.
[9] Based on quarterly data, 1947–52; monthly data, 1953–58.
[10] Based on the average quarterly seasonal index, 1951–58.
[11] Based on quarterly data, 1947–56; monthly data, 1957–58.

1. SEASONAL MOVEMENTS IN PRICES OF CONSUMER GOODS

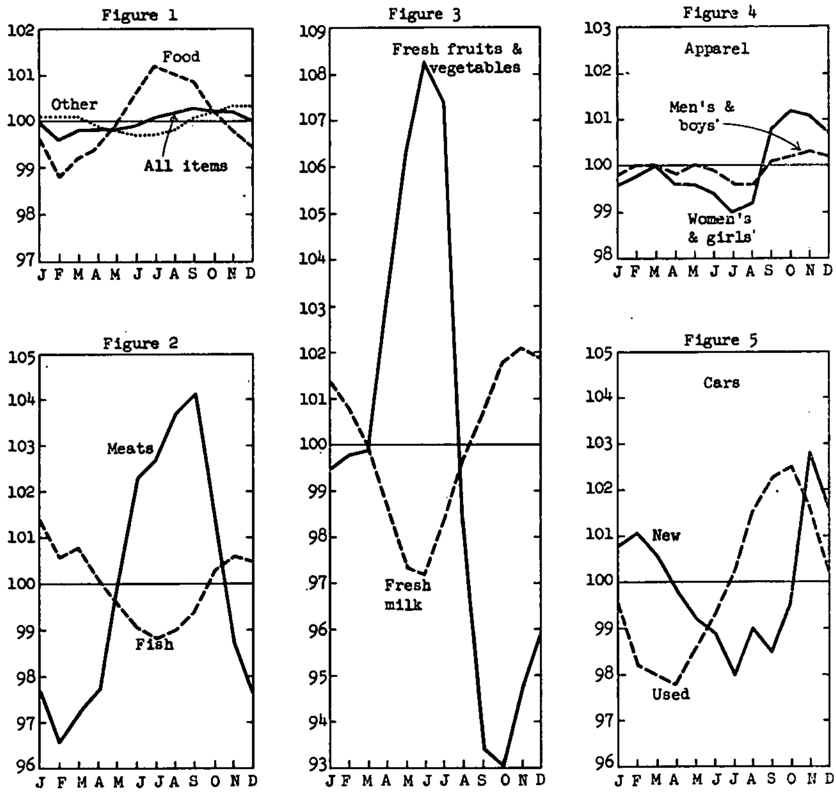
The most outstanding single feature of these movements is their extraordinary diversification. The amplitudes of the average seasonal indexes for a sizable sample of the U.S. Consumer Price Index (CPI) series covering the period 1947–58 range from about 60 to less than 0.5 percent (Table V). Fresh fruits and vegetables and then eggs lead the list with amplitudes exceeding 20 percent of the corresponding average annual levels. In the 5 to 12 percent range there are meats; in the 3 to 5 percent range, milk, new and used cars, and fuels. The remaining ten items (out of the 22 listed in Part B of

Table V) have amplitudes of less than 3 percent. The figure for women's and girls' apparel, for example, is only 2.2 percent.[73]

The average seasonal indexes for the CPI components vary not only in their amplitudes but also in their patterns or the timing, within the year, of their upward and downward movements. Some prices rise seasonally early and decline late in the year, others behave in the opposite fashion. Chart 1 gives several illustrations: prices of meats increase seasonally from February to September, those of fish from June to November (Chart 1, Fig. 2); prices of fresh fruits and vegetables rise from October to June, those of fresh milk from

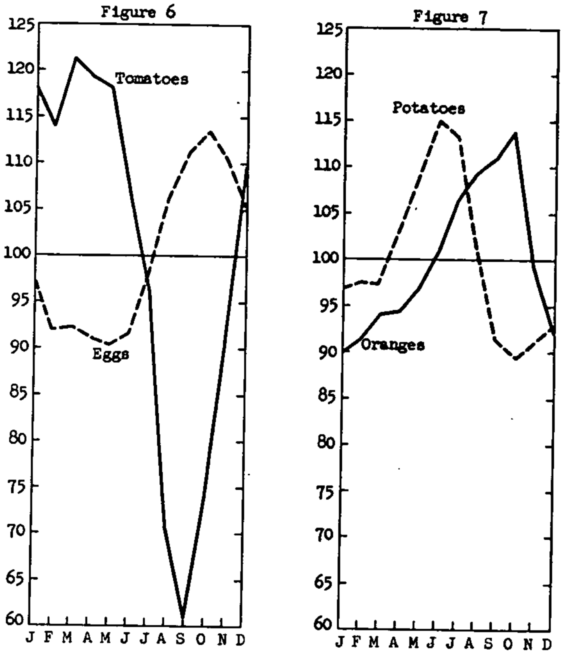
CHART 1

Average Seasonal Indexes for Selected Groups and Items of the Consumer Price Index



[73] It should be noted, however, that these measures relate to certain product classes; the seasonals for specific items within these categories would often show larger fluctuations. Also, each of these measures is based on a set of averages of the seasonal factors for Januaries, Februaries, etc., of all the years covered by the seasonal index in question (the data used in Table V all refer to the 12-year period beginning in 1947, except for two shorter series). This averaging over time is likely to produce amplitudes that are somewhat dampened in comparison with the amplitudes of the indexes for the individual years. This effect, however, should as a rule be weak because the averaged figures are "moving" seasonal factors which vary but slightly from year to year, reflecting the notion that, typically, seasonal movements are fairly stable and changes in them are mostly gradual. (The seasonal factors were all uniformly obtained by the same method of seasonal adjustment: the electronic computer program of the Bureau of the Census based on a rather elaborate version of the ratio-to-the-moving-average approach. For a description of this program, see Julius Shiskin, *Electronic Computers and Business Indicators*, Occasional Paper 57, National Bureau of Economic Research, New York, 1957.)

Chart 1—Concluded



Source: U.S. Department of Labor, Bureau of Labor Statistics.

June to November (Chart 1, Fig. 3). The tomatoes-eggs contrast (Chart 1, Fig. 6) is particularly sharp. To be sure, these examples of almost inverse patterns are somewhat on the extreme side. In many instances, comparison of the seasonals reveals shorter timing differences and a larger number of months with the same direction of movement. Thus the divergent seasonal movements of new and used car prices are concentrated mainly in the April–July interval (Chart 1, Fig. 5). Small amplitude differences alone distinguish the price seasonals for the two categories of apparel in Fig. 4 (Chart 1) as timing differences between them are very slight.

Because the seasonal movements of its component price series offset each other to a large extent, average seasonal changes in the CPI as a whole, in its present form, are of a very small order of magnitude (Chart 1, Fig. 1). The amplitude of the average seasonal pattern for the major group of foods is much larger, but still small compared with that of any of the patterns for the individual food items covered by our measures (Table V). The other major groups combined have an average seasonal index that moves in the opposite direction to the food index in most months but is much flatter. As shown in Chart 1, Fig. 1, the overall index for the CPI resembles more the food seasonal in the direction, and more the "other items" (nonfood) seasonal in the size, of movements. (In terms of value weights developed from the 1950 consumer expenditures survey adjusted to December 1952 prices, foods accounted for 30 percent of the total CPI.)

While the monthly change in the seasonal index for all items of the CPI combined was on the average only ±0.13 percent in 1947–58, it is nevertheless true, as observed in the introduction to this study, that "seasonal influences may and at certain times did dominate the short-run behavior of . . . the Consumer Price Index." It should be noted that the total CPI is a sluggish series; under more or less "normal" peacetime conditions, e.g., during most of the recent post-Korean period, the index would not often vary from month to month by more than 0.1 or 0.2 of an index point (which in percentage terms amounts to still smaller changes). Moreover, among the components of the CPI that are particularly stable in the short run, those that show little seasonal sensitivity appear to have the greatest importance. Thus changes in prices of the seasonal items will frequently be allowed to exert a relatively strong influence upon the month-to-month behavior of the total index.

2. SEASONAL MOVEMENTS IN PRIMARY-MARKET PRICES

The evidence on seasonal fluctuations in the components of the U.S. Wholesale Price Index (WPI) is presented in this section in the same way as was the evidence for the CPI items in the preceding section. This will save description space and facilitate comparisons. Again, the dominating impression is that of diversity. Among the average seasonal amplitudes for prices paid in the primary markets, a number exceed the largest of such amplitudes for prices paid by consumers, so that the range of the former measures is still considerably wider than that of the latter (cf. Parts B of Table V and VI). In these terms, then, wholesale prices are found to be on the whole more sensitive seasonally than the consumer price indexes.[74] A comparison of the measures for the comprehensive series (in Parts A of the two tables) also provides some evidence of the same relation, although these amplitudes are small for both the CPI and the WPI for the already familiar reason, the offsetting seasonals in the component price indexes.

Again, several kinds of vegetables and fruits lead the list with the largest seasonal amplitudes—in excess of 30 percent for eight items. Meats, poultry, livestock, hides, eggs, and milk are found in the middle range. Other items—about half of the total collection—show amplitudes of less than 5 percent. They include predominantly durables, both producer and consumer goods, but also fuels and apparel (see the rankings in Table VI).

Chart 2 parallels to a certain extent Chart 1 and shows that the seasonals for the WPI items, too, vary greatly in their patterns. For example, the index for fresh fruits contrasts sharply with that for fluid milk (Chart 2, Fig. 3). Florida and California oranges have quite different seasonals (Chart 2, Fig. 10). Prices of two types of lumber show almost entirely inverse (but small) seasonal fluctuations (Chart 2, Fig. 7). Other diagrams (e.g., Chart 2, Figs. 2 and 6) illustrate smaller timing differences and partial overlaps. Some comparisons show relationships that are very similar to those found for the corresponding consumer price series (cf. Figs. 8 and 10 in Chart 2 with Figs. 6 and 7 in Chart 1).

The indexes for "farm products" and "all commodities less farm and food" (Chart 2, Fig. 1) are broadly similar in direction of move-

[74] It will be recalled that over the cycle, too, wholesale prices have historically tended to fluctuate more widely than retail prices.

TABLE VI.—*Range of Average Seasonal Indexes for Selected Groups, Subgroups, Product Classes, and Items of the Wholesale Price Index, 1947–58*

Line	Group or item	Range of average seasonal index [1] (1)	Rank [2] (2)
	A. GROUPS AND SUBGROUPS [3]		
1	All commodities	0.8	41.5
2	All commodities less farm and food	1.1	36
3	Farm products	2.8	28
4	Fresh fruits	14.0	17
5	Fresh and dried vegetables	31.0	9
6	Processed foods	2.1	30
7	Meats	8.9	22
8	Textile products and apparel	1.2	32.5
9	Hides and skins	9.1	21
10	Lumber and wood products	0.7	44
11	Lumber	0.8	41.5
	B. PRODUCT CLASSES AND ITEMS [4] [5]		
12	Snap beans	93.8	1
13	Cabbage	72.0	2
14	Tomatoes	63.4	3
15	Oranges, Florida	60.1	4
16	Carrots	41.2	5
17	Potatoes, white, Chicago	40.6	6
18	Onion	38.2	7
19	Lettuce	34.2	8
20	Pork loins, fresh	29.2	10
21	Celery [6]	26.0	11
22	Barrows and gilts, 200–240 pounds	22.0	12
23	Oranges, California	18.9	13
24	Lemons	17.0	14
25	Cattle hides	16.4	15
26	Live poultry	15.7	16
27	Eggs	11.0	18
28	Beef, choice	9.9	19
29	Livestock	9.8	20
30	Fluid milk	7.9	23
31	Steers, choice	5.0	24
32	Coal	3.5	25
33	Douglas fir lumber	3.2	26
34	Leather	3.1	27
35	Southern pine lumber	2.3	29
36	Agricultural machinery	1.3	31
37	Gasoline	1.2	32.5
38	Construction machinery	1.1	36
39	Household furniture	1.1	36
40	Commercial furniture	1.1	36
41	Structural clay products	1.1	36
42	Apparel	1.0	39
43	House appliances	0.8	41.5
44	Concrete ingredients	0.8	41.5

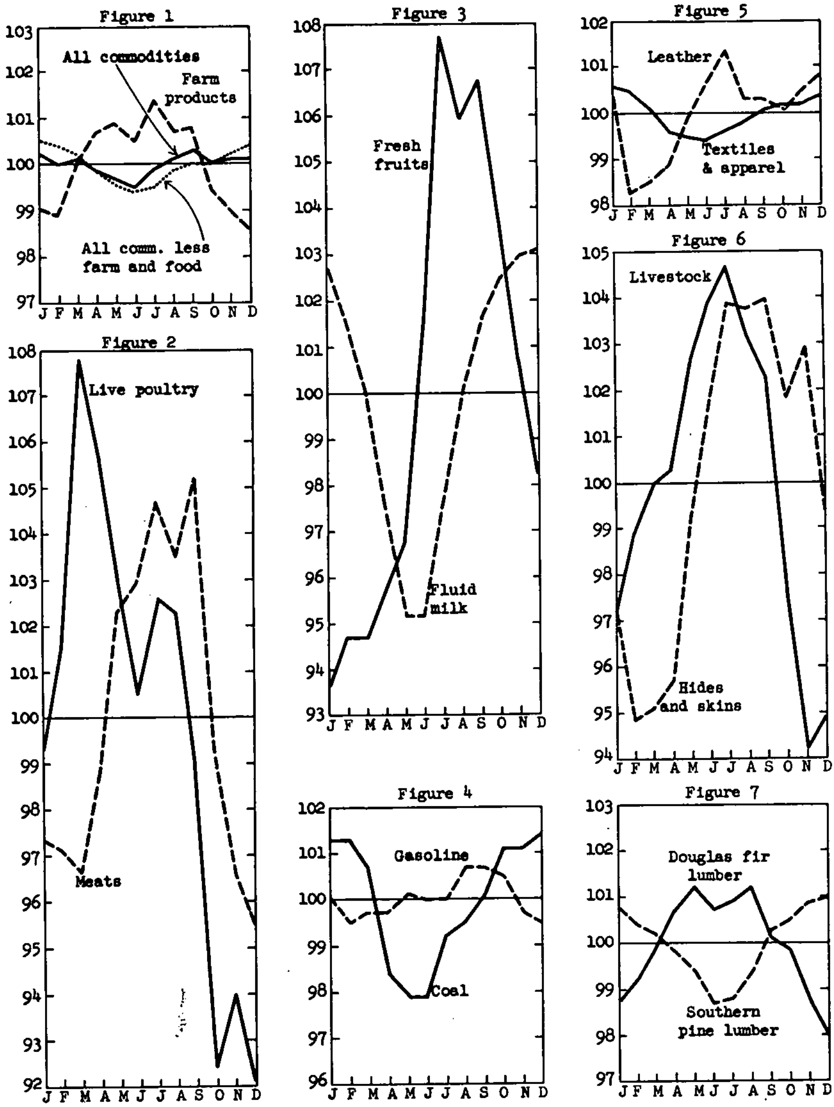
[1] Based on average monthly seasonal indexes for 1947–58 (except line 21).
[2] Based on entries in column 1, from the largest (rank 1) to the smallest (rank 44).
[3] Includes overall aggregates and groups containing any of the items listed in Part B below.
[4] Listed according to their ranks in column 2.
[5] Includes some groups for whose components no separate price seasonals are available (see note 3).
[6] Based on the average monthly seasonal index, 1950–58.

ment to the indexes for the CPI groups "food" and "all items less food" (Chart 1, Fig. 1), but are somewhat larger in amplitude. The seasonal pattern of the total WPI ("all commodities") resembles rather closely that of commodities other than farm products and processed foods. The CPI seasonal, on the other hand, is apparently influenced relatively more by food and less by other items.[75]

[75] The relative importance within the WPI of farm products and processed foods combined is about 30 per cent—much like the relative importance of foods within the CPI.

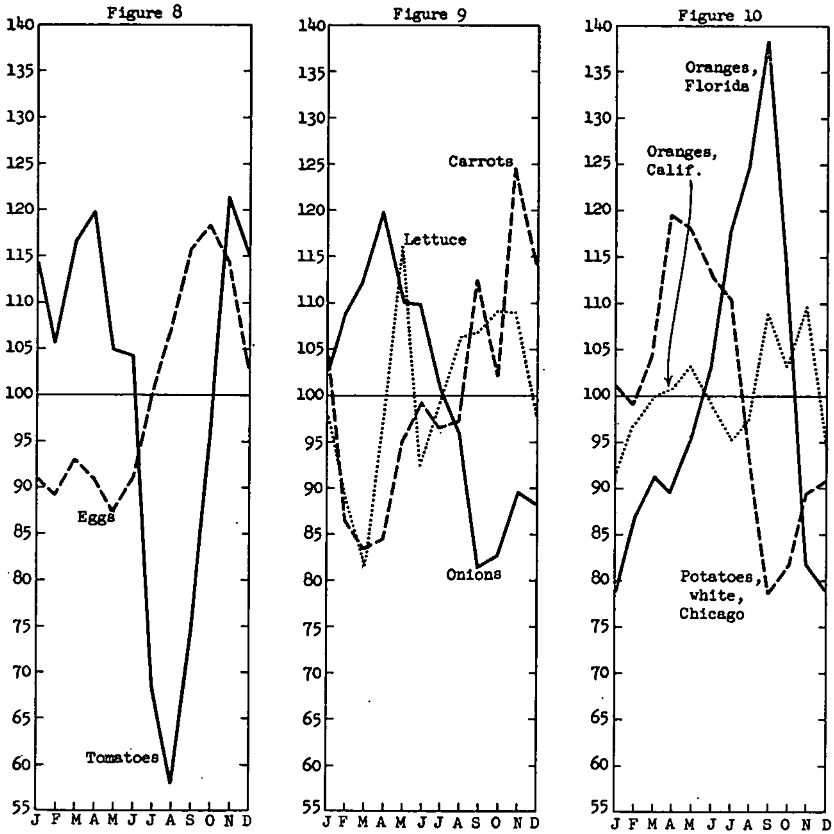
CHART 2

Average Seasonal Indexes for Selected Groups and Items of the Wholesale Price Index



Source: U.S. Department of Labor, Bureau of Labor Statistics.

CHART 2—Concluded



Source: U.S. Department of Labor, Bureau of Labor Statistics.

3. SEASONAL MOVEMENTS IN PRICES RECEIVED BY FARMERS

Many component items of the Index of Prices Received by Farmers fluctuate widely over the seasons. Index numbers of seasonal variation have been computed by the Agricultural Marketing Service, U.S.D.A., and published for all those price series that have significant and not excessively erratic seasonal patterns based on sufficiently long and comparable historic data. The average amplitudes of these indexes are listed in Table VII.

Not surprisingly, the commodities with the largest seasonal amplitudes are here again fresh vegetables and fruits. These, together with potatoes, account for the entire first half of the list (lines and ranks 1–22 in Table VII).[76] Few generalizations can be made about the other commodity groups which include prices with intermediate or small seasonals, but the relatively high ranks of wholesale milk and

[76] Among the items with the very largest amplitudes are some that have short marketing seasons and can be priced directly only in certain months of the year (cf. Table VII, lines 1–3, 7 and 11).

TABLE VII.—*Range of Average Seasonal Indexes for Selected Items of the Index of Prices Received by Farmers*[1]

Line	Commodity[2]	Group	Range of average seasonal index
1	Asparagus[3]	Commercial vegetables for fresh market	142
2	Watermelons[3]	do	141
3	Cantaloupes[3]	do	123
4	Cucumbers	do	109
5	Peppers, green	do	98
6	Corn, sweet	do	85
7	Tangerines[3]	Fruits	84
8	Tomatoes	Commercial vegetables for fresh market	77
9	Grapefruit	Fruits	73
10	Spinach	Commercial vegetables for fresh market	69
11	Strawberries[3]	Fruits	62
12	Onions	Commercial vegetables for fresh market	57
13	Carrots	do	56
14	Beans, snap	do	51
15	Cabbage	do	46
16	Sweet potatoes	Potatoes, etc	39
17	Oranges excluding tangerines	Fruits	37
18	Celery	Commercial vegetables for fresh market	30
19	Lemons	Fruits	29
20	Lettuce	Commercial vegetables for fresh market	28
21	Cauliflower	do	25
22	Potatoes	Potatoes, etc	24
23	Milk, wholesale	Dairy products	22
24	Soybeans	Oil-bearing crops	20
25	Hogs	Meat animals	18
26	Eggs	Poultry and eggs	18
27	Sheep	Meat animals	17
28	Corn	Feed grains and hay	17
29	Turkeys	Poultry and eggs	16
30	Apples	Fruit	16
31	Flaxseed	Oil-bearing crops	16
32	Oats	Feed grains and hay	15
33	Grain sorghums	do	14
34	Broccoli	Commercial vegetables for fresh market	13
35	Cottonseed	Oil-bearing crops	12
36	Rice	Food grains	12
37	Chickens	Poultry and eggs	10
38	Beef cattle	Meat animals	10
39	Lambs	do	10
40	Calves	do	9
41	Hay, baled	Feed grains and hay	9
42	Barley	do	8
43	Rye	Food grains	8
44	Wheat	do	7
45	American upland	Cotton	7

[1] The seasonal indexes are based on ratios to centered 12-month moving averages for the following periods of years: Meat animals (lines 25, 27, and 38–40): 1921–53 (excl. 1942–46); corn, barley, rye, wheat and cotton (lines 28 and 42–45): 1923–52; potatoes, oats, rice, and chickens (lines 22, 32, 36, and 37): 1933–52; turkeys and grain sorghums (lines 29 and 33): 1934–52; hay (line 41): 1925–52; oil-bearing crops (lines 24, 31, and 35): 1947–51; sweet potatoes (line 16): July 1940–June 1954; eggs (line 26): 1954–58; lemons (line 19): 1938–58; apples (line 30): 1944–58; all other fruits, all commercial vegetables, and milk (line 1–18, 20–21, 23, and 34): 1948–58.

[2] Listed according to the seasonal range, from largest to smallest.

[3] Pricing season is less than a year.

Source: U.S. Department of Agriculture, Agricultural Marketing Service Crop Reporting Branch.

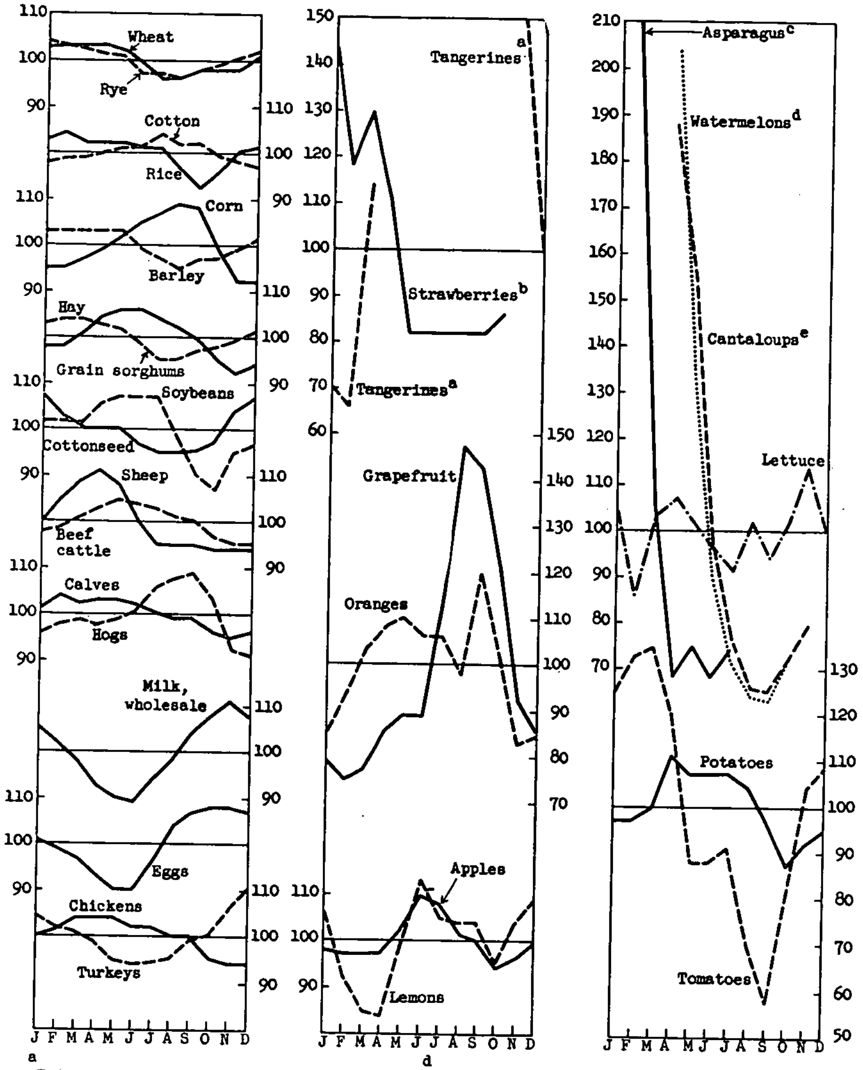
eggs and the position at the bottom of the list of food grains and cotton may be noted.

The large variety of seasonal patterns found among prices received by farmers is demonstrated in Chart 3. Some striking contrasts will be noted there between indexes for items belonging to the same commodity groups. For the All Farm Products Index of Prices Received by Farmers, no index of seasonal variation is computed since the patterns of the various component price series are virtually offsetting. For some commodity groups, however, index numbers of prices received are published both in the seasonally unadjusted and adjusted form.[77]

[77] These groups are: (a) fruit; (b) commercial vegetables for fresh market; (c) potatoes, sweet potatoes, and dry edible beans; (d) dairy products; and (e) poultry and eggs.

CHART 3

Average Seasonal Indexes for Prices Received by Farmers, Selected Commodities



[a] Pricing season: November-March.
[b] Pricing season: January-October.
[c] Pricing season: February-July.
[d] Pricing season: April-October.
[e] Pricing season: April-November.

Source: Crop Reporting Board, Agricultural Marketing Service, USDA.

4. SEASONAL MOVEMENTS IN QUANTITIES

Data on short-run changes in quantities consumed, and in particular on their seasonal variation, are very scanty. For large groups of products and on a national basis, this information is not available at all at the present time. In fact, lack of quantity data of adequate coverage and in suitable form is a major stumbling block that would have to be laboriously removed should an attempt be made to use seasonal weights in the construction of the principal U.S. price indexes.

Foods is the only major commodity group for which a large amount of material on seasonal variation in quantities consumed is available. The U.S. Bureau of Labor Statistics prepared a detailed tabulation on the "Estimated Relative Change in Quantities of Selected Foods Purchased per Month" and kindly gave us permission to make restricted use of these materials for the purpose of this study. The Bureau describes these data as "derived from various sources and selected as appropriate for use with average weekly expenditures for food items reported by households in Chicago, Ill., in Spring 1951." Table VIII presents a summary of these data by what is regarded as their single most significant characteristic, namely the size of the seasonal movement. The classification by food categories employed in this table is such that items in different groups do not, while items in the same group often do, have common seasonal patterns.

TABLE VIII.—*Indexes of Seasonal Change in Quantities of Food Items Purchased per Month, Distribution by Group and Amplitude Range*

Line	Group	Number of items [1]	Indexes of seasonal change in quantities purchased: Total number	Number within specified amplitude range: Less than 50 percent	50 to 99 percent	100 to 149 percent	150 to 199 percent	200 to 250 percent	Number of items with no seasonal
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Milk, cream, ice cream, cheese	11	5	5	------	------	------	------	2
2	Fats and oils	12	9	9	------	------	------	------	------
3	Eggs, meat, poultry, fish	51	19	15	4	------	------	------	------
4	Potatoes, peas, beans, and nuts	12	9	2	3	1	3	------	------
5	Fresh fruits	8	6	1	1	2	------	2	1
6	Fresh vegetables	15	14	2	2	2	5	3	1
7	Canned, frozen, and dried fruits	19	16	11	4	------	1	------	------
8	Canned, frozen, and dried vegetables	23	12	10	2	------	------	------	------
9	Sugars and sweets	12	5	4	1	------	------	------	1
10	Grain products	31	16	13	3	------	------	------	4
11	Miscellaneous and unspecified [2]	17	8	7	1	------	------	------	3
12	Total (groups 1-11)	211	119	79	21	5	9	5	12

[1] A number of these items form groups of two or more which have the same seasonal patterns. Hence the total number of items (211) exceeds considerably the total number of the various seasonal indexes estimated (119; see col. 2). A few items, too, have been found to show no significant seasonal variation (see col. 8).

[2] Mainly beverage and accessories, and also baby foods.

Source: Special tabulation made available by courtesy of the U.S. Bureau of Labor Statistics. Derived from various sources and selected as appropriate for use with average weekly expenditures for food items reported by households in Chicago, Illinois, Spring 1951.

The table shows that the seasonal indexes for food consumption reach into the ranges of extremely large amplitudes. Nineteen, or about one-sixth, of them show amplitudes in excess of 100 percent; fourteen, or more than one-eighth, exceed 150 percent; and a few even exceed the 200 percent mark (Table VIII, cols. 5–7). In contrast, the four most pronouncedly seasonal of the consumer prices listed in Table V (lines 17–20) show amplitudes of only 23–26 and (in one case) 60 percent, and the four largest seasonal amplitudes for wholesale prices in Table VI (lines 12–15) fall between 60 and 94 percent. While the samples of the price and of the quantity seasonals leave much to be desired in regard to comparability, the above observations refer to prices and quantities of similar if not identical commodities. The comparisons could be extended further with analogous results. Hence the inference seems warranted that seasonal movements tend to be larger in quantities purchased than in prices, at least for many food products.

The commodities with seasonal consumption amplitudes of 100 percent or more all belong to the fruits and vegetables categories (15 items, all but one fresh products) and to the group of potatoes, peas, beans, and nuts (4 items). These highly seasonal commodities account for the bulk of items in these three product groups (Table VIII, lines 4–6). Of the twenty-nine items in these groups, only five have amplitudes of less than 50 percent. As will be recalled from Tables V and VI, the same groups also show the largest seasonal amplitudes of *price* movements. This, of course, is due to the conditions of supply of these commodities, which account for the seasonality of both their consumption and their prices.

Chart 4 illustrates the great diversity of seasonal patterns in quantities purchased of the various food products. Again, as in the diagrams for price seasonals (Charts 1–3), these comparisons bring out the approximately inverse behavior of the seasonal components of some of the items (e.g., Chart 4, Figs. 4, 8, and 11), the timing differences between some other patterns (e.g., Chart 4, Figs. 3 and 5), and the amplitude dominating still other situations (Chart 4, Fig. 1). In comparisons between the figures, which may also be instructive, differences of the amplitude scales ought to be noted.[78]

Of particular interest is the relationship between fresh and canned varieties of the same or similar products, as suggested by Chart 4. The most striking example of an almost perfectly inverse relation found among the materials at our disposal is given in Fig. 8 (Chart 4), where canned apples and applesauce are contrasted with fresh apples. Substantial elements of inverse behavior, however, will also be noted in the comparisons of fresh and canned fish (Chart 4, Fig. 3), fresh and canned tomatoes (Chart 4, Fig. 6), and fresh oranges and concentrated orange juice (Chart 4, Fig. 9).[79] These examples provide strong support for the a priori plausible notion of seasonal substitution between fresh and canned varieties of the same food products or product classes.

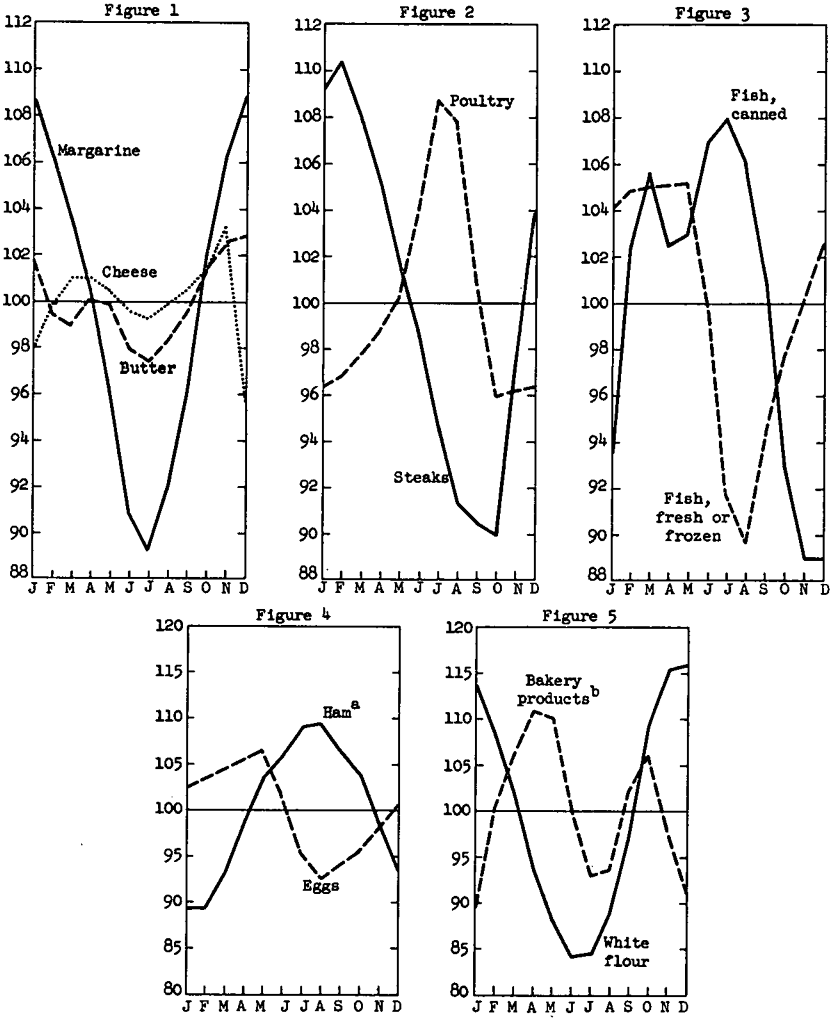
The findings based on the special BLS tabulation are confirmed by independent evidence. Surveys of family food budgets conducted in 1948–49 for the Department of Agriculture provide valuable data on various characteristics of food consumption, including seasonal

[78] Because of the larger seasonal movements in consumption, larger scales had to be used in most of the figures of Chart 3 than were used in Charts 1 and 2.

[79] An inverse relation is also present in the case of grapefruit (Chart 4, Fig. 7), but here it is the contrast between the amplitudes of the two indexes that is the dominant feature of the comparison. (Grapefruit consumption declines to minimal amounts in July–September, and actually this is one of the "seasonal fruits" that are not priced throughout the year by the BLS.) Canned juices show smaller amplitudes and more agreement in the direction of change with the fresh products than do the other canned varieties (cf. Figs. 6 and 9, Chart 4).

CHART 4

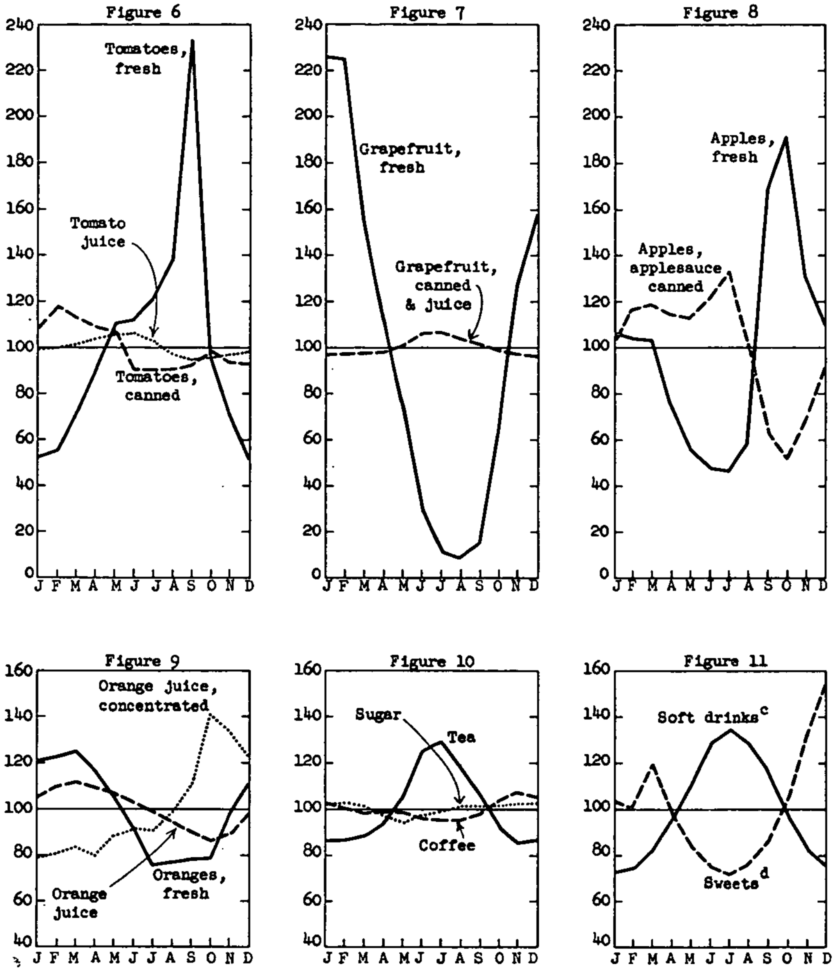
Estimated Seasonal Change in Quantities of Selected Foods Purchased per Month



[a] Whole and sliced; also includes picnics (shoulder).

[b] Cookies, cake, doughnuts, pies, sweet rolls, pastry, and other bakery products.

CHART 4—Concluded



c Cola drinks, other carbonated drinks (excl. ginger ale) and other non-alcoholic beverages (incl. malted milk and powdered fruit drinks).

d Prepared icings, fudge mix, candy, chewing gum, glazed fruit, and other sweets.

variation.[80] Salient features of the four-season indexes derived from these surveys are presented in Table IX. Again, fresh fruits and vegetables are found to be far more sensitive seasonally than any other foods. They reach their seasonal peaks in summer and troughs in winter (except for citrus fruits), which is the opposite of the patterns prevalent among other foods, where summer is the season of the lowest standings. Fresh and processed products have inverse seasonal movements. Also, among the fresh fruits, citrus fruit consumption was seasonally high when the consumption of other fruits was seasonally low, and vice versa. Meat and poultry consumption (low and high in the summer, respectively) interacted in a similar way. For most groups of foods, however, seasonal differences in consumption appear to be relatively small, owing in a large measure to offsetting variations in their individual components.

TABLE IX.—*Measures of Seasonal Variation in Quantities Purchased of Selected Food Items, 1948*

Line	Food item	Seasonal index (year's av.=100)			Change in the seasonal index		
		Highest standing [1] (1)	Lowest standing [1] (2)	Amplitude [2] (3)	Winter-spring (4)	Spring-summer (5)	Summer-fall (6)
1	Milk, cream, ice cream, cheese	105.5 (W)	94.7 (Su)	10.8	−6.7	−4.1	+2.5
2	Bakery products	104.8 (F)	95.9 (Su)	8.9	−4.2	−0.8	+8.9
3	Eggs	106.4 (Sp)	91.5 (Su)	14.9	+3.5	−14.9	+3.9
4	Meats	104.5 (W)	90.6 (Su)	13.9	−4.8	−9.1	+10.0
5	Poultry	112.3 (Su)	96.1 (F)	16.2	+3.7	+12.0	+16.2
6	Fresh fruits	177.1 (Su)	80.9 (W)	96.2	+0.5	+95.7	+84.3
7	Citrus	124.9 (W)	66.0 (F)	58.9	−6.8	−44.0	−8.1
8	Other	245.7 (Su)	51.4 (W)	194.3	+5.4	+188.9	−135.1
9	Canned and frozen fruits	140.7 (W)	59.7 (Su)	81.0	−27.8	−53.2	+0.2
10	Fresh vegetables	122.9 (Su)	80.6 (W)	42.3	+8.4	+33.9	−1.2
11	Canned and frozen vegetables	139.7 (W)	44.1 (Su)	95.6	−29.7	−65.9	+30.5
12	Canned and frozen juices	103.8 (F)	93.2 (Su)	10.6	−4.1	−4.8	+10.6

[1] The seasons corresponding to the figures in these columns are identified in brackets, as follows: W—Winter (Dec.-Mar.); Sp—Spring (Apr.-June); Su—Summer (July-Aug.) and F—Fall (Sept.-Nov.).
[2] Equals the difference between the corresponding figures in cols. 1 and 2.

NOTE: This table refers to "urban housekeeping families of 2 or more persons in the United States."

Source: Based on Table 52 (p. 102) of the Agriculture Information Bulletin No. 132 (1954). See reference in footnote 80.

Regrettably, information on seasonal changes in consumption of products other than foods is exceedingly scanty and inadequate; indeed, what little of it is available to us does not seem to merit presentation. Considerable information on seasonal varieties exists for series on outputs and some for series on inputs and shipments of a variety of products, mostly manufactures. These materials, then, relate to stages preceding consumption or to goods destined for producers rather than consumers. They do throw some light upon the nature of seasonal changes in quantities sold in primary markets by

[80] *Food Consumption of Urban Families in the United States*, by Faith Clark, J. Murray, A. S. Weiss and E. Grossman, Agriculture Information Bulletin No. 132, Home Economics Research Branch, U.S. Department of Agriculture, Washington, D.C., October 1954. This study presents seasonal indexes based on data gathered in the winter, spring, and fall of 1948 and in the spring and summer of 1949. The 1949 data were collected in Birmingham, Ala., and Minneapolis-St. Paul, Minn.; the 1948 data, in the same two cities and also in Buffalo, N.Y., and San Francisco, Calif. In these surveys approximately 4,500 schedules were furnished by households on their weekly food consumption and on certain family characteristics. Careful procedures were followed in combining data for individual food items from the four cities into a single set of weighted seasonal indexes which was described as being fairly representative of U.S. urban consumption. (For the details of the method of constructing these indexes, see the above-cited bulletin, pp. 51–53.)

industrial producers and farmers, although most of the data are for outputs rather than shipments or sales.

A few more general and pronounced characteristics of these output seasonals are brought out in a summary and selective fashion in Table X. There is clearly a considerable degree of similarity between the indexes for several industries. Inspection of the seasonal dia-

TABLE X.—*Highest and Lowest Standings of Seasonal Factors for Selected Components of Federal Reserve Production Indexes*

[Seasonal Index (year's av.=100)]

Industry	1st high [1] (1)	Midyear low [2] (2)	2d high [3] (3)
Primary metals	105	88	101
Fabricated metal products	101	95	104
Nonelectrical machinery	104	95	101
Electrical machinery	102	85	112
Textile mill products	104	85	105
Apparel and allied products	110	85	102
Leather and products	110	88	101
Rubber products	106	82	108
Paper and allied products	104	89	106
Chemical products	102	96	102
Vegetable and animal oils	115	76	121
	1st low	Midyear high	2d low
Food manufactures	[4] 91	[5] 117	[6] 97
Beverages	[7] 80	[8] 119	[6] 84

[Seasonal Index (year's av.=100)]

Consumer durables	1st high [9] (1)	Midyear low [10] (2)	2d high [11] (3)
Autos [12]	115	56	121
Household furniture	100	95	106
Floor coverings	109	76	108
Refrigeration appliances	127	73	96
Laundry appliances	114	71	113
Radio sets [12]	105	56	139
Television sets [12]	106	59	135
Miscellaneous home and personal goods	100	93	108
	1st low	Midyear high	2d low
Auto parts and tires	[4] 95	[5] 109	[6] 97

[1] Standings in March (6), February (3), January (1), and April (1).
[2] All July standings except for one August (nonelectrical machinery).
[3] Standings in October (9), November (1), and December (1).
[4] March.
[5] September.
[6] December.
[7] January.
[8] July.
[9] Standings in February (4), March (3), and April (1).
[10] Standings in July (6), August (1), and September (1).
[11] Standings in October (1), September (2), and November (2).
[12] 1957 indexes used (1955 and 1956 indexes slightly different).

NOTE.—The indexes are those for 1955–57 or 1956–57, except as indicated in note ([12]).

Source: Division of Research and Statistics, Board of Governors of the Federal Reserve System Seasonal Adjustment Factors, 1947 to 1957, Federal Reserve Production Indexes (May 1959 mimeo.).

grams for the major components of the Federal Reserve production indexes shows that common to most of them is a broad "double-peak" pattern of fluctuation. A peak or high standing of the seasonal in the first quarter of the year is followed by a descent to a summer vacation trough, mostly in July, which is often conspicuously low. Then there is a rise to a second peak in the last quarter. Otherwise the patterns vary greatly; for example in some the first peak is higher, in others the second. Outputs of major consumer durables show particularly large movements of this type, except for automobiles, where the nadir occurs at the model-changeover time, now early in the fall. Products processed from agricultural raw materials show less but still relatively high seasonal sensitivity. Some of them, such as vegetable and animal oils, conform to the double-peak model. But food manufactures and beverages have entirely different patterns, with single peaks in September and June, respectively.

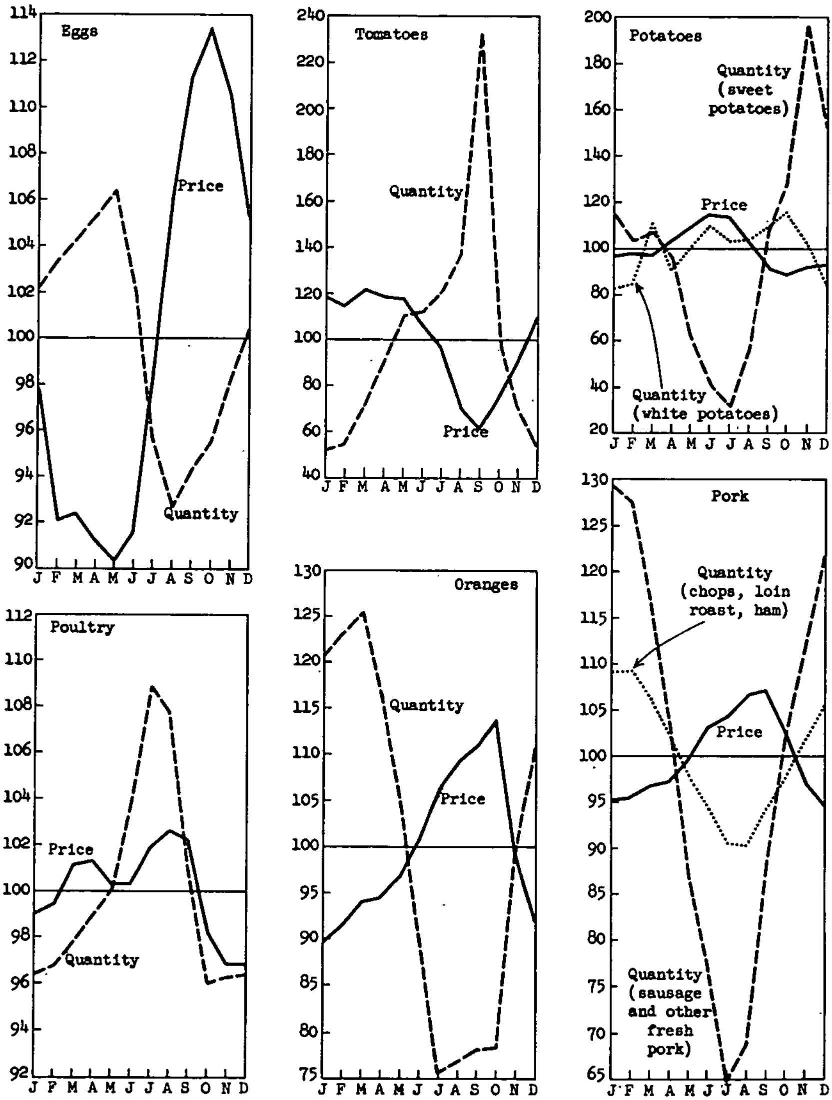
5. PRICE-QUANTITY INTERACTIONS OBSERVED IN SEASONAL PATTERNS

The seasonal indexes that we were able to collect for this study offer few possibilities of even roughly matching the data on prices and quantities by product and transactor characteristics. A few examples for food products are shown in Chart 5. The price data are seasonal factors for selected CPI components; the indexes for quantities consumed came from the special BLS tabulation (see Section 4 above).

As illustrated by Chart 5, the evidence for food products confirms what would be expected on theoretical grounds, viz, that seasonal movements in the prices and quantities of many goods are inversely correlated. The negative relationships are very pronounced indeed for such highly seasonal commodities as eggs, tomatoes, and oranges. The evidence for some food groups—dairy products, meats, and fish—is somewhat mixed, but here too elements of negative association seem to prevail and are sometimes very strong (as in the case of pork shown in the chart). In some instances, however, relations that are on the whole positive rather than negative are found. The best example for this that we could establish is given in the diagram for poultry in Chart 5. This also is in accord with theoretical considerations. As noted before, where seasonal changes in prices and quantities are due to shifts in demand rather than in supply curves one would expect the seasonal price-quantity relationship to be positive, not negative.

CHART 5

Seasonal Movements in Quantities Purchased and Prices for Selected Food Products



6. COMMODITIES NOT PRICED OR NOT AVAILABLE IN CERTAIN SEASONS

Some items of extreme seasonal sensitivity are not directly priced throughout the year in the process of compiling the price index series. The treatment of such "part-year" commodities in the major U.S. price indexes has been broadly discussed in Part II, Section 2; in what follows these items and their principal characteristics will be identified for each of the indexes under review.

TABLE XI.—*Items With Pricing Seasons of Less Than a Year in the U.S. Consumer Price Index*

Line	Group	Commodity	Specification no.	Pricing season
1	Food, fresh fruits	Grapefruit	F-423	November-May.
2	do	Peaches	F-425	July-September.
3	do	Strawberries	F-426	April, May, and June.
4	do	Grapes	F-427	July-November.
5	do	Watermelons	F-428	June, July, and August.
6	Apparel, Women's and girls'	Coat, fur	A-407	September-January.
7	do	Coat, without fur trim	A-410	Do.
8	do	do	A-415	Do.
9	do	Dress, all new wool	A-490	Do.
10	do	Coat, all new wool, girls'	A-600	Do.
11	do	Skirt, all new wool, girls'	A-620	Do.
12	do	Sweater, Orlon, girls'	A-632	Do.
13	do	Suit, all new wool	A-431.1	September-April.
14	do	Suit, rayon acetate	A-441	Do.
15	do	Dress, cotton, street	A-495	March-July.
16	do	Coat, sport, light	A-420	February-April.
17	Apparel, Men's and boys'	Sweater, all new wool	A-141	September-January.
18	do	Jacket, Gabardine rayon acetate.	A-150 ser.	Do.
19	do	Jacket, rayon, boys'	A-340 ser.	Do.
20	do	Topcoat, all new wool	A-101	September-March.[1]
21	do	Suit, all new wool, boys'	A-310	Do.
22	do	Shirt, sport, long-sleeve, men's.	A-213.1	Do.
23	do	Shirt, sport, long-sleeve, boys'.	A-371	September-February.[1]
24	do	Suit, tropical, worsted	A-118	March-July.
25	do	Suit, rayon tropical	A-120	Do.
26	do	Shirt, sport, short-sleeve, men's.	A-212	April-August.[1]
27	do	Shirt, sport, short-sleeve, boys'.	A-370A	March-August.[1]

[1] Approximately.

Source: Bureau of Labor Statistics, U.S. Department of Labor.

a. *Consumer Price Index.*—Until 1953 the group of "part-year" commodities in this index consisted only of certain apparel items; since that time, a few food items—all fresh fruits—have been added. The list now includes five fruits, eleven items of women's and girls' apparel, and eleven items of men's and boys' apparel. These commodities and their respective pricing seasons are identified in Table XI.

The present procedure is for the seasonally disappearing apparel items to be estimated during their off-season periods by the movement of the year-round apparel products.[81] The method used for the food items is somewhat different. Here those commodities that cannot be priced directly in a given month have their price movements estimated by the change in price of total fresh fruits, including not only the year-round items but also those "part-year" fruits for which direct prices are available in the months concerned. The food method utilizes more information than the apparel method but it thus strengthens the influence of the highly seasonal "part-year" fruit items which are extremely variable and at times volatile. As a result, very large price relatives for fresh fruits are reflected in the index at the beginning of the season for such commodities as peaches, grapes, and watermelons, i.e., in the months of June and July when these fruits are still expensive. For this reason, we are informed, the BLS is considering the advisability of applying the procedure now used for apparel to the seasonal fruits as well.

[81] Before 1953 these prices were assumed to undergo no change off-season.

Large price declines usually occur between the first and second month of pricing a seasonal item such as any of the fruits listed in lines 1–5 of Table XI. The other fresh fruits do not show such declines at these times (see the accompanying tabulation).

Retail Price Relatives, Chicago

Year	Strawberries (April-May)		Peaches (July-August)		Watermelons (June-July)		Grapes (July-August)	
	Actual	Year-round fresh fruits	Actual	Year-round fresh fruits	Actual	Year-round fresh fruits	Actual	Year-round fresh fruits
1956	68.3	108.1	92.9	91.3	82.1	106.0	65.7	91.3
1957	71.4	94.2	79.7	86.4	86.9	109.7	60.2	86.4
1958	78.9	100.5	89.4	81.9	71.1	105.3	75.4	81.9
1959	70.3	102.2	79.9	100.6	69.5	97.5	67.8	100.6

Taken at their face value, these comparisons would seem to suggest that the errors involved in the imputation procedure as applied to the above items are very substantial. However, it is important to note that this is surely an extreme test of the possible imputation errors, since it is restricted in each case to a single month-to-month interval which, in the present context, has very special characteristics.[82]

Chart 6 presents monthly retail price relatives (Chicago, 1955–58) for all "part-year" items in the fresh fruits group and about half of those in the apparel group.[83] The chart shows very large up and down movements of fruit items during their pricing seasons and suggests that these movements often influence strongly the behavior of the total fresh fruits index. The apparel items, on the other hand, are very stable, their price relatives being frequently equal to 100, or approximately so, for several months.[84] (Prices of women's and girls' apparel are appreciably less stable than those of men's and boys' apparel). It should make little difference whether the off-season prices of these items are varied with the apparel group index or are held constant at their end-of-season levels.

A limited objective that the index maker may wish to pursue is to avoid sudden "breaks" in the series at the time a commodity reappears after its off-season period. This can be achieved retroactively through periodic revisions in which estimates for the seasonally disappearing items that are based on interpolation between the initial and the terminal dates of their respective off-season periods would be substituted for the original estimates based on extrapolation from the former dates. Another practical consideration is that the imputation procedure can be expected to present less difficulty when it is applied

[82] Another qualification, believed to be minor, is that the tabulation in the text lists the relatives for the year-round fruits only, whereas in the actual BLS procedure the relative used to estimate items during the off-season is based on a combination of year-round items and any of the "part-year" goods priced in the current month. (If one assumes that this procedure is extended to the first two months of pricing a seasonal item, then the price of the latter should, strictly speaking, be omitted from the estimating relative for these months.) We are indebted to Mr. Sidney A. Jaffe of the BLS for both the figures used in the tabulation above and the critical remarks on the significance of these comparisons.

[83] It should be noted that the price relatives in the first month of the pricing season are composed differently for fruits and for apparel. Those for fruits represent the change from the previous month's implicit price, which is the estimated price obtained by continuous application over the off-season period of the price relatives for all priced fresh fruits. Those for apparel represent the change from the end of the previous pricing season.

[84] The items included in Chart 8 are in this respect representative of those that have been omitted.

CHART 6

Monthly Retail Price Relatives for Seasonal Fruits and Apparel, Chicago, 1955-58

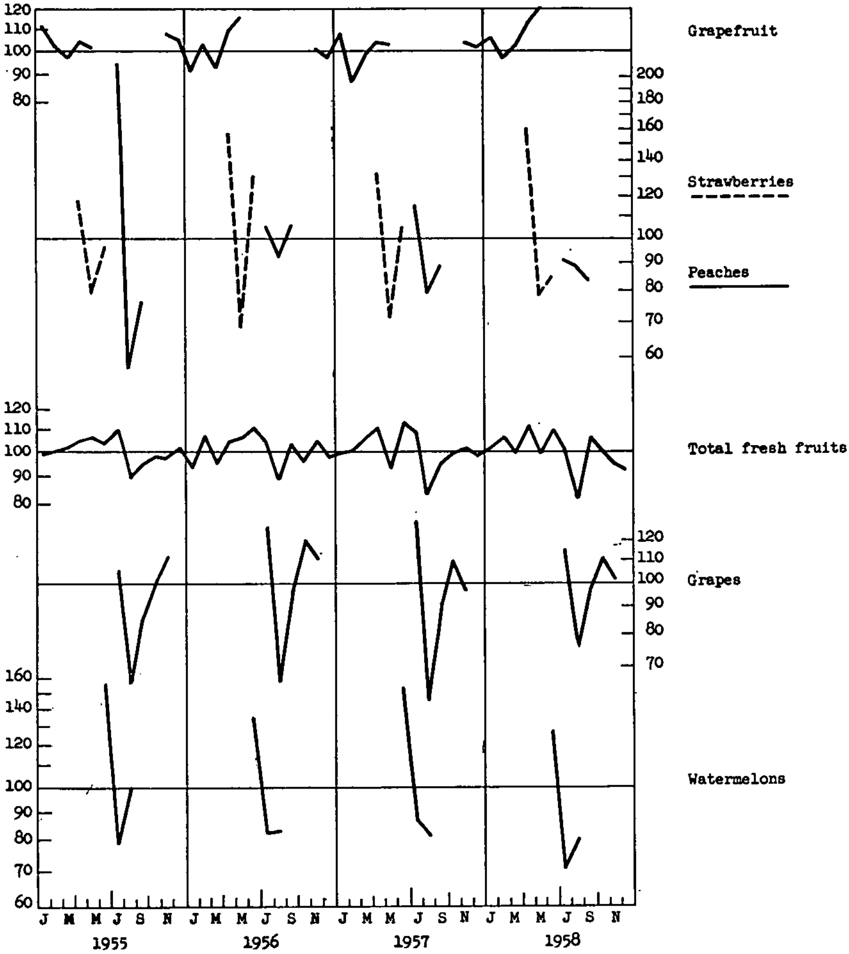
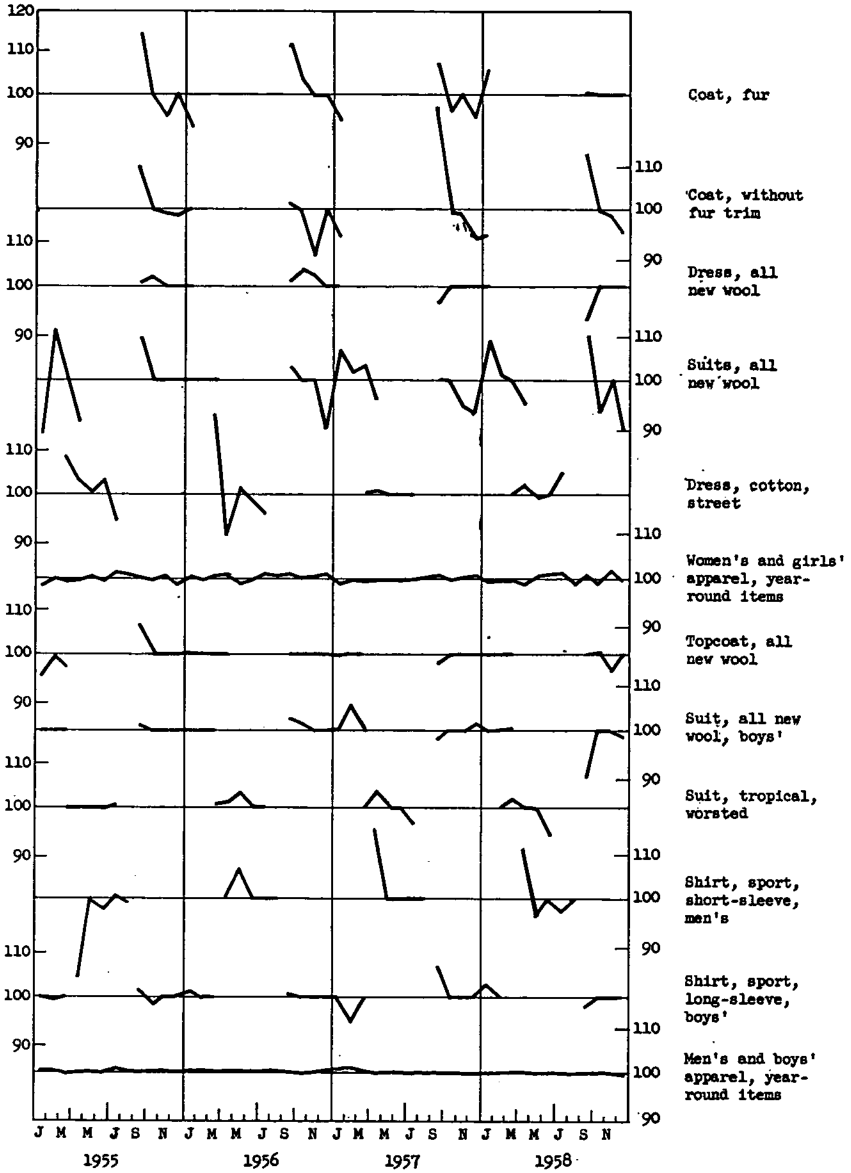


CHART 6—Concluded.



to seasonally adjusted price series than when unadjusted data are used. This is because the month-to-month changes are smaller in the former series and because elimination of their different seasonal components is likely to reduce the dissimilarity between the series used in the imputation procedures.[85]

b. *Wholesale Price Index.*—This index includes twenty-four "part-year" items evenly divided between a group of farm products (all fresh foods) and a group of apparel and textiles. These commodities and their pricing seasons are identified in Table XII.

TABLE XII.—*Items with Pricing Seasons of Less Than a Year in the U.S. Wholesale Price Index*

Line	Group and subgroup	Commodity	Code	Pricing season [1]
1	Farm products; Fresh fruits	Apples, Delicious	01-11-01	October-May.
2	Farm products; Fresh fruits	Apples, Winesap	01-11-02	March-August.
3	Farm products; Fresh fruits	Grapefruit, Florida	01-11-21	October-June.
4	Farm products; Fresh fruits	Oranges, Florida	01-11-26	October-July.
5	Farm products; Fresh fruits	Grapes	01-11-31	July-March.
6	Farm products; Fresh fruits	Peaches	01-11-36	July-September.
7	Farm products; Fresh fruits	Pears	01-11-41	July-May.
8	Farm products; Fresh fruits	Strawberries	01-11-51	Apr.-Aug., Nov.-Jan.
9	Farm products; Fresh and dried vegetables.	Cantaloupes	01-13-21	April-October.
10	Farm products; Live poultry	Turkeys, hens	01-32-80	June-January.
11	Farm products; Live poultry	Turkeys, toms	01-32-85	June-January.
12	Farm products; Oilseeds	Cottonseed	01-73-21	July-March.
13	Apparel; Women's and misses'.	Women's coat, trimmed	03-51-12	July-October.
14	Apparel; Women's and misses'.	Women's coat, untrimmed	03-51-14	May-December.
15	Apparel; Women's and misses'.	Women's skirt	03-51-62	January-May.
16	Apparel; Women's and misses'.	Women's skirt	03-51-66	May-December.
17	Apparel; Infants' and child	Girls' coat	03-54-12	May-December.
18	Apparel; Men's and boys'	Men's suit	03-52-06	September-April.
19	Apparel; Men's and boys'	Men's suit	03-52-07	October-May.
20	Apparel; Men's and boys'	Men's topcoat	03-52-12	July-October.
21	Apparel; Men's and boys'	Men's sport shirt	03-52-36	January-April.
22	Apparel; Men's and boys'	Boys' cotton broadcloth shirt	03-52-41	December-April.
23	Apparel; Knit underwear	Boys' polo shirt	03-56-15	November-February.
24	Textile products; Broad woven goods.	Tropical blend fabrics	03-33-32	June-March.

[1] Pricing seasons for food items are somewhat flexible, depending upon supply. Pricing seasons for apparel items are approximate, varying slightly for individual firms.

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor.

Until April 1959, prices of these items during off-season months were held constant. After that date, the practice regarding farm products was changed; their off-season prices are now imputed to the movement of the product class in which they fall. The constant off-season price method, however, is still used in the WPI for the apparel items.

c. *Prices Received by Farmers.*—Among farm products priced for this index are some that have short marketing seasons. For these commodities—the tobaccos, cottonseed, and seven fruit and vegetable crops—current prices are not available on a year-round basis.

In the case of tobacco, average prices for the most recent season are used for those types not currently sold. These are included along with the actual current prices of the actively marketed types in the average price of tobacco as a whole. The weights used in the computation of this U.S. average price are in all months the annual produc-

[85] The observations made in this paragraph of the text apply to the imputation method generally. They are thus equally pertinent to the problem of seasonal disappearances in the WPI (to be discussed presently) as they are to the same problem in the CPI.

tion estimates for the various tobacco types. As explained in a statement received from the Agricultural Marketing Service, use of the average price of current sales as the index price would result in drastic month-to-month changes due to shifts in the types being sold during different seasons.

In the case of cottonseed and the fruit and vegetable crops with short marketing periods (varying from 4 to 11 months), the price of the last month of the season is used in the index until the next crop starts to be marketed. The AMS statement notes that the use of the season average in the off-months of marketing (as in the case of tobacco) would here result in rather sharp shifts in price from the last price of the season toward that average and then again from the latter toward the first price of the new season. The practice of using the price of last month of marketing apparently causes fewer shifts and is thus considered preferable.

7. POSSIBLE IMPROVEMENTS AND FURTHER RESEARCH

It is clear that pronounced seasonal movements are characteristic of many price series and that they should not be ignored.[86] As a minimum, the series should be prepared and published in the seasonally adjusted as well as unadjusted form. True, given the present systems of fixed annual weights, the aggregate price indexes at our disposal are not truly "unadjusted" and mere application to such group or overall indexes of some standard statistical "deseasonalization" methods cannot assure us of the precise meaning and quality of the resulting "seasonally adjusted" series. But by adjusting the individual series and combining them with annual weights, aggregative indexes can be produced that may in practice be quite satisfactory as measures of the nonseasonal price change. There is obvious need for such measures and their regular calculation would, in this writer's view, be very desirable.

Beyond this, any possible improvement on a larger scale would involve the use of seasonal weights and be far more difficult and costly to achieve. But we do not face an "all or nothing" alternative in this area. The advance can be partial and yet significant, and the studies needed for a detailed decision of what can and should be done would be of great interest in themselves.

We need to know more about how stable the seasonal patterns of change in prices and quantities are over time. It is possible and rather likely that sufficiently stable and pronounced patterns exist for some part of the commodity universe but not for the rest of it. To identify these two parts would then be an essential prerequisite for a practical program of constructing a seasonal price index. For the portion of the index with large and stable seasonalities, a fixed-base, seasonal-weight formula would be appropriate. For the portion with small or variable seasonalities, annual weights would probably have to be retained, since chain indexes with seasonal weights are not likely to offer a practical solution. Periodic corrections of the results, perhaps with the aid of independently determined annual averages, are compatible with the seasonal procedures suggested and would pre-

[86] The problem of seasonally vanishing goods, in particular, cannot be avoided. Having given it much attention before, we need not return to it in these concluding remarks, except to say that the treatment of these commodities must be a compromise but as such should be made as logical and consistent as possible.

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sumably be needed. Indeed, a separation between monthly estimates and annual series may prove necessary if the requirements on a monthly series could not be met.

The most ambitious undertaking that might be considered in this area is an attempt to identify a basic set of seasonal market baskets of equivalent utility contents. To prepare the way for it, all available information bearing on seasonalities in quantities and prices would need to be brought together and appropriately systematized by groups with different degrees of substitutability. Existing studies of demand elasticities, etc., should be utilized. At the least, this work would indicate the dimension of gaps in our present knowledge that future effort should be directed to close. At the most, probably, the study would yield encouraging indications that the project can be accomplished within a reasonable period of time rather than being only of remote feasibility.

STAFF PAPER 6

CONSUMER DURABLES IN AN INDEX OF CONSUMER PRICES

Peter O. Steiner, University of Wisconsin

The focus of this paper is the proper treatment of durable consumer goods within an index number that is concerned with measuring the changes over time of *a fixed quantity and quality of goods and services* for an appropriately defined population. We take as given, first, the "fixed-base" concept, and second, the definition of the appropriate population (e.g., city wage earners and clerical workers in Cleveland). Since few goods are literally consumed at the moment of purchase, durability is an elusive concept but we shall limit attention to those commodities whose life is sufficiently long (relative to the consumption horizon of the population) that there is a relatively active market in used commodities of the kind in question. For such commodities there is a real question as to what is meant by a "fixed quantity and quality of goods and services": are these commodities consumption goods or are they assets which produce consumable services?

The oldest axiom of index number construction is that the purpose of use governs the form of the index and therefore it is in principle possible to justify a variety of different procedures. It is not difficult to think of uses for which each of the following three sorts of measures might be useful:

1. An index of the *prices of assets* purchased (or contracted for) by members of the index population.
2. An index of the *current outlays out of income* made by members of the index population.
3. An index of the *user (or opportunity) cost* of consuming the services produced by the assets in question.

For goods of very short durability, the concepts become virtually identical; for goods of substantial durability, but which are typically held for their whole useful lives and which are purchased regularly, the concepts differ, but the three tend to the same result. (This appears to be the case with clothing—while any individual piece has substantial durability, annual expenditures on clothing by the family are relatively stable. Whether it is true for furniture and appliances is not clear to me.) For commodities of long durability that are perforce purchased only intermittently because of the amount of expenditure (or investment) on the individual acquisition is a large fraction of annual income, the differences in the three approaches become substantial. Where in addition the assets are typically not held throughout their full useful lives, the differences become extreme. These conditions are strikingly present with respect to home ownership, and to a somewhat lesser extent with automobile purchase and use. We shall limit attention to these two classes of consumer durables.

Which approach is most nearly appropriate to the CPI? My own view is that it is the third: the user cost of consuming a fixed quantity and quality of services. With respect to housing, this would make the shelter cost of the homeowner congruent with that of the renter (with which it is ultimately combined in the overall index). With respect to automobiles (transportation), it would give proper perspective to the relative importance of this service to shelter, food, apparel, and other services. In this view, then, the index concerns valuation of the cost of using a fixed quantity and quality of services in all cases—although for many services this cost is adequately measured by the purchase prices of the service-producing commodity. Only where such prices prove a poor proxy for user cost is there need to approach the problem indirectly: that this is the case with both housing and automobiles will be shown in this paper.

Present BLS practice is to follow the first approach (asset prices) with respect to automobiles, and a mixture of the first and second approaches with respect to housing. A detailed description of present procedures may be found elsewhere; [1] some discussion of it will follow a development of the user cost approach.

I. The Cost of Using Asset Services

The overall problem may be viewed initially as three separable subproblems:

a. Determining the cost at different periods of time of using a particular asset service from an identifiable asset. This cost for the period dt in the neighborhood of time t we designate as $F_t dt$.

b. Determining the cost of using the asset service from a particular aggregate of assets. The characteristics of the fixed-base index permit visualization of an "average asset" whose cost of service for the period dt in the neighborhood of time t we designate as $\bar{F}_t dt$.

c. Finding appropriate weights that permit combination of the changes in the cost of this asset service with those of other services in an overall index of consumer services. Such weights are determined in the base period and correspond to the fraction of the index population consuming the service in question; we designate them as W_0.

Thus we may describe the desired measure as of the form

$$\frac{\bar{F}_t dt}{\bar{F}_0 dt} W_0 \qquad (1)$$

in which year 0 is the base year both for comparison and weighting purposes.

We may note that while equation (1) appears to be very similar to:

$$\frac{P_t}{P_0} W_0^* \qquad (2)$$

in which P_t is a price at time t, and W^*_0 is an appropriate weight at time 0, (1) and (2) will not move together unless $\bar{F}_t/\bar{F}_0$ is proportional to P_t/P_0—unless, that is, prices are an adequate index of

[1] See, for a start, *Monthly Labor Review*, November 1955, February 1956, and April 1956.

user costs. It is precisely in the case of durable goods that this may not be the case.

The fixed-base character of the desired index may be interpreted to mean the *use* of a given quantity of a prototype asset for a given period of time. This prototype asset has given physical characteristics, a given age, etc. (It may of course be a synthetic concept corresponding to an appropriate weighted average of actual assets differing in physical characteristics, age, etc.)

The principal components of user cost seem to be:

Depreciation (R)
Interest (I)
Incidental Purchase Costs (J)
Taxes (X)
Maintenance and Repair (MR)
Insurance (G)

Each of these requires careful definition; in principle it is the real cost in dollars of the period in question, whether such costs are reflected in cash outlays or not.

The general form of the required index is

$$\frac{\overline{F}_t dt}{\overline{F}_0 dt} W_0 = \frac{\overline{R}_t + \overline{I}_t + \overline{J}_t + \overline{X}_t + \overline{MR}_t + \overline{G}_t}{\overline{R}_0 + \overline{I}_0 + \overline{J}_0 + \overline{X}_0 + \overline{MR}_0 + \overline{G}_0} dt \cdot W_0 \cdot \qquad (3)$$

It is worth noting, for future reference, that if the relative size of the individual components changes over time, this does not decompose into an aggregate of separate indexes of the components. That is, if:

$$\overline{R}_t : \overline{I}_t : \overline{J}_t : \ \ldots \neq \overline{R}_0 : \overline{I}_0 : \overline{J}_0 : \ \ldots , \qquad (4)$$

$$\frac{\overline{F}_t dt}{\overline{F}_0 dt} W_0 \neq \frac{\overline{R}_t}{\overline{R}_0} w_0^R + \frac{\overline{I}_t}{\overline{I}_0} w_0^I + \frac{\overline{J}_t}{\overline{J}_0} w_0^J + \ \ldots \qquad (5)$$

where the w_0 are fixed-component weights. As we will show, there is nothing in the fixed based concept that requires the condition (4) to be an equation.

We turn to a component by component analysis.

A. A NOTE ON NOTATION

While there is nothing formidable in the algebra that follows, a number of different concepts are involved that make the notation complex. In order to be as nearly clear as possible, let me note certain rules of interpretation. (A general glossary of symbols appears as Appendix A.)

We are in all cases concerned with evaluation of costs at a moment in time t; but the costs refer to an interval dt, where dt is of the dimensions of fractions of a year. All magnitudes that are not clearly instantaneous magnitudes are annual rates or amounts unless otherwise indicated. Thus, if i is an interest rate, i_t is the annual rate at t, and $i_t dt$ is the monthly rate if $dt = 1/12$, etc. In our notation dt is not always infinitesimal.

But the assets at time t may be of different ages, and we let the subscript $j (j = t, t-1, t-2, \ldots)$ indicate the date at which the asset was new. $t-j$ is thus the age of the asset in years. While nothing inherently prevents fractional age, we arbitrarily assume assets have birthdays on a common date. We thus substitute a finite set of age strata for a continuous age distribution.

In a similar way the assets may have been purchased at different dates, and we let the subscript k ($k=t, t-1, t-2, \ldots j$) indicate the date of purchase by the present owner. $t-k$ is thus the years the asset has been owned, again assumed integral. If, but only if, the asset was purchased new, $j=k$.

If P designates price, ${}_tP_j$ indicates the price at t of the asset which was new at year j. If M indicates the size of a mortgage, ${}_tM_{k,j}$ indicates the size of a mortgage at t on an asset acquired in year k, when it was $k-j$ years old. (Its price at k was ${}_kP_j$), etc. In general we shall not identify individual assets, but where it is necessary to do, it will be by superscript. E.g., ${}_tP^i{}_j$ is the price of the i-th asset at time t (the asset was new in year j).

If f designates a frequency distribution, ${}_tf_j$ designates the frequency distribution over j at time t. f_{t-j} (or simply $f_{t,j}$) indicates that the frequency distribution is constant over time, that is, that the fraction of assets having a common pair of values for t and j is a function of $(t-j)$ alone. The difference between ${}_tf_j$ *and* f_{t-j} is that the former is a specific relation at time t, the latter is only a function of $t-j$. ${}_tf_{j,k}$ *and* $f_{t,j,k}$ are bivariate frequency distributions at time t. The latter is constant over time, the former is a changing function of t.

B. DEPRECIATION

1. The Problem: An Intuitive Introduction. To see the problem, consider the following simplified example. Suppose we purchase a new asset at $t=0$ for \$100. Two years later we can sell this used asset for \$128, but an asset identical to ours, brand new at $t=2$, would cost \$200. Suppose the following data:

t Year	Price of our asset ${}_tP_0$	Price of new asset ${}_tP_t$
0	100	100
1	80	100
2	128	200

It is clear that in some way it has cost us \$20 to hold and use the asset during the first year and an additional \$52 during the second year. These are the costs compared to the behavior of a nondepreciating asset. An adequate allowance for depreciation should give us a fund of \$20 at the end of the first year and an aggregate fund of \$72 at the end of the second year. Our problem is to determine how large a contribution to make to this fund during every short time period dt in order that the aggregate amount of the fund is adequate to acquire a new asset in exchange for our used one. Suppose that at $t=1$ we (somehow) had a depreciation fund on hand of the required \$20. Would we have needed to find an additional \$52 during the second year? Not if the fund on hand at the beginning of the period had been properly invested. Indeed, if it had been invested in assets of this type, it would have shared in the asset inflation and been worth \$40 by $t=2$. If we wait until the end of year 2, it would be necessary to contribute \$32 to the fund; but if we set aside each month (week, day, minute) a contribution which was invested (and shared in the inflation), it is clear that the sum of required actual contributions would be less than \$32 in the aggregate.

Of course, using a depreciating asset during a period of rising asset prices is expensive. During this period the owner-user of the asset is (1) consuming in each moment a service which decreases the value of the asset and should be "costed" in current dollars of the moment of consumption, *and* (2) disinvesting implicitly and perhaps unconsciously. Roughly, the distinction is that the first of these causes the loss of value during the period in question whereas the second leads to the loss of capital appreciation in the periods lying ahead of the disinvestment. The second is of course costly, but it is not a proper cost of *using* the asset service for it might be conceptually avoided in any of several ways (that are equivalent): one is to keep utilizing an asset of constant age by trading in a one day (minute) old asset for a new but otherwise identical one every day (minute); another is to invest in a sinking fund that appreciates at the rate of inflation. Each of these succeeds in keeping the real asset position constant, while measuring the unavoidable cost of using the asset to produce its service.

It seems quite clear to me that maintaining a fixed real asset position is appropriate within the context of the fixed-base index number of the costs of goods and services. But if this is not clear—if some rate of "asset acquisition" belongs in such an index—it is evident that it should be included as a separate category and not be confused with the cost of using asset services.

2. Depreciation of an Individual Asset. Let ${}_tD_j$ = the required size of a depreciation fund at time t for an asset that was new in year j.

$$ {}_tD_j = {}_tP_t - {}_tP_j. \tag{6} $$

At time t we want a fund ${}_tD_j$; at time $t-dt$ we have a fund ${}_{t-dt}D_j$. Assume this fund, and all subsequent additions to it, is actually or conceptually viewed as invested in assets whose prices move with the price of the asset in question. It thus appreciates (if asset prices are rising) at an annual rate r_t defined immediately below. Consider the year as divided into n periods of length dt. Further, let each period dt be divided into m subperiods.

We will define r_t by the condition that

$$ {}_tP_t = {}_{t-dt}P_{t-dt}\left(1+\frac{r_t dt}{m}\right)^m $$

and letting $m \to \infty$

$$ e^{r_t dt} = {}_tP_t / {}_{t-dt}P_{t-dt}. \tag{7} $$

Our problem is to determine the required amount of contributions (${}_tR_j dt$) to the fund during the period dt so that the fund has the required size at time t. We visualize making m equal contributions, one in each of the subperiods.

$$ {}_tD_j = {}_{t-dt}D_j \cdot e^{r_t dt} + \frac{{}_tR_j dt}{m} (S_{\overline{m}|}), \tag{8} $$

where $S_{\overline{m}|}$ is the amount of an annuity of unit value after m subperiods at an "interest rate" of

$$ \frac{r_t dt}{m} $$

per subperiod.

$$ S_{\overline{m}|} = \frac{m}{r_t dt}\left[\left(1+\frac{r_t dt}{m}\right)^m - 1\right]. \tag{9} $$

Define:

$$ {}_t\alpha_j = {}_tP_j / {}_tP_t, \; all\ t,j, \tag{10} $$

and note that the α's provide the structure of used to new asset prices at the same moment in time. We will assume that ${}_t\alpha_j$ is a constant for a given t and j—in other words, it is the "average" or "normal" used to new asset price ratio at time t, and does not vary among individual assets of the same age at that time. (See the discussion of maintenance and repair, below, for the justification of this assumption.)

Rewriting (6), using (7) and (10), we have:

$$ {}_tD_j = {}_tP_t\ (1 - {}_t\alpha_j) $$
$$ {}_{t-dt}D_j = {}_{t-dt}P_{t-dt}\ (1 - {}_{t-dt}\alpha_j) = \frac{{}_tP_t}{e^{r_t dt}}\ (1 - {}_{t-dt}\alpha_j). \tag{11} $$

Substituting (9) and (11) in (8).

$$ {}_tP_t\ (1 - {}_t\alpha_j) = {}_tP_t\ (1 - {}_{t-dt}\alpha_j) + \frac{{}_tR_j dt}{r_t dt}\left[(1+\frac{r_t dt}{m})^m - 1\right]. $$

Letting $m \to \infty$, and solving for ${}_tR_j dt$,

$$ {}_tR_j dt = {}_tP_t \cdot \left(\frac{r_t dt}{e^{r_t dt} - 1}\right)\left({}_{t-dt}\alpha_j - {}_t\alpha_j\right) \tag{12} $$

which is the charge for depreciation sought.

This is an important result and its interpretation may be clarified by the following remarks. Evidently we have factored the depreciation charge into three parts, the second and third of which are dimensionless coefficients whose significance is explained presently. The first term is the current price of the new asset of the prototype—the replacement cost, if you will. As we have suggested earlier, if prices are rising using a depreciating asset is more expensive than otherwise, and the ${}_tP_t$ term, besides giving magnitude and dimension to the depreciation charge, reflects this fact.

But not all of the change in price level requires a corresponding contribution, for, as we have seen, inflation (to take the rising price case) increases the value of past contributions to the depreciation fund. The second term reflects this influence. If prices are rising, it has a value between 0 and 1; if falling, greater than 1. It is a function of ${}_tP_t$ and ${}_{t-dt}P_{t-dt}$ only.[2] It appears in the expression because we assume that past and present contributions to the depreciation fund change in value with the asset price level.

The justification of this assumption is that it has the effect of separating the cost (if asset prices are rising) or gain (if asset prices are falling) of disinvestment from the cost of using an asset while keeping the total real asset position constant. Thus if the owner of the asset has access to investments that change in value at the rate $r_t dt$, it is the appropriate rate to use whether he chooses actually to invest in them or not.[3] What if he cannot find such investments? Life will cost him more (if prices are rising), but whether this is a proper cost of consuming the asset service is a priori unclear. On the one hand, if there exist nondepreciating assets that appreciate at this rate but, owing to some imperfection in asset markets, the individual owner is denied access to them, he will suffer a (relative) real asset loss over time no matter what assets he holds, depreciating or not. Whether this should be included in his cost of living as the "cost of holding assets" or whether it should be regarded as a change in his income position, it *is* clear that it is not the cost of using the depreciating asset. In this case the use of rdt is still appropriate. On the other hand, if the imperfection in the asset market is such that there exists *no* nondepreciating asset whose price rises at the rate rdt (or more), the excess cost is truly an unavoidable cost of using the asset service.[4] This possibility is subsequently neglected. It does not seem very plausible to me.

The third part of equation (12), ${}_{t-dt}\alpha_j - {}_t\alpha_j$, which will hereafter be designated as ${}_tA_j$, is a determinable function of the age of the asset in question. Since each of the α's reflects the used to new asset price at a moment in time, it may be regarded as the pure effect of age on value. ${}_tA_j$ shows the *joint* effect of the asset growing one period older *and* of any change in the normal used to new price ratio that may have occurred during the period. To see that the latter is a proper cost of using the asset, consider the owner of a car who finds to his dismay that used car prices have collapsed, thus reducing his expected trade-in value. This has been an unanticipated but nonetheless real cost of using the car during the period.

If for a particular type of asset there is a constant age-price structure over time, so that we may replace the ${}_t\alpha_j$ by a_{t-j}, it is often possible

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[2] See the following:

$$\frac{rdt}{e^{rdt}-1} = \log_e \frac{{}_tP_t}{{}_{t-dt}P_{t-dt}} \Big/ \left(\frac{{}_tP_t}{{}_{t-dt}P_{t-dt}} - 1\right)$$

[3] Note that we do not credit earnings to the sinking fund. There are of course costs of holding nonearning assets but these are properly treated as implicit (or actual) interest charges and are quite independent of depreciation as such. Depreciation of course can affect interest costs as we shall see below.

[4] If this is the case, if nondepreciating assets rise at the rate $\pi_t < r_t$, we must replace (12) by:

$${}_tR_j dt = {}_tP_t\left(\frac{\pi_t dt}{e^{\pi_t dt}-1}\right)\left[(1-{}_t\alpha_j) - \frac{e^{\pi_t dt}}{e^{r_t dt}}(1-{}_{t-dt}\alpha_j)\right]. \qquad (12a)$$

to define A_{t-j} in simple algebraic form. Consider the following cases (assume $dt=1$):

Straight line depreciation over n years:

$$\alpha_{t-j}=\frac{n-(t-j)}{n}$$

$$A_{t-j}=\frac{1}{n}$$

Declining balance, where a constant proportion, a, of the remaining value is deducted each year:

$$\alpha_{t-j}=(1-a)^{t-j}$$

$$A_{t-j}=a(1-a)^{t-j-1}$$

Sum of years' digits, over n years, where

$$Y=\sum_{i=0}^{n} i$$

$$A_{t-j}=\frac{n-(t-j-1)}{Y}$$

If a constant (for a given $t-j$) pattern of age-price ratios is not appropriate, it is necessary to retain the ${}_tA_j$ which is a function of t as well as $t-j$.

An explicit expression of ${}_tA_j$ is:

$$ {}_tA_j=\frac{{}_{t-dt}P_j\cdot e^{r\,dt}-{}_tP_j}{{}_tP_t}$$

the numerator of which shows the value of the specific asset at the beginning of the period inflated by the rise in asset prices over the period, minus the terminal value; in other words, the loss in value (in constant dollars of t) due to aging.[5]

3. Depreciation of the Asset of Average Age. At time t, suppose there exist in our population ${}_tN$ assets which were identical when new but whose age varies. Suppose we regard them as divided into j strata by year of origin, and assume that all assets of the same age (${}_tN_j$) are fully homogeneous. By definition,

$${}_tN=\sum^{j}{}_tN_j$$

and we define:

$${}_tf_j=\frac{{}_tN_j}{{}_tN},$$

which, as j varies, defines the frequency distribution of assets by age, at time t.

In the previous section we dealt with a particular asset—call it the i-th—and found in equation (12) an expression for ${}_tR^i{}_jdt$ (where the superscript i identifies the particular asset). We need now merely

[5] The reader who suspects that this would be a more convenient form of ${}_tA_j$ than that given in (12) would be correct if (1) we were concerned with a single asset age only and (2) if ${}_tA_j \neq A_{t-j}$. Since the actual problem involves an aggregation of assets of different ages, and since it may frequently be possible to assume ${}_tA_j = A_{t-j}$, the coefficient form proves useful.

to sum over i and j and divide by ${}_tN$ to determine the average depreciation, which we will designate $\overline{R}_t dt$.

$$\overline{R}_t dt = \frac{1}{{}_tN} \sum^{j} \sum^{i} {}_tR^i{}_j dt = \frac{1}{{}_tN} \sum^{j} {}_tN_{j\,t}R_j dt = \sum^{j} {}_tR_j \cdot {}_tf_j \cdot dt$$

$$\overline{R}_t dt = {}_tP_t \left(\frac{r_t dt}{e^{r_t dt} - 1} \right) \sum^{j} {}_tA_{j\,t}f_j. \tag{13}$$

The ${}_tf_j$ are weights reflecting the age distribution of assets. The fixed-base concept requires "exclusion of changes in quality" and requires a constant age distribution. Hence the ${}_tf_j$ can be replaced by f_{t-j}—a constant set of weights determined in the base year. The summation is thus a weighted average of the ${}_tA_j$ with a fixed set of weights determined once and for all. If the ${}_tA_j$ are constant $(=A_{t-j})$, the whole summation is a constant, determinable in the base period. But even if this is not the case, the data required seem within reach since estimates of the structure of used asset prices for particular types of assets are commonly made in fields where an active used asset market exists.

4. DATA REQUIREMENTS

To compute the depreciation component for a period dt requires: (a) ${}_tP_t$ and ${}_{t-dt}P_{t-dt}$, the prices of a new asset of the prototype at the beginning and end of the period, (b) f_{t-j}, the age distribution of assets in use in the base period, (c) ${}_tA_j$, the structure of used to new asset prices for asset ages included in the f_{t-j}, at both the beginning and end of the period. (If ${}_tA_j = A_{t-j}$ this is a once and for all determination, and it may be possible to find a simple algebraic equivalent.)

Put differently, this requires, for a continuing index, at most ${}_tP_j$ for all relevant t and j, plus the base year age distribution. Precisely the same data are required merely to measure the weighted average asset value.

5. Comparison with Present Practice. The BLS index includes both housing and automobiles but in neither case includes a direct depreciation component, since it rejects the user cost approach.[6] It is possible, however, that the purchase price component (which is the way in which automobiles are included, and is one of the components of the BLS owned-housing index) may serve as a satisfactory proxy for depreciation. That this need not be so is shown in Part II of this paper; the reasons can be quickly seen analytically.

Using our notation, the weighted average purchase price in year t is

$$\overline{P}'_t = \sum^{j} {}_tP_j f'_{t-j} = {}_tP_t \sum^{j} {}_t\alpha_j f'_{t-j} \tag{14}$$

where the f'_{t-j} are the frequency distribution of ages of houses purchased (and may of course differ from f_{t-j}—the age distribution of assets in use).

[6] The apparent use by the BLS of a depreciation factor in the automobile computation (described in *M.L.R.*, November 1955) is only for an intrayear adjustment of prices, and is not material to the comparison we make. It comes about because annual birthdays are assumed and thus one cannot define an exactly three-year-old car in, say, both January and July of the same year. We may note in passing that this intrayear adjustment is made only for used cars, not for new ones, and thus appears to neglect the well-known obsolescence of new cars toward the end of the model year.

Comparison of (13) and (14) makes clear three main sources of difference. First, the f'_{t-j} may differ from f_{t-j}. Second, the ${}_t\alpha_j$ need not be proportional to the ${}_tA_j$.[7] Thirdly, the expression in parentheses in (13) need not equal unity—indeed it will do so only in the (uninteresting) case where prices do not change.[8] It would thus be fortuitous indeed if (14) were an adequate proxy for (13).

Even if $\bar{P}'_t/\bar{P}'_0$ was a good proxy for $\bar{R}_t/\bar{R}_0$, it is worth noting that all would not be well as comparison of (3) and (5) above makes clear, and as subsequent examples will illuminate.

C. INTEREST

1. The Nature of the Problem. We wish to know the interest cost during the period *dt* of using the asset in question. This cost may be viewed as the sum of (1) the interest payments on the mortgage (or other loan), if any, which will be determined by the size of the mortgage during the period and by the terms of the loan—including the contract rate of interest and the length and pattern of payoff (which in most cases are a function of the credit conditions at the time the loan was initially contracted), and (2) the imputed interest on the owner's equity in the asset, which depends upon the equity during the period *dt* and appropriate *current* interest rate at which his funds might otherwise be invested.[9]

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[7] Proportional (rather than equal) would be sufficient because it would be easy to inject a constant for level. But they will in general be proportional if, but only if, two conditions are met:

(a) $${}_tA_j = A_{t-j} \qquad \text{(all } t, j\text{)} \qquad \textit{and}$$

(b) $$\frac{{}_t\alpha_j}{{}_t\alpha_{j+dt}} \text{ is constant, all } j.$$

Proof: $${}_tA_j = {}_{t-dt}\alpha_j - {}_t\alpha_j$$

for ${}_tA_j = \lambda\,{}_t\alpha_j$, all t, j, where λ is any constant, requires

$$\frac{{}_{t-dt}\alpha_j}{{}_t\alpha_j} = \lambda + 1$$

For this to be true, it requires for all t, j that:

$$\frac{{}_t\alpha_j}{{}_t\alpha_{j+dt}} = \frac{{}_{t+dt}\alpha_j}{{}_{t+dt}\alpha_{j+dt}}$$

which implies both of the stated conditions.

These conditions are met by the constant declining balance special case discussed above.

[8] The limit of $\frac{rdt}{erdt-1}$ is 1 as $e^{rdt} \rightarrow 1$.

[9] A refinement not incorporated in the subsequent analysis is to recognize that some portion of interest (and also taxes) actually paid will be recovered as a tax credit by those who itemize deductions. Thus we might in subsequent equations introduce a number, $0 < \Theta \leq 1$, which would represent the fraction not recovered tax-free. E.g., in equation (18), replace the expression in parentheses by $(\Theta c^*_t - i_t)$.

While it does not seem safe—especially with respect to home ownership—to assume $\Theta = 1.0$, determination of its magnitude is so difficult as to make this a nonoperational refinement. Even if we knew the percentage of individuals in the relevant population itemizing deductions, and the marginal tax rate for this group—and these I suspect could be obtained—we would have only a lower bound to Θ, since not all of the interest paid would be deductions in excess of the optional 10 percent of adjusted gross income.

The current opportunity cost rate at which the owner can invest we will designate i_t and call the lending rate. Its estimation depends upon what in fact are the lending opportunities (and proclivities) of the particular group who form the index population. Perhaps for the CPI population it may be taken as the current rate on savings deposits, by banks, credit unions, or savings and loan associations.

That this lending rate may differ from the *contract* rate on mortgages, which we will designate c^*_k, is due first to the well-known fact that lending and borrowing rates may differ, and second to the fact that i_t refers to the current rate whereas c^*_k depends upon the (past) conditions at the time the mortgage was negotiated.

Should we limit attention to interest actually paid? While this might be appropriate under a cash outlay approach to the index number problem, it is not appropriate in our user cost approach unless $i_t = 0$. It is perfectly apparent that as long as federal deposit insurance is available and banks pay interest on savings deposits, no one is forced to hold idle cash, and thus i_t is not properly regarded as equal to zero.

Whether we should also charge imputed interest on the reserve funds for depreciation is not clear. The general rule is that such imputation is appropriate when, but only when, earning opportunities must be foregone. Since these reserve funds are conceptually invested in nondepreciating assets whose price behavior is similar to that of the asset in use, they are conceptually tied up. The question is whether such investments have earnings (interest or dividends) and if so how such earnings compare to the lending rate. If these investments earn at the lending rate (after allowances for differences in risk), no charge is required. This (easiest) case is assumed in the formal development that follows. If the earnings rate is lower than the lending rate, only the difference is an appropriate charge. If the adjusted earnings exceed the lending rate, an interest credit is earned.[10]

2. Interest on an Individual Asset. The problem of interest is somewhat different from depreciation because it is necessary to pay attention to the age of the mortgage as well as the age of the asset. (We shall assume that mortgages date from the date of acquisition of the asset, and neglect refinancing, etc.) Owner's equity at any time is the difference between the current price of the asset and the remaining size of the mortgage.

For individual asset (identifying superscript omitted), the instantaneous annual rate of interest cost at t is

$$ {}_tI_{k,j} = ({}_tP_{k,j} - {}_tM_{k,j})i_t + {}_tM_{k,j}c^*_k = {}_tP_{k,j} \cdot i_t + {}_tM_{k,j}(c^*_k - i_t) \tag{15} $$

where k is a running subscript indicating the year the mortgage is

[10] The effect of our assumption is to simplify equations (15) to (18). For example, to (15) should be added; ${}_tD_t\ (i_t - i^*_t)$ where i^*_t is the adjusted rate of earnings on the depreciation reserve. This refinement, like that in the previous footnote, seems doomed by a sensible attention to operationality.

acquired, M is the amount of the mortgage, and the other terms are as previously defined.[11]

${}_tP_{k,j} = {}_tP_j$ since year of acquisition by present owner does not (we assume) affect the price of an asset of given age at time t.

Equation (15) is the instantaneous interest charge, not that for the period $t-dt$ to t. It would appear that to merely multiply this by dt would introduce a systematic downward bias into our formulation, since the size of a mortgage at the end of the period is less than its effective average size. But this is such a convenient approximation that it is used and the downward bias does not occur after aggregation. This is because while the individual mortgage (the tree) grows older, the age distribution of mortgages (the forest) does not, and thus the average age of mortgage remains constant.

Thus, before aggregating we use

$$I_t dt = \left[{}_tP_j i_t + {}_tM_{k,j}(c^*_k - i_t) \right] dt. \tag{16}$$

3. Interest on the Average Asset. We want (simply) to find:

$$\bar{I}_t dt = \frac{1}{N} \sum^{k} \sum^{j} \sum^{i} I_t dt. \tag{17}$$

To do so we need the bivariate frequency distribution of our N assets by age of asset and age of mortgage.

Let ${}_tf_{k,j}$ represent such a bivariate distribution where

f_{t-k} is the distribution of mortgages by age of mortgage

f_{t-j} is the distribution of assets by age of asset

f_{k-j} is the distribution of ages of assets for a given k

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[11] The amount of the remaining mortgage is a simple actuarial function of the size of the original mortgage, given c^*_j and the length and type of repayment formula. For a characteristic mortgage calling for n equal payments per year for T years of principal and interest, we may define a remaining mortgage multiplier

$${}_td_k = \frac{{}_tM_{k,j}}{{}_kM_{k,j}} = \frac{a_{\overline{n(T-tk)}|} \text{ at } c^*_k}{nT}$$

(where $\overline{a}|$ stands for the amount of a unit annuity).

Where nT is large, the continuous approximation to this is:

$${}_td_k = \frac{1 - e^{-c^*_k [T-(t-k)]}}{1 - e^{-c^*_k T}}.$$

If, in addition, the original mortgage is a fixed fraction c_k of purchase price, so that

$$c_k = \frac{{}_kM_{k,j}}{{}_kP_j},$$

$${}_tM_{k,j} = {}_td_k . c_k \, {}_kP_j.$$

Note that we here assume that both ${}_td_k$ and c_k are independent of the age of the house (except as age affects price). This may be wrong—terms of credit may vary with age of houses, but this is a further complication not included at present.

While for computation this is a convenient formula, particularly if terms of credit except interest rate remain stable, we will deal with ${}_tM_k$ only in the algebraic formulation, in order to avoid unnecessary proliferation of terms.

all assumed constant over time.

$$\sum^{k} f_{t-k} = \sum^{j} f_{t-j} = \sum^{k} \sum^{j} f_{t,k,j} = 1$$

We further assume that the N assets are divided into j, k strata and all assets having identical j and k subscripts are homogeneous in all respects.

Performing the operations indicated in (17) we find:

$$\bar{I}_t dt = \left[{}_t\bar{P}_j i_t + \sum^{k} (c^*_k - i_t)\, {}_t\bar{M}_k f_{t-k} \right] dt \qquad (18)$$

$$\text{where } {}_t\bar{P}_j = \sum^{j} {}_tP_j\, f_{t-j}, \text{ and}$$

$${}_t\bar{M}_k = \sum^{j} {}_kM_j f_{k-j}.$$

This says that the interest charge is the imputed interest on the market value of the asset, plus the excess of contract interest paid over imputed interest on the mortgaged portion. If by any chance ${}_t\bar{M}_k$ is a constant, the summation in (18) reflects a weighted average of past interest rates. If not, it is a somewhat more complicated weighted average.

4. Data Requirements. The data requirements are, in a word, substantial. We require:

(a) The ${}_tP_j$ for all relevant j,

(b) The bivariate asset-mortgage age distribution $f_{t,j,k}$ for the base year,

(c) The contract interest rate c^*_k for all relevant k,

(d) The average size of outstanding mortgage for mortgages of each age. This may be most easily estimated directly or it may be derived by using "average" terms of credit in each relevant past year (including downpayment size and length of payoff period in addition to contract interest rate) as described above.

(e) The *current* lending rate i_t.

Of these, it is (b) and (d) that will be most difficult, but there are any number of simplifying assumptions that would reduce the data requirements, and I leave it to others to investigate whether they are justifiable as approximations.

The greatest simplification of all would be if the differences between c^*_k and i_t are small. If $i_t = c^*_k$ the entire summation of (18) vanishes. I doubt if this is justifiable, but the smaller is $(c^*_k - i_t)/i_t$, the less influence the summation term has in the total $\bar{I}_t$.

A less drastic simplification would be to regard the average size of remaining mortgages as a simple function of, say, ${}_t\bar{P}_j$ (as determined perhaps by a survey in the base year). This assumption would permit pulling the average size of mortgage out of the summation of (18) and multiplying it by a moving average of past contract interest rates, the weights reflecting the rate of acquisition of mortgages (taken perhaps as equal to purchases of assets) in the past years.

The potential error in this assumption is that it neglects changes in the terms of credit other than interest rate, specifically the size of downpayments and the length of mortgage payoff periods. It would not be impossible to "adjust" an average mortgage figure for such changes, or to estimate it in a more sophisticated manner.[12]

In short, if contract rates and other terms of credit vary over time, and if contract rates differ substantially from the imputed lending rate, it is necessary to have some estimate of both size and age distribution of mortgages. Given complete data, an exact determination is possible, using (18). But "sufficiently accurate" estimations may be possible using much less data.

5. Comparison with Present Practice. Interest plays an important role in the BLS index with respect to owned housing, and we shall make the comparison in that context. The concept used is: *interest payments contracted for in the current year for mortgages acquired in that year.* For an individual house, given its price and the credit terms in the current year, it is a straightforward actuarial computation to determine (1) the size of the mortgage and (2) the total payments of principal and interest to be made over T years under the terms of the contract. The difference between these two is the amount of interest contracted on that house. The BLS *concept* is a weighted average of these amounts, weighted by distribution of *purchases* in the base year.[13]

It may be noted initially that this concept fits, if at all, only within the first of the conceptions of an index number, discussed in the first pages of this paper. The "current outlay" approach (not advocated here) would use payments of both principal and interest and would be based on all assets owned, not merely current purchases. The user approach, described above, would include current ineterest payments on mortgages of all ages. Apparently the BLS justification is that this is the cost of purchasing a debt instrument without which the house could not have been acquired. Whether this is an appropriate real measure of that cost is questionable in view of the fact that the average actual life of mortgages is substantially shorter than their contract lives, given the mobility of the American population. Leaving this objection aside, it is not clear why future payments are not subject to discounting to find the present value of the future commitment.

For a mortgage of M dollars, contracted at time t, the

$$\text{Interest Contracted} = M \cdot a^{-1}_{\overline{nT|}} \cdot nT - M$$

(where $a^{-1}_{\overline{nT|}}$ is the present value of an annuity of \$1 for nT periods)

$$= M\left[\frac{c^*_t}{n}\frac{1}{1-(1+c^*_t/n)^{-nT}} - 1\right]$$

[12] One might, for example, try to find an estimation relation of the form:

$$\overline{M}_t = a_1 + a_2\overline{P}_t + a_3\overline{T}_t + a_4\overline{c}_t + a_5\overline{c}^*_t$$

where $\overline{T}_t$, $\overline{c}_t$, $\overline{c}^*_t$ are appropriate weighted moving averages of past terms of credit.

[13] In *practice*, the BLS departs from this concept by taking the terms of credit other than the contract interest rate (c, T) as fixed in the base year. This may be a justifiable simplifying assumption, but it has no inherent logic whatsoever. Our comparison will be with the concept rather than the practice, since we may wish to modify our concept in a similar way to reduce the data requirements, discussed above.

and where n is large, this may be approximated by

$$=M\left[\frac{c^*_t}{1-e^{-c^*_t T}}-1\right]. \tag{19}$$

If we consider mortgages on purchases of different ages, the average amount of interest contracted is

$$\sum^{j} {}_tM_j\left[\frac{c^*_t T}{1-e^{-c^*_t T}}-1\right]f'_{t-j} \tag{20}$$

where the f'_{t-j} are the appropriate purchase weights.

Even brief comparison will show this is totally different from (18). The magnitude of the expression in brackets may be of interest. If $c^*_t=.05$ and $T=20$, it has a value of .582. In other words, a $10,000 mortgage acquired under those terms would have an amount of interest contracted of $5,820. Of course, since the purchase weights are small, this magnitude is subject to a considerable reduction, but, as will become clear in a subsequent example, it is quite fortuitous if the overall interest charge in any given year is congruent with the annual amounts of interest paid or imputed. This is significant because it may distort the influence given to interest in the broader context.

The reason that only the current contract interest rate appears in (20) is that this concept of interest is prospective rather than retrospective, and prospective interest payments on current contracts are based on current rates.

D. INCIDENTAL PURCHASE AND FINANCE EXPENSES

These costs, often described in the housing field as closing costs, should (it may be argued) be amortized over the length of asset ownership, but their significance is sufficiently small that it seems satisfactory to treat them as current expenses in the year incurred. This avoids the need to predict the subsequent duration of ownership of assets currently purchased and also avoids a substantial computation.

We note that, in this view, the amount of such charges is aggregated only over the fraction of assets actually acquired in any year.

The appropriate cost figure may be written directly for the average asset:

$$\bar{J}_t dt=\sum^{j} {}_tJ_j f'_{t-j} dt \tag{21}$$

where the f'_{t-j} are the *purchase* weights such that

$$\sum^{j} f'_{t-j}=\frac{{}_tN_{k=t}}{{}_tN}.$$

The fiction of a constant age distribution of assets implies that

$$\frac{{}_tN_{k=t}}{{}_tN}$$

is a constant.

The data required are at most the ${}_tJ_j$ and the f'_{t-j}. If we can suppose that the ${}_tJ_j$ are at any time a constant fraction a_t of purchase prices, and independent of age except as age affects purchase price, the expression simplifies to

$$\bar{J}_t dt = \bar{P}'_t a_t \frac{{}_tN_{k-t}}{{}_tN} dt \tag{22}$$

in which only $\bar{P}'_t$ and a_t vary over time. (There are of course reasons for supposing that these incidental purchase costs may vary among assets of different ages, but perhaps the differences are sufficiently stable over time that the contrary assumption is workable.)

The procedure implied by (22) corresponds to the BLS practice with respect to housing with the additional assumption that a_t is a constant over time, as determined in the base year. We may note that this is the *only* place where use of purchase weights is deemed appropriate in the *user cost* approach, and here as a simplification that is acceptable only because these incidental purchase costs are in general quite small.

E. TAXES AND ASSESSMENTS

Since we are dealing with an aggregate of assets of constant age distribution, there is no serious problem here. The amount of taxes (X) on a given asset is the assessed valuation times the tax rate. For a collection of assets, we have the current tax rate times the weighted average of assessed valuations

$$\bar{X}_t dt = \left[x_t \sum {}_tV_j f_{t-j} \right] dt \tag{23}$$

where x_t is the annual tax rate, and ${}_tV_j$ the assessed valuation.

Equation (23) requires data on assessed valuations of houses of all relevant ages. One simplifying assumption would be to assume that assessed valuations are proportional to prices. A second is to assume that the ratio of assessed valuations of assets of different ages, ${}_tV_j / {}_tV_{j+1}$, is constant over time. This is equivalent to the first assumption if, but only if, ${}_t\alpha_j = \alpha_{t-j}$, for all j.

Supposing the second assumption is adopted, let V_{t-j} be the assessed valuation of an asset of age $(t-j)$ in the base period, and let $\bar{V}_t / \bar{V}_0$ be the average increase in assessed valuation in year t over the base year $(t=0)$. Then (23) becomes

$$X dt = \left[x_t \frac{\bar{V}_t}{\bar{V}_0} \sum^{j} V_{t-j} f_{t-j} \right] dt \tag{24}$$

where the summation is a constant.

Equation (24) corresponds to the concept used by the BLS in its owned housing computation. It may be noted that here BLS uses *ownership* weights, not purchase weights.

F. MAINTENANCE AND REPAIR COSTS (MR)

It seems sufficiently accurate to assume MR expenditures are paid for currently and that the real amount of MR is a function only of the age of the asset in question. If so, the only problem is the definition of what is appropriately considered *MR*. For, given this, we can (given the constant age distribution of assets) estimate the amount of *MR* in the base year and multiply it by a price index of an appropriate sample of maintenance prices.

But while the definitional issue is the only issue, it is important and it is closely related to the concept of depreciation discussed previously. For some of what may be loosely called *MR* expenditures may be in lieu of depreciation, and some may be improvements. For some durables, say automobiles, the distinctions may be clear cut; for some, such as houses, they may be blurred.

In principle the appropriate *MR* expenses on a particular asset are those just required to let the ratio of the price of the used asset to a new asset be at the level indicated by the depreciation ratios—the a's in our earlier notation. That is, depreciation ratios imply some normal or standard condition of used assets, which in turn imply some average amount of *MR*. Actual expenditures on maintenance and repair items may, in individual cases, depart from this normal amount in either direction, and this will be reflected in a variance in actual prices of used assets of the same age. It is clear that if actual and implicit *MR* figures differ, it is the latter that is appropriate in computing the base year *MR* expenditures.

While it is clear that for individual assets actual *MR* may differ from normal, there may be no problem at the level of aggregation actually used. The BLS reports its concept for housing as "estimated average amount paid . . . in the base year." [14] If depreciation ratios are based on the average asset (and if the "averages" are comparable), average actual expenditure is the appropriate base. Whether this is the case must be determined.

A practical problem is the separation of improvement expenditures from *MR*. The concept of a "fixed level of living" that underlies the CPI clearly implies the exclusion of those expenditures (e.g., kitchen modernization) that amount to increases in quality, however regular they may be. The shelter component of the CPI now includes such improvements, improperly.[15]

Letting MR_{t-j} be the amount of normal *MR* on a house of age $(t\text{-}j)$ in the base year, B_t be the price index of *MR* items in year t,

$$\overline{MR}_t dt = \left[B_t \sum^{j} MR_{t-j} f_{t-j} \right] dt. \tag{25}$$

The summation is a constant. The value of this constant and B_t are currently determined by the BLS for housing and present no exceptional data requirements.

Aside from the exclusion of improvements, this is the concept currently employed by the BLS, which here again uses home owner (not purchaser) weights.

[14] The original includes the phrase "per index family" whereas we are talking about the average asset holder, but our subsequent fractional weighting of asset holders will ultimately reduce this to the same basis.

[15] See *Monthly Labor Review*, February 1956, p. 193. Quantitatively these expenditures are about 40 percent of the total of maintenance, repair, and improvement.

G. INSURANCE

Several alternative definitions of constant quality are possible. Among these the simplest, which we use, is the notion of insurance as a constant proportion, b, of market value of the asset.[16]

Letting g_t be an index of annual rates for insurance of specified risks,

$$\overline{G}_t dt = g_t . b_t \overline{P}_t dt. \tag{26}$$

This corresponds to the BLS concept in use in housing; once again home owner (not purchaser) weights are used.

II. Comparison With Present CPI Treatment of Automobiles and Houses

Since the BLS procedure is different for automobiles and for housing, it is necessary to compare the user cost approach, advocated in the paper, to each of them separately. This is most effectively done through use of some artificial examples that will highlight the form and nature of the differences in results that occur.

The comparison with BLS procedure in respect to automobiles is a clearcut comparison of the user cost approach with the asset price approach. The BLS procedure with respect to housing is a mixture of the asset price and outlay approaches. For the automobile comparison, the two principal substantive questions are: first, do the indexes move together under the two approaches? And second, are the weights given automobiles for combination with other elements of consumer purchases in an overall index of the same order of magnitude? For the housing comparison, there is the additional question of whether the several components of the housing costs are given similar relative weights in computing the overall housing index. The answers to all of these questions are negative.

The examples below use hypothetical data and are simplified in many ways so that the essential differences become clear. In a number of places we deliberately chose assumptions that will *minimize* differences between the two approaches. In only one respect will the examples seem extreme—we have chosen data which reflect a very rapid and uneven rate of price inflation. The use of inflation rather than deflation is of course arbitrary and inconsequential. The use of extreme price changes facilitates examination of what is really going on in the alternate approaches. It may be argued that if prices are changing very little the differences we develop will be reduced proportionally. But this misses the point: it is only where price changes are significant that index numbers of prices are important and that the proper form of an index is worth debating.

A. AUTOMOBILE EXAMPLES

The automobile index of the CPI consists, in essence, of computing:

$$\frac{\sum_t^j P_j f'_{t-j}}{\sum_0^j P_j f'_{t-j}} W^*_0 = \frac{\overline{P}_t'}{\overline{P}_0'} W^*_0 \tag{27}$$

where the overall expenditure weight (W^*_0), like the average prices, reflects purchases in the base year.

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16 This seems satisfactory for housing where the principal insurance is on the dwelling. For automobiles, where liability insurance is involved, the assumption seems more dubious.

The user cost index is of the form of equation (3) above. For these examples we use the simplified form:

$$\frac{\bar{F}_t}{\bar{F}_0}=\frac{\bar{R}_t+\bar{I}_t}{\bar{R}_0+\bar{I}_0}W_0. \tag{28}$$

That is, we neglect components other than depreciation and interest and assume $dt=1$. In the examples we also neglect (until the end) the difference between W_0 and W^*_0.

The BLS considers only four age strata of purchases: new cars, and used cars of 3, 4, and 5 years of age. The following distribution of f'_{t-j}, which crudely approximates that in use, is used:

$t-j$	f'_{t-j}
0	0.50
1	.00
2	.00
3	.15
4	.15
5	.20

In order to suppress one element of difference between the approaches, we assume these same weights are the f_{t-j}—the frequency distribution of assets in use by the index population. (There is no reason why the two distributions should be the same. Indeed this particular f'_{t-j} is a virtually impossible distribution of f_{t-j}: what happens to one-year-old cars?) Notice that this distribution gives no clue as to how long individuals operate a given automobile before trading it in, or selling it.

The basic (assumed) price data appear in Table 1. Columns represent the prices of a distribution of cars of different ages at the same time. Rows show the prices at successive times of an automobile built in a specific year.[17]

TABLE 1.—*Prices Relatives* ${}_0P_0=100$

	t			
j	−1	0	1	2
−7	26			
−6	33	26		
−5	41	33	52	
−4	51	41	66	35
−3	64	51	82	50
−2	80	64	102	72
−1	100	80	128	103
0		100	160	147
1			200	210
2				300

[17] I have assumed that the relation of used to new asset prices follows a simple declining balance form, where ${}_t a_j=(1-a)^{t-j}$ with $a=.2$ for the first three columns, and $a=.3$ in the last column. Reference to footnote 7 will show that these assumed values for the first three columns are those that *minimize* the difference between the two approaches.

Table 2, which is derived from these data, permits the direct computation of the depreciation component of our index. The result of this computation, based on equation (13), and the computed values of P'_t are presented in Table 3.

TABLE 2.—*Computed Values, from Table 1*

Age of Asset at t	A_{tj}			$A_{tj}f_{(t-j)}$		
	$t=0$	$t=1$	$t=2$	$t=0$	$t=1$	$t=2$
1	.20	.20	.3000	.100	.100	.1500
4	.10	.10	.2700	.015	.015	.0405
5	.08	.08	.2433	.012	.012	.0365
6	.07	.07	.2133	.014	.014	.0427
				.141	.141	.2697

t	P_{tt}	e^{r_t}	r_t	$\frac{r_t}{e^{r_t}-1}$
0	100	1.0	0.00	1.00
1	200	2.0	0.70	0.70
2	300	1.5	0.41	0.82

TABLE 3.—*Depreciation and Purchase Price Indexes*

t	$\bar{P}'_t$	$\frac{\bar{P}'_t}{\bar{P}'_0}100$	$\bar{R}_t$	$\frac{\bar{R}_t}{\bar{R}_0}100$	$\frac{\bar{R}'_t}{\bar{P}'_t}$
0	70.40	100	14.10	100	.20
1	140.80	200	19.74	140	.14
2	186.25	265	66.34	470	.36

Table 3 casts light on the adequacy of purchase prices as a proxy for depreciation. The comparison between years zero and one reflects only the influence of the r factor—the other two sources of difference have been *assumed* away. (See discussion following equation (14) above.) The assumed (relative) collapse of used car prices between year 1 and 2 serves to *reduce* average purchase price (relative to a new car price index) but to *increase* depreciation. This is a perfectly sensible result: A decline in used car prices makes "buying in" cheaper, but having held a depreciating asset more expensive. The last column of Table 3 makes clear that no value of W^*_0 in equation (27) will bring the indexes into alignment. In general, then, purchase prices will not be a reliable proxy for depreciation.

To compute the interest component requires data on interest rates and average effective sizes of mortgage. The data assumed for the latter are given in Table 4.[18]

TABLE 4.—*Size of Mortgages*

Asset Age $t-j$	$t=0$	$t=1$	$t=2$
1	72.0	144.0	189.0
4	28.7	57.4	50.4
5	19.8	39.6	30.0
6	13.0	26.0	17.5
$\Sigma_t M_j f_{t-j}$	45.87	91.75	110.06

Reference to equation (18) makes clear that an index of user interest costs will differ from an index of asset prices even if interest rates and other terms of credit are unchanging over time (but $c^*_k = i_t$) if the ratio of size of remaining mortgage to asset price varies either over time *or* among assets of varying ages. Example 1 in the tables below illustrates this; example 2 lets interest rates vary. The assumed interest data are given in Table 5. (Example 2 again oversimplifies by assuming $f_{t-k} = f_{t-j}$. The problems of the bivariate distribution are deferred to the housing example.)

TABLE 5.—*Assumed Interest Rates*

[Annual, percent]

t	Example 1		Example 2				
	i_t	c^*_k	i_t	c^*_k For mortgages of age 1 year	4 years	5 years	6 years
0	4	12	3.0	12	10	10	8
1	4	12	3.5	14	12	10	10
2	4	12	4.0	16	14	12	10

Table 6 summarizes the results of the interest computation.

TABLE 6.—*Interest Component*

t	Example 1			Example 2		
	$\bar{I}_t$	$\frac{\bar{I}_t}{\bar{I}_0}100$	$\frac{\bar{R}_t}{\bar{I}_t}$	$\bar{I}_t$	$\frac{\bar{I}_t}{\bar{I}_0}100$	$\frac{\bar{R}_t}{\bar{I}_t}$
0	6.49	100	2.17	5.99	100	2.35
1	12.98	200	1.52	14.66	245	1.35
2	16.26	251	4.08	20.12	336	3.30

[18] These numbers were found from the basic price data by the following simplifying assumption: Suppose that the average effective size of mortgage during the period $t-1$ to t is a fraction, e_{t-j}, of $_tP_j$, with the following value:

$t-j$	e_{t-j}
1	.9
4	.7
5	.6
6	.5

This assumption neglects the influence of changing credit conditions on mortgage sizes. The size-of-mortgage problem is faced head on in the housing comparison in Part II, Section B, below. A more sophisticated approach here would not change any substantive conclusion, although it would change the numerical values.

Notice not only that the interest indexes, *in both examples*, differ from *both* the depreciation component and the purchase prices of assets, but also that the amounts of interest do not bear an even approximately constant relation to the amounts of depreciation. This means that the user cost index must be a ratio of sums, not a sum of ratios. (See nonequalities (4) and (5) above.)

The indexes corresponding to (27) and (28) are presented in Table 7, neglecting the overall weights W^*_0 and W_0. The last column in the table sheds light on these weights. Notice that the amount in the $\overline{P}'_t$ column is greater than in the $\overline{F}_t$ column. The former will be given a weight, W^*_0, proportional to *purchasers* of cars in the base year; the latter a weight, W_0, proportional to *users* in the same year. Whether the amount of car expense [19] to be included in the overall index is larger, smaller, or the same under the two procedures depends upon the ratio of W^*_0 and W_0. But since $\overline{F}_t/\overline{P}'_t$ varies over time, there is no pair of values of W^*_0 and W_0 that will make the procedures equivalent.

TABLE 7.—*Summary of Examples*

t	Amounts: $_0P_0=100$				Indexes: year 0=100				$\overline{F}_t/\overline{P}_t$
	$\overline{P}_t$	$\overline{F}_t$	$\overline{R}_t$	$\overline{I}_t$	Purchase Price	User Cost	Depreciation	Interest	
Example 1:									
0	70.40	20.59	14.10	6.49	100	100	100	100	.29
1	140.80	32.71	19.74	12.98	200	159	140	200	.23
2	186.25	82.60	66.34	16.26	265	401	470	251	.44
Example 2:									
0	70.40	20.09	14.10	5.99	100	100	100	100	.29
1	140.80	34.40	19.74	14.66	200	171	140	245	.24
2	186.25	86.46	66.34	20.12	265	430	470	336	.46

To summarize, our simple example shows several things:

1. The two procedures lead to results that are strikingly different in, first, the magnitude of the size of price changes, and second, the *relative* rankings of years with respect to rate of changes in the index.
2. The several components of the cost of using an asset vary in their relative sizes from year to year so that we must use a ratio of aggregates, not a weighted aggregate of ratios. This point will become critical with respect to housing.
3. The overall weights W^*_0 and W_0 are not only different concepts but there exists no fixed conversion factor that will make them equivalent.

B. HOUSING EXAMPLE

Whereas the BLS treatment of automobiles represented a consistent (if mistaken, according to the user cost approach) use of purchase prices and purchase weights, the home owner index is an amalgam of purchase costs, current user costs—and even future costs.

The simplified representation in equation (29) will highlight certain general problems. We will return to specifics subsequently. Let $\overline{H}_t$=BLS index of home owner costs in year t. (The fraction

[19] Recognizing that we have not included all elements of that expense in our examples. Compare (3) and (28).

W_0—about .5 in 1952—is factored out of all specific weights in the subsequent representation.)

$$\bar{H}_t = W_0 \left[\frac{\text{Purchase Price}_t}{\text{Purchase Price}_0} \text{Purchase Weight}_0 + \right. \tag{29}$$

$$\frac{\text{Incidental Purchase Cost}_t}{\text{Incidental Purchase Cost}_0} \text{Purchase Weight}_0 +$$

$$\frac{\text{Interest Commitment}_t}{\text{Interest Commitment}_0} \text{Mortgage Acquisition Weight}_0 +$$

$$\frac{\text{Insurance Costs}_t}{\text{Insurance Costs}_0} \text{User Weight}_0 +$$

$$\frac{\text{Tax Cost}_t}{\text{Tax Cost}_0} \text{User-Weight}_0 +$$

$$\left. \frac{\text{Maintenance, Repair \& Improvement}_t}{\text{Maintenance, Repair \& Improvement}_0} \text{User Weight}_0 \right]$$

Notice particularly the following criticisms:

1. The first three elements in the square brackets apply only to the small fraction of the homeowners who purchase (and/or mortgage) in a specific year. Indeed, it is the fraction in the base year. The last three elements apply to all homeowners. The relative weights given the components may thus be subject to a distortion even if the components are sensible.

2. The limitation to purchasers alone is appropriate only for incidental purchase costs. Purchase price is not an element of user cost at all, unless it is a proxy for depreciation. But if it is that, the limitation to a fraction of homeowners makes it an inherently inadequate proxy for a real user cost. Similarly the interest commitment is largely a stream of future costs over T years from t. That this is not even approximately a satisfactory "proxy" for the true user costs is evident from: (a) the use of a mortgage acquisition rate—limited, like purchase weights, to a fraction of users; (b) the neglect of user cost on past acquisitions, at other interest rates; (c) the neglect of user costs on nonmortgaged assets or on fractions not mortgaged.

3. The index is an aggregate of ratios, aggregating the several ratios with weights from the base year. It thus does not permit changes in the relative importance of components over time, although such changes are fully consistent with an index based upon the use of a constant quantity-quality of houses.

4. The inclusion of improvement in the index seems improper within the fixed base concept of constant quality.

The basic data for this example are specified in Tables 8–11. While we intend to construct an index for years 0, 1, and 2 only, it is necessary to specify data for earlier years because in this example we derive (rather than specify) the size of remaining mortgage in terms of purchase prices and dates, and the terms of credit existing at those dates.

TABLE 8.—*Prices of New Houses* (${}_tP_t$)

${}_0P_0=100$

Year	${}_tP_t$	Year	${}_tP_t$
−21	60	−9	84
−20	62	−8	86
−19	64	−7	88
−18	66	−6	90
−17	68	−5	92
−16	70	−4	94
−15	72	−3	96
−14	74	−2	98
−13	76	−1	100
−12	78	0	100
−11	80	+1	200
−10	82	+2	300

TABLE 9.—*New to Used Prices*

Year	Depreciation Pattern	Depreciation Rate
−21 to +1	Straight Line	2 percent (50 years).
+2	Straight Line	2½ percent (40 years).

TABLE 10.—*Bivariate Distribution of Age of Houses and Age of Mortgages*

[Percent]

Age of Asset ($t-j$)	Total f_{t-j}	f'_{t-j}	Age of Mortgage (years owned): $t-k$								
		0	1	2	3	4	5	10	15	20	More
0	5	5.0	-----	-----	-----	-----	-----	-----	-----	-----	
1	5	1.0	4.0	-----	-----	-----	-----	-----	-----	-----	
2	5	1.0	2.0	2	-----	-----	-----	-----	-----	-----	
3	5	1.0	1.0	1	2	-----	-----	-----	-----	-----	f_{k-j}
5	20	3.0	3.0	3	3	4.0	4.0	-----	-----	-----	
10	20	3.0	2.0	2	2	2.0	2.0	7	-----	-----	
20	20	3.0	2.0	2	2	2.0	2.0	3	2	2	
30	10	1.5	1.5	1	1	.5	.5	1	1	1	1
40	10	1.5	1.5	1	1	.5	.5	1	1	1	1
Total	100	20.0	17.0	12	11	9.0	9.0	12	4	4	2
		f_{t-k}									

TABLE 11.—*Terms of Mortgage Credit*

[Interest rates in percent]

Year	Contract rate c^*_k	Length of mortgage T_k	Fraction of sale price c_k	Lending rate i_t	Year	Contract rate c^*_k	Length of mortgage T_k	Fraction sale price c_k	Lending rate i_t
−21	4.0	14	0.75	(1)	−9	4.0	16	.71	(1)
−20	4.0	14	.75	(1)	−8	4.5	17	.70	(1)
−19	4.0	14	.75	(1)	−7	4.5	18	.69	(1)
−18	4.0	14	.75	(1)	−6	5.0	19	.68	(1)
−17	4.0	14	.75	(1)	−5	5.0	20	.67	(1)
−16	4.0	15	.75	(1)	−4	5.0	20	.66	(1)
−15	4.0	15	.75	(1)	−3	5.0	20	.65	(1)
−14	4.0	15	.75	(1)	−2	5.5	20	.64	(1)
−13	4.0	15	.75	(1)	−1	5.5	20	.63	3.5
−12	4.0	15	.75	(1)	0	5.0	20	.62	3.0
−11	4.0	15	.73	(1)	+1	5.5	20	.61	3.5
−10	4.0	15	.72	(1)	+2	6.0	20	.60	4.0

[1] Not required.

Since there is a one-to-one correspondence of terms in equation (29) with terms in the numerator of (3) (if we pretend purchase price is a proxy for depreciation), it will facilitate presentation of the results of the comparison to treat the items sequentially, although, as we have seen in Part I, the individual components are different in the two approaches in some cases, and although relationship (5) is not an equation.

C. PURCHASE COMPONENT (BLS) AND DEPRECIATION

The BLS purchase component is computed from purchase prices in each year weighted by the precentages, f'_{t-j}, in the zero column of Table 10. These weights not only reflect the acquisition pattern but reduce the figures to a "per homeowner" basis. The results of this computation are shown in the first two columns of Table 12. (Had we used weights reflecting the distribution of assets—as we did in the automobile examples—as shown in the total column of Table 10, adjusted for the purchase ratio of 1/5, the results would have been slightly different and are shown in columns 5 and 6 of Table 12.)

TABLE 12

Year	BLS Purchase Component (purchase weights) f'_{t-j}		Depreciation Computation (ownership weights) f_{t-j}		BLS Purchase Component $1/5 f_{t-j}$	
	Amounts (1)	Index (2)	Amounts (3)	Index (4)	Amounts (5)	Index (6)
0	15.68	100	2.00	100	14.28	100
1	31.36	200	2.80	140	28.56	200
2	43.80	279	23.12	1156	38.55	270

Notice not only that the indexes behave very differently but that the expenditure weights in the BLS index are consistently too high. This is due to the fact that we assume that the purchase rate is substantially higher than the reciprocal of the useful life of a house. That is, notwithstanding that houses last 40 to 50 years, we assume that the purchase rate is 20 percent. While the specific numbers are arbitrary, the well-known high mobility of the American population makes these magnitudes seem reasonable.

D. INTEREST

Since the two alternative approaches were compared in Part I, Section C5 above, we shall turn directly to the results of applying (18) and (2) to the assumed data. They are presented in Table 13.

TABLE 13.—*Interest*

Year	BLS: Interest Contracted		User Cost: Interest						Interest Charge*	
			Imputed: $i_{t-t}\overline{P}_t$		Extra Explicit		Total		Price	
	Amount (1)	Index (2)	Amount (3)	Index (4)	Amount (5)	Index (6)	Amount (7)	Index (8)	BLS (9)	User Cost (10)
0	5.66	100	2.142	100	.846	100	2.99	100	7.9	4.2
1	12.42	219	4.998	233	.849	100	5.85	196	8.7	4.1
2	18.83	333	7.710	360	1.020	121	8.73	292	9.8	4.5

*Per average homeowner (percent).

The results of the interest contracted (on a per homeowner basis) calculation are shown in columns 1 and 2; the results of the user cost computation (on the same basis) are shown in columns 3–8. While the overall indexes (columns 2 and 8) are not drastically different under the two approaches, this is due to the numbers chosen rather than to any fundamental similarity of the concepts employed, as attention to the detail will suggest. The *amounts* (columns 1 and 7), which are the implicit weights given interest in total expenditures on housing, are very different. Columns 9 and 10 shed some light on this. Our approach (column 10) reflects current lending rates, modified by a weighted average of past contract rates, and the figures in column 10 are meaningfully related to the underlying interest rates of Table 11. The figures in column 9 bear no such relation—their magnitude is crucially related to length of mortgage and to the mortgage acquisition rate. The latter is chiefly related to the duration of ownership of houses.

E. INCIDENTAL PURCHASE EXPENSES

We assume that these expenses amount to 2 percent of purchase price in year purchased. They appear in Table 14. They are thus *properly* weighted by purchase weights and move with the BLS purchase index, as shown in column 2 of Table 12.

TABLE 14.—*Incidental Purchase Cost*

Year	Amount	Index
0	0.3136	100
1	.6272	200
2	.8760	279

While these amounts are identical in the two procedures, it should be noted that the relative size of incidental purchase expense to depreciation (on the one hand) and to the purchase component (on the other hand) are very different year by year.

F. TAXES, MAINTENANCE-REPAIR, INSURANCE

To simplify drastically, we lump these items together and assume arbitrarily that they amount in any period to 4 percent of the market value of the house at the end of the period. (This will introduce a bias in our index toward conforming with the BLS concept because these amounts then vary exactly with the amounts in column 5 of Table 12—which are closely correlated with the purchase component of the BLS index.) We will use these amounts weighted by the ownership distribution (f_{t-j}) and use identical amounts for the two approaches. The results are shown in Table 15.

TABLE 15.—*Insurance, Taxes, and Maintenance-Repair*

Year	Amounts	Index
0	2.86	100
1	5.71	200
2	7.71	270

(We have here suppressed certain differences discussed in Part I, Sections E and F, above.)

G. TOTAL HOUSING COST

Tables 16 and 17 present the combined costs under the two procedures. The upper parts of the tables show the amounts of the components and the indexes based thereon; the lower parts reflect the implicit weights of the individual components in the totals. The BLS implicit weights are stable because stability is built in—the wisdom of that assumption is challenged. It should be noted that the relative size of the individual components in the BLS procedure is *critically affected* by the purchase ratio. In our procedure this ratio directly affects incidental purchase costs and to some extent the interest component; but the relative size of the principal components is largely insensitive to the magnitude of the (assumed fixed) purchase ratio.

TABLE 16.—*BLS Concept: Summary*

Year	* Purchase cost	* Incidental purchase cost	* Interest committed	Taxes, etc.	Total	
					Amount	Index
0	15 63	.31	5.66	2.86	24.51	100
1	31.36	.63	12.42	5.71	50.12	204.5
2	43.80	.88	18.83	7.71	71.22	290.6
HORIZONTAL PERCENTAGES						
0	64.0	1.2	23.1	11.7	100.0	
1	62.6	1.2	24.8	11.4	100.0	
2	61.5	1.2	26.4	10.8	99.9	

NOTE.—Starred columns reflect purchase weights, others ownership weights.

TABLE 17.—*User Cost Concept: Summary*

Year	Depreciation	* Incidental purchase cost	Interest	Taxes, etc.	Total	
					Amount	Index
0	2.00	.31	2.99	2.86	8.16	100
1	2.80	.63	5.85	5.71	14.99	183.7
2	23.12	.88	8.73	7.71	40.44	495.6
HORIZONTAL PERCENTAGES						
0	24.5	3.8	36.6	35.0	99.9	
1	18.7	4.2	39.0	38.1	100.0	
2	57.2	2.2	21.6	19.1	100.1	

NOTE.—Starred items reflect purchase weights, others ownership weights.

It may be noted, finally, that not only do the indexes move differently, but that the amounts, which become implicit weights for combining home owner costs with renter costs in a total shelter component, are different in the two approaches. Since rental cost is clearly a user cost, a comparison is valid. Suppose, to get some notion of magnitude, we use the familiar rule of thumb that a long-run average rental of 1 percent per month of market value is appropriate. For the average prices of our housing example this yields *annual* rental amounts of 8.57, 17.14, and 29.13 for years 0, 1, and 2, respectively. These magnitudes are strikingly congruent with the user costs developed and much below the amounts in the BLS index.[20]

III. Conclusion

It has been the primary purpose of this paper to develop the user cost approach to the problem of consumer durables in an index of consumer prices, to describe and characterize the present BLS approach to the two most important durable consumer goods, and to see if the results are significantly different. Both the algebraic analysis of Part I and the examples of Part II indicate that the differences are fundamental, pervasive, and striking. If the user cost approach is accepted in principle, it can hardly be suggested that present procedure is a reasonable approximation to it. At issue is more than just the magnitude of price changes. Additionally there is the behavior of the index over time and the weights given the included durable goods in the overall index.

Is the user cost approach the sensible one? It is clearly *one* sensible one, and in my view perhaps the most sensible one for a general purpose index. But the issue of which is the most useful approach depends crucially upon the purpose for which the index is used, and that is beyond the scope of this paper.

If the user cost approach, here advocated, is adopted, the discussion of present practice can be neglected. If, however, this approach be deemed inappropriate or impractical, a secondary purpose of this paper has been to highlight certain fundamental difficulties in the current procedures. Among the most important of these are:

1. The critical need for the definition of the approach to be used and its implementation. Thus the fundamentally different treatment currently given to automobiles and owner-occupied housing can hardly both be consistent with the same concept. One cannot escape the conclusion that the latter-day introduction of durables into the CPI has been in a series of *ad hoc* steps which have no coherent logic.

2. Should a component-by-component computation such as is currently employed in the treatment of housing be retained, it is essential that attention be directed to two problems. The first concerns the proper determination of the relative weights given to the several components. The second reflects the fact that component weights will not remain constant over time even if the quantity and quality of goods remain constant.

3. The use of a purchase price component creates difficulties of two sorts. The first is whether it is necessary to distinguish among purchases that are (a) net increases in asset holdings by the index population, (b) exchanges among assets of different types, or (c) exchanges of specific assets (e.g., houses or cars) of the same type. The extent of each of these clearly affect the expenditure weights, but equally clearly they are very different in character and bear very differently on the concept of "a fixed quantity and quality of goods and services."

[20] To what extent this is a fortuitous result of the data and assumptions of our hypothetical example is not known. Should a similar result occur in an application to real data, it suggests a very simple shortcut to finding expenditure weights that seems superior to present BLS procedure.

Only the third is even approximately handled by using prices net of trade-ins. The second (and related) difficulty arises from the fact that, e.g., houses are typically not retained for the whole of their useful lives and thus the expenditure weights are critically affected by turnover rates. In particular the interest component of housing seems subject to systematic distortion. In any case such turnover rates must be (as they are not) explicitly introduced into any calculation using asset purchases.

4. The ultimate combination of durables with nondurables in a comprehensive index requires explicit determination of the appropriate relative weights to be given commodities of each kind. Following either a user cost or a current outlay approach, the implicit weights are satisfactory. Using an asset price approach or a mixed approach, the implicit weights are arbitrary and capricious.

Appendix A. Glossary of Symbols Used

Attention is directed to Part I, Section A of the text for an explanation of the principles of subscript notation employed. The following classified glossary omits identifying subscripts in most cases.

TIME: DATING AND DURATION

Time is of the essence of durable goods, and is measured in years from $t=0$, the base date for weighting *and* comparison purposes.

t: a general running subscript identifying years from base date.
j: the year an asset was new.
k: the year an asset was acquired.
dt: fractions of a year.

n: $\frac{1}{dt}$.

m: number of subperiods of n, generally $\rightarrow \infty$.

DOLLAR MAGNITUDES

If unbarred (D) refer to an individual asset; if barred ($\overline{D}$), to an appropriate weighted average collection of assets. See below.

D: Required size of a reserve for depreciation.
F: Total user cost, per year.
G: Insurance cost, per year.
H: Home owner cost, BLS.
I: Interest cost, per year.
J: Incidental purchase cost.
M: Size of loan or mortgage.
MR: Maintenance and repair cost, per year.
P: Price of the asset, at market.
R: Depreciation cost, per year.
V: Assessed valuation.
X: Tax cost, per year.

WEIGHTS

At time t, there are N assets of the type in question owned by the index population which vary according to age of asset, length of ownership by present owner, and in other ways. There are subsets of N which satisfy:

$$N=\sum^{j} N_j=\sum^{k} N_k=\sum^{j}\sum^{k} N_{j,k}$$

${}_tf_j$: the frequency N_j at t; also (for all j) the frequency distribution of asset owners over $\overset{N}{j}$. (Likewise for ${}_tf_k$ and other subscripts.)

${}_tf'_j$: the frequency distribution of *purchases* in the year t. I.e., the frequency distribution over j for $k=t$.

f_{t-j}, f_{t-k}, f'_{t-j}, etc., indicate constancy of ${}_tf_j$, etc., over time.

W_0: fraction of asset owners to total index population in base year.

$\left.\begin{matrix} W^*_0: \\ w_0\ : \end{matrix}\right\}$ base year weights, defined in context.

WEIGHTED AVERAGES

$${}_t\overline{P}_j=\sum^{j} {}_tP_j f_{t-j}$$

$$\overline{P}'_t=\sum^{j} {}_tP_j f'_{t-j}.$$

(There is no second subscript since $k=t$. Thus the summation must be over j only.)

Etc. for other dollar magnitudes.

ANNUAL RATES

i_t: the lending rate of interest, at t. (If i is used as a running superscript, it is without any subscript of its own.)

c^*_k: the contract rate of interest, at k.

r_t: the rate of inflation (+) or deflation (−) of the asset, at t. Defined by:

$$e^{rdt}=\frac{{}_tP_t}{{}_{t-dt}P_{t-dt}}$$

π_t: another rate of inflation; like r, but $r\neq\pi$.

x_t: tax rate per dollar of assessed valuation.

DERIVED RATIOS

$${}_t\alpha_j=\frac{{}_tP_j}{{}_tP_t}$$

$${}_tA_j={}_{t-dt}\alpha_j-{}_t\alpha_j$$

$$c_k=\frac{{}_kM_j}{{}_kP_j}$$

$$ {}_td_k=\frac{{}_tM_{k,j}}{{}_kM_{k,j}}$$

CONSTANTS AND UNSPECIFIED PARAMETERS

$$a,\ a_1,\ a_2,\ \ldots$$

$$b,\ b_1,\ b_2,\ \ldots$$

$$\lambda,\ \theta$$

OTHER

g_t: An index of insurance rates.
B_t: An index of *MR* prices.
$a_{\overline{n}|}$: Present value of an annuity of 1 } for n periods at a specified rate of interest.
$a^{-1}_{\overline{n}|}$: Annuity whose present value is 1 } for n periods at a specified rate of interest.
$S_{\overline{n}|}$: Amount of an annuity of 1 } for n periods at a specified rate of interest.

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STAFF PAPER 7

COST OF LIVING INDEXES FOR SPECIAL CLASSES OF CONSUMERS

Eleanor M. Snyder

Scope of Report

To some degree, the scope of this paper is limited by the availability of the price-quantity-expenditure information basic to the construction of indexes of consumers' prices. Under ideal circumstances, the function of the paper would be threefold:

a. To determine the extent to which indexes for particular subgroups in the population (or for the population as a whole) would differ from the current CPI for urban wage and lower salaried workers.
b. To analyze the types of problems that would be encountered in the construction and maintenance of indexes in addition to those currently prepared.
c. To specify the appropriate scope of consumers' price indexes published by the federal government.

The demand for indexes for specified subgroups in the population, as well as for a comprehensive index relating to the total population, is based on the premise that the movement of such indexes would deviate from that shown by the present CPI. The most conclusive empirical evidence as to whether the basic premise is true or false, for each separate index, obviously would be obtained by construction of actual indexes completely comparable to the CPI in construction and statistical reliability, so that any variation in the indexes would reflect only real differences in changes in living costs of specified populations and not differences due to sampling or procedural innovations.

Valid test indexes cannot be constructed at the present time because of the lack of basic data; estimates of probable differences in indexes of special subpopulation groups therefore must be based on incomplete and isolated information. On this account the scope of this paper falls far short of the ideal. Nevertheless, although the available data are extremely limited, it will be possible to indicate possible sources of variation in movement of consumers' price indexes relating to different populations.

Population Groups To Be Considered

The population for which consumers' price indexes are in greatest demand falls into four classes: one, the total population in the United States; two, special classes of consumers (low and high income, the aged, single working men, single working women, public assistance recipients, etc.); three, total population in communities of varying sizes, individually and in combination; four, total population in specified economic or geographic areas.

This listing does not exhaust all the special indexes for which some demand exists, and not all those listed will be considered here in detail. For illustrative purposes, the empirical work has been focused on indexes for low and high income groups, in the belief that these extremes would give some indication of the possibility of variation in the movement of indexes for different classes of consumers, because of substantial differences both in the items purchased and in the quantity weights.

Limitations of Available Data

It has been stated that reliable and complete test indexes cannot be constructed at the present time because of basic limitations in the two types of data required—the details of the distribution of consumption expenditures of the specified populations and adequate samples of representative prices over a reasonably long period of time.

A. CONSUMER EXPENDITURE MATERIAL

Inadequacy of the basic data is to be expected. The major purpose of federally conducted consumer expenditure surveys, such as those undertaken by the BLS and the Department of Agriculture, is to find out what "index" families buy. While the current BLS cross section surveys attempt to cover the total urban population, the emphasis, especially in the design of the questionnaire, is placed on families of wage and lower-salaried workers. Items thought to be most important in the current purchases of this group, or of increasing importance in the near future, tend to be those for which information is recorded separately. Other items frequently are recorded as residuals combined into a single total within the appropriate subgroup of items. The more important items are those which will subsequently be priced for the index; expenditures on nonpriced items are needed only to build up to subgroup, major group, and total expenditure weights. From the most recent survey of food expenditures, conducted in 1955 by the Department of Agriculture, for example, separate data are available for about 135 separate food items, and about 85 combined totals based on two or more items. Out of the total list of items recorded separately or in combinations it was possible to identify only 34 that were of greater importance,[1] absolutely and relatively, to low income families than to high income families, and, one-fourth of the 34 were "combined" items for which separate details are not available.

Another difficulty in calculating test indexes lies in the fact that the item detail recorded in the consumer surveys for various dates has undergone some changes—items have been added, dropped, or combined with other items. These changes apparently reflect not only changes in items currently available in the market but also changes in the relative income position of "index" families. As the index population moves up the income scale, items for which the greatest detail is recorded in the consumer surveys are similarly upgraded. As to be expected, therefore, earlier cross-section surveys included relatively more detailed information on items purchased by low income families than the more recent studies. While the

[1] Items with a negative or zero income elasticity.

number of food item line-entries rose from about 135 in the 1936 study to 220 in 1955, the number of "low income" items that could be identified did not increase proportionately, rising from 30 to 39. The comparison appears below in Table 1.

TABLE 1.—*Number of Food Items Recorded in Specified Consumer Surveys, U.S. Urban, 1936–55*

Date	Number of food items			Number with negative or zero income elasticity for urban families
	Total	Separate items	Grouped item entries	
1936	135	111	24	30
1942	176	118	58	31
1950	222	128	94	(1)
1955	220	130	90	39

1 Quantity data not available.

Analysis of the food category produces the most clear-cut example of changes in item detail, since customarily information is recorded (or can be derived) on prices paid and quantities purchased as well as expenditures, and, in addition, items are more narrowly defined. For other categories of consumption, particularly clothing, housing, medical and personal care, differences in spending patterns of low income families and other families are concentrated more heavily on the quality of item purchased rather than on the items themselves—all men wear suits, but one man pays a price of $25 and another $200 for the same type of suit—i.e., serving the same function in terms of seasonal wear. Since price distributions for particular line-entries on the expenditure schedule can be derived, expenditure weights for indexes for special classes of consumers could be constructed from the available data most readily for categories other than food.

The decreasing amount of detail on low income goods and services obtained in the successive cross section studies of the Departments of Labor and Agriculture inevitably has meant that greater detail has become available for families with incomes relatively higher on the income scale. On this account, it would be less difficult to construct a set of expenditure weights for high income families than for low income families.[2]

B. RETAIL PRICE DATA

Detail price series, the other basic component of consumers' price indexes, are equally inadequate, if not more so, than the expenditure data available for populations other than index families. Price collection on a regular recurring schedule is an expensive undertaking and the official collection agencies quite naturally have limited their coverage to prices of goods and services represented in the major indexes. And, following the same trend evidenced in the cross-section material, items included in the CPI retail pricing program in recent years, by and large, are the middle-to-higher-cost items. This is il-

2 This is true only if one were content to base the weights on the data available from, say, the 1950 BLS survey, for urban consumers with annual incomes of $10,000 or more. There is no breakdown in the published figures by income classes above $10,000 because of the limitations of sample size.

lustrated by the fact that in 1935, of the 84 foods for which the BLS published average prices, only 17 were those that displayed a negative or zero income elasticity in the 1936 consumer survey. Of the 97 foods for which prices are available currently, 15 are low income items but, to a greater degree than in 1935, the low income foods currently priced have a smaller relative importance in low income diets. In the meat, poultry, and fish group, for example, the items that displayed a negative income elasticity in the 1955 study and are included in BLS pricing are limited to frankfurters, canned luncheon meat, and pink salmon. This compares with the following low income items priced in 1935: plate beef, strip bacon, salt pork, lamb breast for stews, and pink salmon.[8]

Not only are relatively few items and qualities of particular importance to low income groups included in the official retail price collections, but also the usefulness of the available retail price series is further limited by the type of outlet from which the prices were obtained. The outlet sample for the CPI is designed to be representative of sellers frequented by the "index family." Such a sample would not be equally appropriate for families for other classes of consumers. Prices paid for identical items vary substantially between sellers and it is possible that price trends may also vary between types of outlets. To a large degree, stores patronized by some low income groups constitute a separate market within a given community; their supply and demand functions probably are quite independent of those of stores catering to higher income consumers.

C. PRICE DATA FROM THE CROSS-SECTION SURVEYS

In addition to consumer expenditures, the surveys also include retail prices paid (and quantities purchased) for some categories of consumption, notably food, clothing, and some consumer durables. While these are not "specification" prices, since they represent the average, per income class, of different qualities of items, nevertheless they are an important source of price information.

Index Formula Assumed

We assume in this discussion that any additional indexes for special population groups (or for the total population) are to be Laspeyres indexes, and that the terms "cost of living index" or "consumers' price index" are not synonymous with the "true" cost of living index as described in the general theory of index numbers. (The true cost of living index is, of course, a measure of the changing cost of a constant [equivalent] level of satisfaction and in theory there is no limit to the time span for which it may be calculated.) The current CPI is based on a standard variation of the Laspeyres formula,

$$\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0},$$

while all formulae for estimating the "true" index in effect are weighted averages of two separate indexes. In this respect the latter resemble Fishers' Ideal Index formula.

[8] In 1940, following a revision of the index, plate beef, strip bacon, and lamb stew meat were dropped from the index.

In actual calculation, nevertheless, the CPI methodology does represent an effort to approximate the true index over very short periods of time and therefore presumably so would any additional indexes for other population groups, since it is assumed that the same methodology would apply.

While index number theory is not included in the scope of this paper, it may not be amiss to examine briefly the theoretical base of the assumption that cost of living indexes would differ between economic groups.[4]

Arrow says, for example, "The consumption pattern of the rich is quite different from that of the poor and a shift in prices which increases the cost of living to one may decrease it for another . . . . There should be a separate cost-of-living index number for each income level."[5] The assumption of most economists that the true index varies by income level is in turn based on the assumption that expenditure-equivalence curves are nonlinear. (The expenditure-equivalence curve is the theoretical curve that relates minimum expenditures yielding the same level of satisfaction in two periods, prices and quantities being allowed to vary.) Since indifference maps cannot be derived empirically, neither can expenditure-equivalence curves, although Wald and others have suggested methods by which they may be approximated from cross-section data.

Simple Hypothetical Illustrations of Effects of Varying Prices and Quantities

As an introduction to exploration of differences in index movements, it might be useful to construct simple arithmetic models illustrating some of the effects of changes in prices and weights in index level.

In the simplest case, in which the array of prices in each index is identical and only the weights vary, the total differences, if any, in price indexes for different groups is due to variation in relative importance of identical items. While unrealistic, hypothetical indexes so constructed may be somewhat useful in indicating the extent to which weighting diagrams must vary before significant differences in the weighted price movements emerge.

Algebraically, the total effect of weight differences can be expressed in terms of the correlation between the relative quantities and the relative prices.[6]

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[4] Ulmer suggests that ". . . perhaps three or four separate vocational index numbers might be required (e.g. to measure the cost of living experience of all numerically important groups in the United States)—one each (say) for urban wage earners and lower-salaried workers, farm workers, farm proprietors, and business executives and professionals," Melville J. Ulmer, *The Economic Theory of Cost of Living Index Numbers*, Columbia University Press, 1949.

[5] Kenneth J. Arrow, "The Measurement of Price Changes," a paper appearing in *The Relationship of Prices to Economic Stability and Growth*. Joint Economic Committee, U.S. Congress, March 31, 1958.

[6] I am indebted to Dorothy S. Brady for showing me that these expressions are the same as the formula originally presented by Bortkiewicz for comparing a chain index with a fixed weight index. ("Zweck und Struktur einer Preisindexzahl," Bortkiewicz, *Nordisk Statistisk Tidskrift*, III, 1924.)

$$I_b = I_a\left[1 + r_{xy}\frac{\sigma_x\sigma_x}{xx}\right] \tag{1}$$

where

$$I_a = \frac{\Sigma p_1 q_a}{\Sigma p_0 q_a},\ I_b = \frac{\Sigma p_1 q_b}{\Sigma p_0 q_b},$$

and the

$$p_0 q_a\text{'s are weights } X = \frac{p_1}{p_0},\ Y = \frac{q_b}{q_a},$$

r is the weighted correlation coefficient and $\sigma_x\sigma_y$ the weighted standard deviations. I_a and I_b are cost of living indexes for two different population groups; p_0, p_1, prices in periods 0 and 1; q_a and q_b are the quantities purchased by income groups a and b, in period 0.

To facilitate calculation, the equation can be rendered as follows:

(2, 3, and 4 can be calculated directly).

Where $I_a = \frac{\Sigma p_1 q_a}{\Sigma p_0 q_a}$, and $I_b = \frac{\Sigma p_1 q_b}{\Sigma p_0 q_b}$,

then

$$I_b = \frac{\Sigma p_1 q_a}{\Sigma p_0 q_a}\left[\frac{\Sigma p_0 q_a}{\Sigma p_0 q_b}\cdot\frac{\Sigma p_1 q_b}{\Sigma p_1 q_a}\cdot\frac{\Sigma p_0 q_a}{\Sigma p_0 q_a}\right], \tag{2}$$

$$= \frac{\Sigma p_1 q_a}{\Sigma p_0 q_a}\left[\frac{\dfrac{\Sigma p_1 q_b}{\Sigma p_0 q_a}}{\dfrac{\Sigma p_1 q_a}{\Sigma p_0 q_a}\cdot\dfrac{\Sigma p_0 q_b}{\Sigma p_0 q_a}}\right], \tag{3}$$

$$= \frac{\Sigma p_1 q_a}{\Sigma p_0 q_a}\left[\frac{\dfrac{\Sigma p_0 q_a\cdot\frac{q_b}{q_a}\cdot\frac{p_1}{p_0}}{\Sigma p_0 q_a}}{\dfrac{\Sigma p_0 q_a\frac{p_1}{p_0}}{\Sigma p_0 q_a}\cdot\dfrac{\Sigma p_0 q_a\frac{q_b}{q_a}}{\Sigma p_0 q_a}}\right] \tag{4}$$

Time-to-time differences in the cost of two fixed-quantity budgets with the same sets of prices equal the weighted covariance of the price changes and the quantity ratios. In the equation above, the numerator of the bracketed term is simply the relative difference between hypothetical expenditures on Budget a in the base period and hypothetical expenditures on Budget b in the second period. The denominator is the cross-product of a price index with Budget a weights and a quantity index with base year price weights; it thus shows the separate effects of price and quantity changes.

Some simple examples will serve to illustrate how indexes for different economic levels might vary. All of the following illustrations assume prices are rising. (If the price situations were reversed, the resulting indexes would be the reciprocals of the indexes found in the case of rising prices.)

Case 1: Interaction Effects=0 [7].

Items	Prices ($)		Quantities		Relative importance (%)			
					Period 0		Period 1	
	Period 0 (p_0)	Period 1 (p_1)	Budget a (q_a)	Budget b (q_b)	Budget a (p_0q_a)	Budget b (p_0q_b)	Budget a (p_1q_a)	Budget b (p_1q_b)
1	10	10	10	15	21	20	16	15
2	20	25	6	8	26	22	25	20
3	30	50	4	6	26	24	33	31
4	40	50	2	4	17	21	16	20
5	50	70	1	2	10	13	10	14
					100	100	100	100

$$I_a=\frac{\Sigma p_1q_a}{\Sigma p_0q_a}=131.9^+,$$

and

$$I_b=\frac{\Sigma p_1q_b}{\Sigma p_0q_b}=132.0$$

In this example, while quantities are substantially larger in Budget b than in Budget a, the relative importance of each item in the two budgets is fairly similar. Level of prices and relative changes vary between items.

Case 2: Interaction Effects of Some Significance (+4%).[8]

All q's the same as in Case 1; p's also the same except for item 5, where the price in period 1 is changed to 200. Then,

Item	Relative importance (%)			
	Period 0		Period 1	
	Budget a	Budget b	Budget a	Budget b
1	21	20	13	12
2	26	22	20	16
3	26	24	27	24
4	17	21	13	16
5	10	13	27	32
Σ	100	100	100	100

$$I_a=160,$$

and

$$I_b=167.$$

In this example as in Case 1, the distributions of expenditures in Budgets 1 and 2 in the base period are not significantly different. In period 1 the item with the highest price but lowest relative importance in the base period was allowed to rise by 300 percent as compared with a much smaller rise in the prices of the remaining items, thereby more than doubling its relative importance. Nevertheless,

[7] Interaction effect as measured by expression in bracket, equation (3) or (4).
[8] See footnote 7.

the separate effects of the combined price and quantity differences were identical, so that half of the difference between I_a and I_b was caused by the price change, and half was due to the differences in weights. (I should confess that in setting up this example exact symmetry was unplanned; it was a result of the fact that $\Sigma p_1 q_a$ and $\Sigma p_0 q_b$ happened to be numerically equal.)

Case 3: Interaction Effects=23%.[9]

Item	Prices ($)		Quantities		Period 0 (%)		Period 1 (%)	
	Period 0 (p_0)	Period 1 (p_1)	Budget a (q_a)	Budget b (q_b)	Budget a	Budget b	Budget a	Budget b
1	10	20	200	50	47	7	56	9
2	20	40	40	80	19	19	22	29
3	40	50	15	30	14	11	10	14
4	80	90	5	12	10	12	6	10
5	200	210	2	20	10	48	6	38
Σ					100	100	100	100

$$I_a = 171.9, \text{ and}$$
$$I_b = 132.9.$$

In this example, the lowest priced item in period 0 represents nearly one-half of Budget a in the base period, while the highest priced item equals half of Budget b. This might be considered as an exaggerated illustration of very low income and very high income budgets. As stated, this example assumes that the largest increase in relative prices occurred among the lowest priced items. If, on the other hand, relative price changes were reversed, so that the lowest priced items increased substantially less than the highest priced items, the relative level of the two indexes would also be reversed, I_b greater than I_a, a relationship which conceivably could occur. (Arrow stated, for example, that if servants' wages go up while the prices of manufactured goods fall, an index for the wealthy could rise and that for the poor could decline.)

The effect of the difference in weights was considerably greater than the effect of the price changes, with a quantity index

$$\left(\frac{\Sigma p_0 q_b}{\Sigma p_0 q_a}\right)$$

of 197, as compared with 172 for the price index

$$\left(\frac{\Sigma p_1 q_a}{\Sigma p_0 q_a}\right),$$

a difference of 15 percent.

The above illustrations assumed no uniformity of price change and were designed simply to provide some indication of relative effects of some combinations of price and quantity variations. It might be

[9] See footnote 7.

well to conclude these few hypothetical examples with a more general case in which certain conditions are specified.

The level of an index tends toward a maximum (or minimum) the greater the correlation between price changes and relative value weights per item. Thus, if there is perfect and positive correlation in a given case, the resulting index will have a higher value than with any other set of prices yielding price relatives with values between 100 and 200. If the correlation is perfect and negative, the index will have a minimum value.[10]

In Case 3, prices and quantities in the base period are highly (although not perfectly) correlated. With certain adjustments, these data can be used to illustrate correlation effects in this type of situation.

Case 4: Prices and quantities highly correlated in base period and price changes in period 1 are proportionate to relative importance of individual items in base period expenditures.

If the Q_a and the Q_b are the same as in Case 3, then:

Example A. If prices in period 1 are proportionate to the item relative importances in Budget a, the resulting index values are:

$$I_a=130,$$

and

$$I_b=115.$$

Example B. If prices in period 1 are proportionate to item relative importances in Budget b, the resulting indexes are:

$$I_a=123,$$

and

$$I_b=138.$$

In Example A, the price in period 1 of each item

$$P_1=P_0\left[1+\frac{P_0Q_a}{\Sigma P_0Q_a}\right]=P_0[1+W_a].$$

Then,

$$I_a=\frac{\Sigma P_0Q_a[1+W_a]}{\Sigma q_a p_0}$$

$$=\frac{\Sigma P_0Q_a}{\Sigma P_0Q_a}+\frac{\Sigma P_0Q_aW_a}{\Sigma P_0Q_a}$$

$$=1+\Sigma W_a^2.$$

[10] I am indebted to George Stigler for suggesting an illustration of the maxima and minima effects obtained when base period prices and quantity weights are given and second period prices are prefectly correlated with relative expenditure weights.

And, letting

$$P_oQ_b = W_b,$$

$$I_b = \frac{\Sigma P_oQ_b[1+W_a]}{\Sigma P_oQ_b}$$

$$= \frac{\Sigma P_oQ_b}{\Sigma P_oQ_b} + \frac{\Sigma P_oQ_bW_a}{\Sigma P_oQ_b}$$

$$= 1 + \Sigma W_aW_b.$$

ΣW_aW_b is the cross-product of the relative importances of the two budgets at base period prices. Hence, the similarity or dissimilarity of the two indexes will depend on the extent to which the weights (i.e., the relative importances) are correlated.

In Example B, the notation is the same except that in the price equation the Q_b are substituted for the Q_a.

In the above illustrations, the assumption that in the same market prices paid are the same for items common to budgets of different population groups does not imply the further assumption that all budgets include some quantity of every item; rather, zero quantities are admissible. It would, therefore, be possible to construct hypothetical indexes such that differences between them were caused by price changes of items included in one budget but not in the other. (It should be noted that the Brady formula as presented does not admit of zero quantities. This restriction is relaxed if the q's are taken as subgroup totals, and the p's are quantity weighted.)

Empirical Examination of Sources of Variation Between Indexes for Different Economic Groups

The contents of budgets at successive income levels, when residence and population characteristics are held constant, vary according to overall volume and the number, quality, and quantity of individual items. As compared with high income budgets, a typical budget for a low income group contains a smaller number of specific goods and services, its total contents add up to a substantially lower volume, and quantities of individual items are smaller, except for inferior goods purchased as substitutes for more preferred items. Finally, of the items for which varying qualities are available, the average low cost budget includes a preponderance of the lowest qualities.

Since all items do not have identical price movements, it is possible that different combinations of consumption goods and services display diverse price trends. To what extent can the separate sources of price differences be isolated and measured?

Analysis of budgetary differences, by major category of items, in part will indicate whether items that are low cost substitutes for more preferred items display the same relative price trends as items that are the cheaper versions of similar but higher quality items and whether these low income goods and services follow a price path similar to or different from items representative of higher income budgets. The food, transportation, and personal care categories in particular provide illustrations of item substitutions (margarine for butter, public transportation for automobile expenses, home beauty care for purchased services, etc.). Housing and clothing budgets at different income levels, on the other hand, vary primarily in the quality of items purchased.

For the purpose of testing empirically for possible differences in price changes of items of particular importance in average budgets of families at various income levels, it was necessary to establish a procedure for item classification. For food, a category of consumption for which both quantity and price detail by income level is available or could be calculated, items were classified on the basis of their income elasticity.[11] Low income items were defined as those with a negative or zero elasticity, items with a moderate income elasticity were classed as middle income items, and high income items were those with the highest elasticity. (See Table 2.)

TABLE 2.—*Food Items Classified by Income Elasticity in 1936*

Item	Income elasticity		
	Negative or zero	Positive	
		Moderate	Highest
Meats, etc	Chuck roast	Round steak	Rib roast
	Boiling beef	Liver	Sirloin steak
	Ground beef	Pork roast	Other steak
	Veal stew	Corned beef	Veal chops
	Lamb stew	Dried beef	Pork chops
	Pork sausage	Bacon	Lamb chops
	Strip bacon	Fresh fish	Whole ham
	Salt pork		Leg lamb
	Bologna		Bacon
	Canned salmon		Chicken
Dairy products	Loose milk	Bottled milk	Cream
	Buttermilk	Butter	
	Skim milk	Ice cream	
	Dry milk	Cheese	
	Evaporated milk		
Fats and oils	Lard	Mayonnaise	
	Margarine		
Cereals, etc	White flour	Corn flakes [1]	Cake
	White bread	Rolled oats [2]	Whole wheat bread
	Rice	Wheat cereals	
	Macaroni		
Fruits and vegetables	White potatoes	Cabbage	Asparagus
	Canned green beans	Carrots	Celery
	Baked beans	Onions	Lettuce
	Canned tomatoes	Peas	Lima beans
	Dried beans [1]	String beans	Oranges
	Dried peas	Sweetpotatoes	Grapefruit
	Dried, other	Tomatoes	Melons
	Dried other canned vegetables	Bananas	Apples
		Berries	Pears
		Canned:	Canned:
		Peas	Pineapple
		Corn	Fruit juice
		Peaches	Beets
		Asparagus	
		Dried: prunes	
Sweets		Sugar [1]	Candy [1]
		Corn syrup [1]	Preserves
			Packaged desserts [1]
Miscellaneous		Peanut butter	Nuts
			Soft drinks [1]

[1] Not tabulated separately in 1936 summary pamphlet.
[2] No longer available.

[11] For some surveys, quantity data for clothing is also available but the 1950 BLS study tabulated quantities only to the first decimal and thus significant differences by income level do not emerge for the majority of items. The classification of items by income elasticity thus could not be employed for this category and others for which quantity data were not available.

Food

A. PRICE DATA

A detailed examination was made of food budgets, by income level, as recorded in the national urban consumer surveys of 1936, 1942, and 1955. Since all of these surveys recorded quantity as well as income and expenditure data, it was possible to classify items by their income elasticity. It was found that while some items shifted classification over the period 1936–55 no major changes occurred and some of the minor changes shown undoubtedly are artificial, resulting from sampling variations rather than a real change in tastes. Although the total number of line entries on the food schedules increased from 135 to about 220 in the 1936 and 1955 surveys, the number of items separately identified with a negative or zero income elasticity did not increase proportionately, rising from 30 to 39.[12] The relative importance in total food expenditures of the inferior items declined steadily across the income scale, measuring, in each of three surveys, from the next to lowest income class to the highest.[13] (See Chart 1.)

In current dollars, the relative importance of these items was about the same in 1936 and in 1955. (Information in these two surveys relate to households or families of two or more persons.) While inferior items appear to be of significantly less importance in 1942, about 40 percent of the apparent variation can be due to the fact that the 1942 survey presented combined data for households of one person and two or more persons. For all single-person households in 1955, average income was less than $1,700, and expenditures of these households on inferior items represented 13 percent of the food budget, as contrasted to about 25 percent for larger households. If one-person households with incomes around the average also spent about 13 percent of food expenditures on these items, then in 1955 the relative importance of these items for all households combined would be about 18 or 19 percent. The difference that remains, which is significant, is probably accounted for by changes in the economic regimen; in the Spring of 1942, when the survey was conducted, the United States had just entered the war. Market dislocations, however, had been building up since the beginning of World War II in September 1939 although governmental controls were not applied until 1942. In the face of rising demand and restricted supplies, shortages appear first, in many instances, in the low cost and inferior goods sector. On this account alone, one might expect that living costs of the lowest income groups would rise faster than others during such periods. (Throughout this paper, while "lowest income groups" is not quantitatively defined, it is taken to represent the 15 percent or so of the population at levels of living that are substandard; a significant portion of this group is not completely self-supporting.)

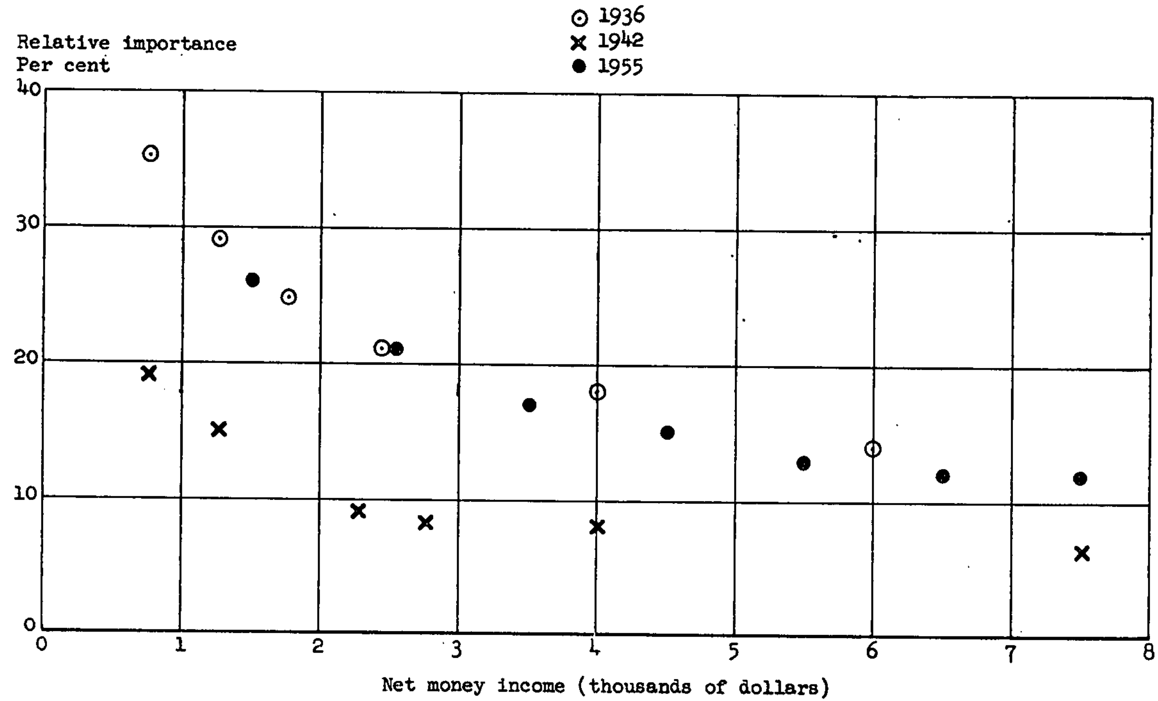
Given the differences between the two periods one would not expect the 1936 and 1955 curves to be at the same level. The virtual

[12] A few items display a positive elasticity from the lowest to the upper middle income groups, then become negatively elastic. Such items were not included in the negative or zero elasticity group.

[13] Lowest income class omitted since it contains families with negative and zero reported incomes and families living on savings.

CHART 1

Relative Importance of "Inferior" Items in Total Food Expenditures,
Urban Households, 1936, 1942, 1955,
in Current Dollars



identity can be explained only by differences in the structure of prices in the two periods.

An examination was made of differences in prices of items recorded in the three surveys. A comparison of price relatives of food items roughly classified by income elasticity (zero or negative, moderate, and most elastic) shows considerable variation between the three distributions. The items were grouped according to income elasticity as of the 1936 survey, then, insofar as possible, the same items were identified in the two later surveys and their prices compared.) Some attrition occurred between surveys and therefore a few additional items were added for the 1942–55 survey comparisons, based on estimated elasticity in 1942. These were items for which prices and quantities were not summarized separately in the U.S. urban summary for 1936, although regional data are available.[14]

During the period 1936–42, when the CPI food index increased by 22 percent, the "low income" items on the whole responded more quickly to the upward pressures on the market; only 10 percent showed no change in prices or registered a small decline, as contrasted to 30 percent of the "high income" items. Items classified as "middle income" averaged a higher rise; the great majority of these, however, are also purchased relatively more by the low income than the highest income classes, and it could thus be inferred that the cost of the total food budget would rise more for the lowest, not the highest income groups. (See Table 3.)

In the succeeding period, 1942–55, when the CPI food index showed an 81 percent rise, the low income items steadily forged ahead; 59 percent increased by more than the index, as compared with 47 percent of the high income items, and 37 percent of the middle income items. This calls attention to the fact that when the general price level continues an upward movement over an extended period, even though the average income level may also be rising, a portion of the population is experiencing no change or a decrease in real income. This group, as well as the group whose permanent income is low, seeks out lower cost substitutes with the result that there is always a substantial demand for such items.

[14] This type of analysis requires price and quantity data for individual food items. To my knowledge, the only source of such data on individual food items from the 1936 survey for U.S. nonfarm families by income level is a mimeographed report prepared by the Department of Agriculture in 1940 and privately circulated within the Federal Government. The tabulations did not extend to all food items although none of major importance were omitted. These materials are based on two BLS surveys conducted in the periods of 1936 and conducted in large- and middle-sized cities and some smaller cities, and a survey conducted by the Bureau of Home Economics in small cities and rural nonfarm areas. Families on relief were not included. The data from the three sources were weighted together and then smoothed. Data from the later surveys were not smoothed before publication.

Inevitably, comparisons based on survey data for different dates also include the effects of methodological, definitional, and perhaps operational differences that affect the primary data. The 1936 material relates, for example, to nonfarm, nonrelief families; the 1942 data to all urban households, including those of single individuals, and the 1955 survey material to urban households of two or more persons. All of the 1936 summarized quantity data referred to in this paper are in terms of pounds, while those for the 1942 and 1955 surveys give dairy products (in part), in quarts, eggs in dozens, etc. Necessary conversions to a common unit of measurement introduce another level of estimation and hence are additional sources of error.

For reasons such as these, the empirical data presented are intended only as very rough approximations which presumably indicate the trend of possible differences in indexes for the different classes of consumers under consideration. The samples of items on which tentative conclusions are based are statistically small and, from one group to another, are associated with different levels of relative importance in total food expenditures. Such limitations are inherent in the published data; some could be overcome via retabulations, others only by the collection and tabulation of new material.

TABLE 3.—*Distribution of Price Relatives for Food Items, by Income Elasticity, 1936–42, 1942–55 (as Derived from Urban Cross-Section Data)*

Price relative	Income elasticity of items		
	Zero or negative	Moderate	Most elastic
	(1936=100)		
1942:[1]			
100 or less	10	18	30
100 to 110	33	11	8
110 to 125	14	18	25
125 or more	43	53	37
Total:			
Percent	100	100	100
Number	21	28	24
	(1942=100)		
1955:[2]			
140 or less	5	13	25
140 to 180	36	50	28
180 to 200	27	9	16
200 or more	32	28	31
Total:			
Percent	100	100	100
Number	22	32	32

[1] CPI relative, all food items, 121.
[2] CPI relative, all food items, 181.

Despite sustained demand for low cost foods by a significant portion of the population, supplies of some of these items were limited in 1942. In the meat line, for example, many of the low cost cuts were practically unavailable. As Margaret Reid points out, meat products add up to "the total animal." There are a number of ways in which a carcass can be cut up with no change in item prices, the overall realized price can be increased, decreased, or left unchanged. Individual cuts can be upgraded or downgraded, with no net loss to the butcher. When upgrading occurs, some of the cheaper cuts are absorbed into those of higher quality. The possibilities can occur with all items with a joint supply.

With only one exception, all of the low income meat items as of 1936 represent "scraps" of more expensive cuts, and the single exception, chuck roast, had become a preferred item by 1942. Further, hamburger, although it can be made from beef of varying qualities, had experienced a greater than average price change and was no longer considered an inferior item by 1942.

B. TEST INDEXES FOR FOOD

1. *Laspeyres Index.*—At the present time it is not possible to construct a standard Laspeyres index for low or high income families, due to lack of sufficient price information on many items they purchase. BLS retail price series that are representative of purchases of these two population groups are not sufficiently comprehensive to provide adequate budget coverage. Since far more material is available from the cross-section data, it would seem that test indexes must be derived from this source.

Although base period weights can be derived without difficulty for specific income classes, since the data are so tabulated, the price data by income class, from successive surveys, obviously cannot be matched without prejudice since equivalent income levels are unknown, and average prices paid do vary by income level. On this account, an item rather than a family plan of classification was adopted.

Comparative indexes were calculated for all food items with a negative or zero income elasticity, food items displaying a positive income elasticity, and all foods combined. (See Table 4.) The weights represent total family consumption in 1936 for each set of items. The first set of items is of greatest importance to the lowest income groups (35 percent in budgets of families with incomes of $500–$1,000 in 1936 as contrasted to 14 percent for families with incomes of $5,000 or more. (See Chart 1.) The index calculation included adjusting the quantity data for the three surveys to a common unit of measurement (pounds), and computation of average prices from the quantity and expenditure averages.

TABLE 4.—*Test Food Indexes for Specified Types of Items, 1936, 1942, and 1955, U.S. Urban (Laspeyres Index Formula)*

Type of item	1936	1942	1955
	1936=100		
Total (all items)	100	119	200
Items with negative or zero income elasticity	100	124	257
Items with a positive income elasticity	100	117	190
CPI food index	100	122	221
	1942=100		
Total		100	168
Items with negative or zero income elasticity		100	208
Items with a positive income elasticity		100	164
CPI food index		100	181

Over the six-year period 1936–42 and the thirteen-year period 1942–55, the "low income" index increased more than the "higher income" index and the CPI. And, the increase in the CPI lies between that of the "low income" and the "higher income" indexes.

The comparison of the movement of the index of low income items (30 in all) and the CPI must be approached with considerable caution. In general, it is not surprising that the low income index rose substantially more than the CPI between 1942 and 1955, a period that included World War II and the Korean War, increased demand, and a continuing upward movement of prices during the postwar period. As the ranks of the permanently low income group are augmented by others whose real income is falling (e.g., the fixed-income group, etc.), sustained demand for the low income items acts as an upward pressure on prices and is further strengthened by the general upward movement of prices. Moreover, there is a "unit of measurement" effect also operating. Since the low income items are also those at the bottom of the price ladder, a small absolute change in price can be large in percentage terms as compared with the same dollar change for items with an initially higher price. In addition, low income groups make many of their food purchases at small neighborhood retailers whose total sales volume is low and unit markup relatively high, compared with that of the large supermarkets patronized by middle income groups. Under such conditions, during upswings it seems possible that price rises in such outlets could lead the market.

2. *Unit-Cost Indexes for Food.*—A unit-cost type of index was constructed, again using the same basis for classifying items as established for the Laspeyres index and with prices as well as quantities derived from the survey data. (See Table 5.) The unit-cost index, however, allowed the contents of each basket of goods to vary at each survey date, by classifying items according to their elasticity as of the survey period. This type of index is an expenditure ratio,

$$\frac{p_1q_0}{p_0q_0},$$

where, in the case of the low income index, the p_0's and the q_0's relate to items with a negative or zero income elasticity in period $_0$, and the p_1's and q_1's to items that display similar elasticities in period $_1$. Since items and quantities are allowed to vary, as well as prices, indexes so calculated show greater fluctuation than a Laspeyres index. (See Table 4.)

TABLE 5.—*Test Unit-Cost Indexes for Specified Types of Food Items 1936, 1942, and 1955, U.S. Urban*

Type of item	Date		
	1936	1942	1955
	1936=100		
Total	100	141	253
Items with a current negative or zero income elasticity	100	156	269
Items with a current positive income elasticity	100	132	238
CPI food index	100	122	221
	1942=100		
Total		100	179
Items with a current negative or zero income elasticity		100	173
Items with a current positive income elasticity		100	180
CPI food index		100	181

Overall changes from 1936 to 1955, and changes from 1936 to 1942 were greatest for items with a negative or zero income elasticity, but items with a positive elasticity showed a slightly larger rise during the period 1942 to 1955, partly due to a greater increase in total quantities of items purchased. The index for the latter group of items (positive elasticity) was more comparable in movement to the CPI food index than to the index based on low income items, especially over the period 1942–55.

3. *CPI-Based Food Index.*—Finally, a Paasche index was calculated, using 1955 survey expenditure weights. The price change measured covered the period 1950–55. CPI item indexes were applied to 1955 expenditures of matching items, and the average change of priced items per subgroup applied to the total expenditure weight per subgroup. Indexes were prepared for three income levels, $1,000–$2,000, $4,000–$5,000, and $10,000 and over. No significant variation

was shown in the three indexes (108, 108, and 110) nor between them and the actual change in the CPI food index—110. The lack of differences between the three test indexes is explained by the relatively minor variations in relative importance of subgroups of items. No major differences were to be expected between the CPI and the index for the middle income group.

This comparison shows in part, the dangers inherent in item imputation. Although item weights vary in the three budgets, the lack of extreme variation in subgroup expenditure totals deadens item differences in price changes. The major difference in subgroup totals occurs in the food-away-from-home group, which is of minor significance (17 percent) in the low income budget, and of substantial importance in the highest income budget (33 percent). However, food away from home was an imputed, not a priced subgroup in the 1950 CPI.

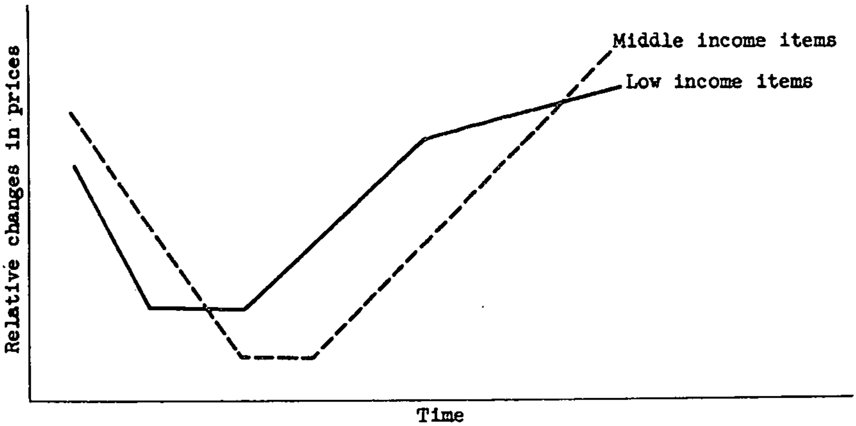
C. TENTATIVE CONCLUSIONS AND CONJECTURES: THE FOOD INDEX

Since the consumer surveys uniformly have been conducted during periods of rising prices, from these sources relative changes in retail prices of items purchased by families at varying economic levels can be estimated only during cyclical upswings. In such periods, the available data suggest that prices of items of particular importance to low income groups advance more rapidly than prices of other items. If this is true, it can then be inferred that a Laspeyres index of total food costs for this population group would show a greater increase than the CPI food index during such periods. While items with a relatively high income elasticity showed the smallest advance, on the average, a less positive inference can be drawn concerning the relative movement of an index for high income groups: it would depend upon the relative importance on the total budget of items with a high income elasticity as compared with items with a positive but relatively low elasticity.

Relative price movements during other phases of the business cycle can only be surmised. Assuming a free market, there exists a certain logic to support the assumption that prices of items with a negative or zero income elasticity tend to be inelastic during downswings, relative to items with a moderate income elasticity. Throughout such periods, the size of the low income population is expanding and hence demand for inferior and low cost items is sustained. Supply of such items probably is relatively inelastic in the short run since by and large these foods comprise the basic staples. If this is true, one might expect a relatively greater decline in prices of these items, unless demand was either sustained or increased. In recession periods, demand for low cost items would be least affected. Middle income items, on the other hand, are subjected to more severe market pressures as real income of this population group declines, total demand falls, and simultaneously is downgraded to lower quality goods. Supply is presumably rather inelastic but less so than that of low income items. In a similar vein, it could be argued that the price response of the highest income items may lie between that of the low and middle income items.

On the other hand, measuring from peak to trough, or trough to peak, it is possible that overall changes in indexes for the lowest and the highest income groups may not be as large as the change in the CPI for moderate income families.

On this hypothesis, indexes for the extremes of the income distribution might lead the CPI but their overall swings could be narrower. These possible relationships are illustrated in the diagram appearing below.



If middle income items on the average display the greatest overall changes, despite their lag, it must mean that at some later stage of an upswing prices of other items tend to reach an equilibrium level and display only a minimal response to the general increase in market prices. During such a stage real income is rising, the low income population declines, and low income food items tend to assume the characteristics of byproducts.

The above hypotheses assume no restrictions on supply. If, however, market disturbances such as those created during wartime cause low income items to disappear from the market more rapidly than other items or if their supplies become relatively more limited, a low income index conceivably could show a greater overall increase over a complete business cycle on this account.

Clothing and House Furnishings

The consumer surveys consistently have shown that the budgets of the lowest income groups are heavily weighted with "inferior" goods—the low cost substitutes of more preferred goods and services—and with the lower-priced qualities of items belonging to the same generic group (men's suits, women's street dresses, etc.). Inferior goods, which were broadly defined as having a negative or zero income elasticity, were discussed in the previous section where food items were discussed as an illustrative case. Here, some of the meager data available on differing qualities of clothing and furnishings items are examined.

Not all persons in the low income group regularly purchase the lowest available quality but in general the average purchase price of most items increases across the income scale. (I would expect, however, that if consumers were classified by their permanent income rather than current money income, distributions of prices paid, by income level, would show less dispersion.) Nevertheless, it is probable that if the surveys could record purchase data for consumption items stratified by a high degree of specification (which index number theory incorrectly assumes to be standard procedure) differences in average purchase price of identical items would still be shown by income level. Transaction prices vary between types of outlets; stores frequented by the higher income groups incorporate a larger component representing the cost of extra services, prestige factors of various kinds, credit costs, and so on.

There are thus two separate questions to be answered, relative to changes over time in prices of items classified according to quality. First, do price trends of identical items vary between low income stores and middle and high income outlets? Second, what are the differences, if any, in price movements of items belonging to the same generic class but highly differentiated by quality level?

The first problem can be approached best by the agencies in charge of the price collections and will not be discussed further in this paper. The published price information is insufficient to provide a framework for quantitative analysis of this type. It is quite possible, if not probable, that such differences do exist.

We are only slightly better off, however, as regards data relevant to the second question. It has been pointed out that in recent years the number of items priced at different quality levels by the BLS has steadily declined. More and more, CPI policy has tended towards pricing one quality of an expanding list of items. This may result in a better CPI but places unfortunate limits on a study of price trends by quality level.

The category of clothing, like that of food, includes a smaller physical volume in the low income budget, but contains fewer low-cost item substitutes. Rather, it is characterized by the greater importance of the lowest cost qualities of identical items, items being defined generically.[15] (The same generalization can be made of the house-furnishings budget.)

It would appear that in the survey data a very much smaller proportion of the low cost clothing budget, as compared with food, consists of items with a negative or zero income elasticity. Clothing items displaying this characteristic primarily are those in the work clothing category. The apparent difference between categories undoubtedly results from the variation in item identification. Apparel is standardized as to items, across all income groups; everyone has to wear shoes, outer apparel, etc., and the quantity saturation point per item is reached more quickly than in a category such as food where greater substitution is possible between items. Thus, very few of the clothing items, as recorded in the consumer surveys, display a negative or zero income elasticity. However, if low cost items (the lower qualities) were recorded separately, as in the food schedule, undoubtedly these would show up as inferior goods.

Prior to World War II the regular CPI price collections included two or more qualities of a substantial number of clothing items, and a few house-furnishings items. This was also the case in the period im-

[15] This nomenclature differentiates "rib roast" and "chuck roast" as separate items, although both are roasts of beef, while "women's rayon street dresses" is a single item for which many different qualities are available. This differentiation, while somewhat artificial, is in line with the manner in which details are recorded in the consumer expenditure surveys.

mediately preceding World War I except that prices are available for many more furnishings. Both sets of price data, while limited, indicate that in the prewar-inflationary periods, mid-1914 to mid-1918, and from June 1939 to December 1941, average retail prices of the lower quality items in these two categories advanced significantly faster than did the higher qualities also included in the pricing list. The comparison appears in Table 6.

TABLE 6.—*Price Relatives for Selected Clothing and House-Furnishings Items, by Quality Level, June 1914–August 1918, and September 1939–December 1941, U.S. Urban*

[Number of items]

Item and date	Total	Largest increase shown by		Same change
		Lowest quality	Highest quality	
1939–41: [1]				
Clothing items	27	19	6	2
House-furnishings items	5	4	1	0
1914–18:				
Clothing items	19	18	1	0
House-furnishings items	13	11	2	0

[1] The items included in Table 6 are as follows:
1939–41: Clothing: Men's overcoats, topcoats, wool suits, wool sweaters, dress trousers, work trousers (2 types), business shirts, cotton trousers, semi-dress, felt hats, socks, pajamas, street and work shoes; women's dress coats, sport coats, dresses (wool, rayon, rayon prints, cotton), silk hose, slips, street shoes; girls' coats, shoes. *Furnishings:* blankets, sheets, floor covering, living room, dining room, and bedroom sets.
1914–18: Clothing: about the same as in 1939–41. *Furnishings:* blankets (2), sheets and sheeting, towels, dining room table, chair; bedstead, mattress, kitchen stove, table knives, skillets.

SOURCE: 1934–41: *U.S. Average Prices of Clothing, Shoes, Furniture, Household Equipment, Electrical Appliances, Drugs, and Miscellaneous Commodities, June 1939 to September 1942.* Ethel D. Hoover, Chief, Retail Price Division, Bureau of Labor Statistics, March 1943. Mimeographed report issued for use of Federal agencies only.
1914–18: *Average Retail Prices: Collection and Calculation Techniques and Problems.* Bul. No. 1182. June 1955. Bureau of Labor Statistics. (See Appendix F.) The price data were assembled from original schedules of reporters in 18 shipbuilding centers and formed part of a BLS study of changes in living costs in these areas that were experiencing an explosive expansion in industrial production, population, and living costs. While the Bureau made every effort to match qualities from one pricing period to the next in order to construct continuous price series by quality level, specification control under such circumstances could not be rigidly maintained. For items with a wide range in prices in the base periods, subgroups were established by price level, and an attempt was made to maintain comparable qualities in succeeding periods.

Both time periods are comparable in that they immediately preceded direct American participation in a major war, and they are characterized by rapidly rising prices, real and anticipated shortages of consumer goods despite expanded industrial activity, and sudden population shifts to production centers with attendant increases in income and consumer demand. Sellers' markets existed during both periods.

It could well be true that the price data for these periods present a biased picture. It would require very intimate knowledge of the relative supply and demand of each quality of the items included in Table 6 to be able to estimate how much of the apparent price rise was due to disappearance of lower quality items and the resulting upgrading within specifications. But, on the other hand, it must be remembered that in these time periods the full effects of wartime shortages, voluntary and compulsory rationing which occurred after U.S. entry into World Wars I and II, and the artificial relationships between relative prices resulting from price control had not yet developed. In any case, the recorded differences in relative price changes were, for the most part, of considerable magnitude, as shown in Table 7.

The limited data presented in Tables 6 and 7 suggest that when the general price level is rising rapidly, prices of low-quality, low-cost

TABLE 7.—*Relative Price Changes of Selected Clothing and House-Furnishings Items, by Quality Level, 1914–18, and 1939–41* [1]

Percentage change in price	Number of items: Clothing	Number of items: House-furnishings
1939–41		
Price increase of lowest quality higher by:		
1 to 5 percentage points	6	1
5 to 10 percentage points	6	2
10 to 20 percentage points	5	----------
20 or more percentage points	3	1
Price increase of highest quality higher by:		
1 to 5 percentage points	4	----------
5 or more percentage points	1	1
No difference in price change	2	----------
Total	27	5
1914–18		
Price increase of lowest quality higher by:		
1 to 20 percentage points	3	1
20 to 40 percentage points	8	4
40 to 80 percentage points	5	5
80 or more percentage points	2	2
Price increase of highest quality higher by:		
1 to 10 percentage points	1	1
Total	19	13

[1] See Table 6 for sources.

items tend to have the greatest advances in the short run. In this response they are similar to inferior goods as defined in the preceding section.

HOUSING

With the exception of the aged who have retained possession of owned homes, homeowners primarily are members of the middle and upper income groups. Except for the group noted, relatively few families at the lowest income levels are homeowners. The discussion on housing will therefore be limited to renters.

For the period 1935–40, the Bureau of Labor Statistics calculated indexes of rents by rent ranges for 33 large cities throughout the country.[16]

In each of these cities, the increase in rents over these 5 years was larger for the lowest rent class, as compared with the highest rent class.

During more recent years it would appear that rental costs, like those of other major components of the family budget, have also increased more rapidly for the lowest income families as contrasted to increases in costs of middle and upper income families.

It is possible to compare changes in identical rental-occupied nonfarm dwelling units between 1950 and 1956, as derived from the 1950 Census of Housing and the 1956 National Housing Inventory. Monthly contract rent is available for identical units cross-classified by rent level during both years.[17] These data show that the relative

[16] I am indebted to Ethel D. Hoover, of the Bureau's Price and Cost of Living Division, for bringing this report to my attention and making it available to me. The mimeographed report presents quarterly indexes for the cities there included in the CPI. Distribution did not extend beyond the Federal Government.

[17] *Components of Change, 1950 to 1956,* Vol. I, Part 1, 1956. National Housing Inventory, Bureau of the Census, 1958.

increases between 1950 and 1956, in rents of units classified by their 1950 rent level, were highest for the units with the lowest rents, and steadily declined at successively higher rent levels. (See Table 8.)

TABLE 8.—*Indexes of Rents by Rent Ranges, Selected Large Cities, 1935 to September 1940 (1935=100)*

[Rent index for September 1940]

City	Rent ranges						
	Under $15	$15 to $19	$20 to $30	$30 to $40	$40 to $50	$50 to $75	$75 and over
Atlanta	113	112	114	113	106	[1] 103	—
Baltimore	117	112	109	105	104	[1] 104	—
Birmingham	161	144	135	124	[2] 115	—	—
Boston	101	100	102	101	99	[1] 97	—
Buffalo	127	118	117	111	107	[1] 102	—
Chicago	120	119	122	121	117	112	107
Cincinnati	111	103	108	104	101	[1] 96	—
Cleveland	130	126	120	113	109	[1] 108	—
Denver	123	122	119	114	107	[1] 104	—
Detroit	—	[3] 156	136	123	118	[1] 114	—
Houston	—	[3] 120	119	111	107	[1] 97	—
Indianapolis	131	126	119	114	[2] 107	—	—
Jacksonville	123	115	107	100	[2] 94	—	—
Kansas City	109	107	107	105	103	[1] 101	—
Los Angeles	—	[3] 135	121	109	108	106	108
Manchester, N.H	106	102	102	100	[2] 99	—	—
Memphis	121	122	115	113	108	[1] 103	—
Minneapolis	130	122	119	113	112	[1] 103	—
Mobile	116	113	110	107	[2] 101	—	—
New Orleans	107	105	106	104	102	[1] 102	—
New York	106	104	106	105	103	102	100
Norfolk	110	104	102	105	102	[1] 100	—
Philadelphia	108	108	107	105	104	[1] 103	—
Pittsburgh	120	117	114	111	110	[1] 107	—
Portland, Maine	104	100	101	100	101	[1] 97	—
Portland, Oreg	124	122	122	118	[2] 108	—	—
Richmond, Va	110	106	108	107	105	[1] 104	—
San Francisco	—	[3] 112	108	106	105	102	102
Savannah, Ga	111	109	109	108	[2] 105	—	—
Scranton, Pa	102	98	96	98	98	[1] 97	—
Seattle	124	120	120	110	[2] 108	—	—
St. Louis	103	104	105	102	100	[1] 99	—
Washington, D.C	—	[3] 105	105	103	101	99	99

[1] $50 and over.
[2] $40 and over.
[3] Under $20.

SOURCE: "Indexes of Rents by Rent Ranges in 33 Large Cities" (for quarterly periods, March 1935 to September 1940). Retail Price Division, Bureau of Labor Statistics (mimeograph).

These comparisons of rates of change in rents are based on median values and hence are subject to some limitations. Medians were assumed to equal midpoints of class intervals, in the case of the year used as classification base, and for the other year were calculated from the distributions given. Use of midpoints as estimates of median values of the arrays by rent level in 1950 probably results in underestimates of rent changes, especially at the upper end of the rent distribution where class intervals are raised from $10 to $20.[18] Errors of estimate, however, would have to be unrealistically large before the trend toward smaller increases at the higher rent levels is eliminated.

Another drawback, of course, is the lack of quality control. Most appropriately, comparisons of time-to-time changes in rental values

[18] The second highest rent class includes units with rents from $80 to $99. Median value in 1956 of dwelling units with 1950 rents from $80 to $99 was calculated at $93.10 for all nonfarm units. If the 1950 median is taken as $90, the midpoint value, the percentage change in median value rose 3 percent between 1950 and 1956. If, on the other hand, the estimated median value is dropped to $85, the percentage change is 10 percent, a change still considerably below that shown at the lower end of the rent scale.

should be based on representative dwelling unit samples in which the quality-mix is held constant. Furthermore, rather than contract rent, a value that standardizes for utilities and furnishings should be used, such as a gross rent that represents contract rent adjusted to include utilities and excludes rental costs of furnishings.[19] In this connection it should be noted that the BLS rent index, which is calculated on an adjusted contract rent concept, eliminating the effects of changes in utilities or furnishings included in rent, increased by 22 percent between 1950 and 1956, as compared with an estimated 30 percent rise in median rents of identical nonfarm rental units, and a slightly smaller estimated rise in average (mean) rents (about 28 percent).

Among nonfarm renter-occupied dwelling units, those located outside standard metropolitan areas showed the smallest increase in costs. This was true at all rent levels. (See Table 9.) Within standard metropolitan areas, differences between rental changes of units in central cities and those in outlying areas were minor, except for the lowest rent class (less than $20 per month), and middle-priced units ($40 to $49). For these two sets of dwelling units median rents increased substantially more in central cities.

TABLE 9.—*Estimates of Changes in Monthly Contract Rent, 1950–56, Identical Renter-Occupied Dwelling Units, by Area* [1]

Rent level	U.S. nonfarm	In standard metropolitan areas: In central cities	In standard metropolitan areas: Not in central cities	Outside standard metropolitan areas
	Median rent in 1956			
1950 RENT				
Total	$50.02	$54.20	$54.80	$37.83
Less than $20	22.91	26.06	24.12	(2)
$20 to $29	35.40	36.52	37.65	31.45
$30 to $39	47.08	48.44	48.89	41.03
$40 to $49	55.67	58.34	53.68	49.92
$50 to $59	62.84	68.16	68.76	58.01
$60 to $79	73.74	74.78	76.14	68.32
$80 to $99	93.10	95.08	90.22	90.00
$100 or more	(2)	(2)	(2)	(2)
	Percentage increases, 1950 to 1956, measured from 1950 midpoints of rent classes			
Total	30	38	37	26
Less than $20	[1] 52	[1] 74	[1] 61	(2)
$20 to $29	42	46	51	26
$30 to $39	35	38	40	17
$40 to $49	24	30	19	11
$50 to $59	14	24	25	6
$60 to $79	5	7	9	−2
$80 to $99	3	5	0	0
$100 or more	(2)	(2)	(2)	(2)

1 Midpoint of 1950 rent class taken as $15.
2 Not available.

SOURCE: See footnote 17.

19 Lawrence N. Bloomberg, Office of Statistical Standards, Federal Bureau of the Budget, is obtaining special tabulations from the Census Bureau which will provide, on a gross rent basis, data comparable to that presented in Tables 8 and 9.

It would therefore appear that rental indexes for the period 1950 to 1956 would have increased most for low income families and least for the high income renters living in standard metropolitan areas. Nonfarm low income renters outside of such areas on the average experienced rental increases of about the same degree as families in standard metropolitan areas paying middle-to-upper rental costs.

OTHER CATEGORIES OF CONSUMPTION

Time limitations have precluded undertaking a detailed study of the remaining categories of consumption. It is possible, however, to make a few general observations.

TRANSPORTATION

The transportation budget consists of two major components—private facilities (automobiles), and public services (local street cars, buses, and subways). Average expenditures on other methods of transportation are relatively small. Automobile purchase and upkeep are of greatest importance in the high income budgets and of least importance in low income budgets, while the converse is true of local transit. Between 1936 and 1955, local transit fares increased by 118 percent, as contrasted to a rise of 79 percent in the cost of car purchase and maintenance, as measured by the BLS item indexes.[20] Over this period, therefore, transportation costs of low income families, excepting those of limited mobility such as the retired, rose substantially more than that of middle income families.

Commencing from a 1936 base, and measuring relative changes over shorter time periods, however, increases in costs of public local transportation facilities did not always lead private facilities. (See Table 10.)

Between 1936 and 1942, local transit fares were stable while the cost of new cars[21] and car maintenance increased substantially.

TABLE 10.—*Price Indexes for Selected Transportation Items 1936–58, U.S. Urban*

[1936=100]

Date	Total transportation	Local transit fares	Automobile purchase and upkeep	New car purchase
1936	100	100	100	100
1942	111	102	118	113
1950	158	150	164	201
1955	180	218	------------	220
1958	200	247	198	245
PERCENTAGE INCREASES, SUCCESSIVE DATES				
1936–42	11	2	18	13
1942–50	41	46	38	79
1950–55	13	45	8	9
1955–58	11	13	10	12

SOURCE: Consumer Price Index, *Price Indexes for Selected Items and Groups*. Bureau of Labor Statistics, September 1959.

[20] Consumer Price Index. *Price Indexes for Selected Items and Groups*, Bureau of Labor Statistics, September 1959.

[21] Used cars were not priced for the index until 1953.

Thereafter, from 1942 to 1958, local public transportation costs rose more rapidly than charges for other transportation items. From 1955 through 1958, prices continued to rise, but at a slower rate; furthermore, there was no significant difference in price changes of the major components.

The lags and leads shown by these figures introduce an artificiality in time comparisons that do not span a complete cycle. Price data are not available for the period immediately preceding 1936, here used as the base date. If local transit fares increased more than private transportation costs during that period, then from the depression low in the early 1930's to 1958, the latest available date, the disparity between local public transportation costs and private transportation costs would be greater than the increase shown from 1936 to 1958. If the reverse were true, relative price changes would have been more nearly alike. It is also possible that following the 1955–58 period of relative equilibrium, costs of car purchase and upkeep may increase more rapidly than local transit fares in the short run, assuming a continuing rise in the general price level.

Over short periods, no definitive statement can be made relative to price changes in transportation costs of low-, middle-, and high-income families because of the lags and leads these items display. Disregarding the technical problems of measuring time-to-time changes in car prices, and assuming for the moment that the relationship between price changes in public and private transportation items shown by the BLS item indexes is reasonably accurate, it seems clear that in the long run the cost of the lowest and highest income budgets rose more than middle-income budgets. The indexes show that prices of new cars and local transit fares increased by the same relative amount over the 22-year period 1936–55. While middle-income budgets include both of these items, they also give the greatest relative weight to purchases of used cars. (Between 1953, when BLS began pricing used cars, and 1958, the item index for used cars declined by 10 percent while the new car index went up 6 percent.) Transportation budgets for the lowest income groups would be limited largely to public transportation; purchases of used cars and upkeep charges would have very little weight, in these budgets, as compared with those for middle- and high-income groups.

In comparing relative changes in local transit fares and prices of other items, perhaps it should be pointed out that a "unit of measurement" problem exists here also. In actual practice fares do not form a discrete price series since now the price of a single ride is based on five-cent multiples; prices in odd cents are possible only when cost of transfers or multiple sales are taken into account (BLS prices are for single rides only). Since the unit price is low, relative to prices of other prices, a small absolute change in price is bound to be large in relative terms.

MEDICAL CARE

Medical care costs have risen more rapidly than the all-items index (CPI) but inferences about indexes for low- and high-income groups that can be drawn from the BLS price series are rather limited in scope since the item coverage is not representative of low (or high) income budgets. The pricing list does include, however, three types of hospital rates—for private and semiprivate rooms and men's pay ward.

Except for the period 1936–42, charges for a ward bed consistently increased more than charges for a private or semiprivate room. The overall change from 1936 to 1958 was somewhat more than substantial—396 percent for ward beds, 256 percent for private rooms. If costs actually paid by the consumer are compared, however, it is likely that charges paid by middle- and upper-income groups have shown a smaller rise than quoted hospital rates because of the expanding coverage of hospitalization insurance among these groups. On this argument the cost of hospital board has increased relatively more for low-income groups than the difference shown in the simple comparison of basic hospital rates, since hospitalization insurance is not a major item for families at the lowest end of the income scale (Table 11).

TABLE 11.—*Price Indexes for Hospital Board Rates 1936–58, U.S. Urban*

[1936=100]

Date	Hospital rates		
	Men's pay ward	Semiprivate	Private
1936	100	100	100
1942	118	117	114
1950	302	260	239
1955	400	329	308
1958	496	397	356
PERCENTAGE CHANGES, SUCCESSIVE DATES			
1936–42	18	17	14
1942–50	154	122	109
1950–55	32	26	28
1955–58	23	14	15

SOURCE: See footnote to Table 10.

The BLS subgroup index for drugs and prescriptions shows less than half the increase reflected in the all-items index since 1936 but this probably is not representative of the increases in costs actually incurred by the index population. (It is relevant to note here that the high and increasing costs of drugs and prescriptions has become a matter of public concern during the past year or two and there have been a number of public investigations concerning the "high" cost of medications.) This subgroup of consumer goods in particular is undergoing rapid changes and technical improvements, and in index construction the "new product" problem is especially acute. Expanding costs of medications for all income groups is partly a result of the availability of new treatments and new products—the "miracle" drugs and antibiotics, etc., items not yet included in the CPI. In order to estimate relative differences in medication indexes for families at different economic levels it would be necessary to construct appropriately weighted indexes based on treatment costs of a sample of illnesses and disabilities. The few simple prescriptions, plus aspirin, milk of magnesia, and vitamin concentrate, on which the CPI index was based until the second quarter of 1960, represent a coverage too limited to provide any information on differential trends of drug prices paid by various economic groups. The sample of prescriptions included in the index has just been revised; 13 new items were added.

PERSONAL CARE

Personal care items, which include both commodities and services, show diverse price movements that are not completely correlated with the classification either by commodity or service. Of the three services currently priced for the CPI, two—men's haircuts, and shampoo and wave sets at beauty salons—have shown very substantial price increases during the entire period 1936–58, while prices of the third, permanent waves, following steady increases between 1936 and 1946, stabilized during the succeeding 12 years. Undoubtedly the stability in cost of permanent waves during the more recent period reflects two factors; simplification of the hair-waving process, and the introduction of a low-cost substitute, a "do-it-yourself" home permanent wave. Prices of refills of the self-applied permanent waves, on the other hand, have increased steadily since 1952 when it was first introduced into the CPI. For another item, shampoo and a simple wave at a beauty shop, the relationship between prices of the purchased service and self-applied commodity (shampoo) is exactly the converse (Table 12).

TABLE 12.—*Price Indexes for Selected Personal Care Items 1936–58, U.S. Urban*

Date	Personal care, total [1]	Men's haircuts	Item: Shampoo and wave set	Shampoo (bottle)	Permanent wave	Home permanent refill
	1936=100		1952=100			
1936	100	100	39		58	
1942	121	107	53		70	
1950	183	230	92		98	
1952	202	270	100	[2] 100	100	100
1955	209	300	110	101	101	124
1958	233	340	130	101	102	149
PERCENTAGE INCREASES, SUCCESSIVE DATES						
1936–42	21	7	36		21	
1942–50	51	79	75		[3] 40	
1950–52	11	18	8		2	
1952–55	3	11	10	1	1	24
1955–58	12	15	18	0	1	20

[1] From 1936 to 1950, subgroup total based on: men's haircuts, shampoo and wave set, permanent waves toothpaste, face powder, toilet soap, razor blades, and sanitary napkins; home permanent refills were added in 1951, and cleansing tissue, shaving cream, face cream, and home shampoo in 1952.
[2] December 1952=100.
[3] This increase occurred during the period 1942–46. The item index for permanent waves has been relatively stable since 1946.

Source: See footnote to Table 10.

Toiletry commodities display similar diversity in price movements, ranging from decreases during the recent period (cleansing tissue, face powder), stable prices (razor blades, shampoo) to price increases (toothpaste, toilet soap, shaving cream, face cream, etc.). Faced with such variation in price trends, it is difficult to estimate relative price movements of personal care items purchased by families at different economic levels. The group as a whole, however, has a relatively small importance in spending patterns of middle and upper income groups, and has least importance at the lowest end of the income scale.

RECREATION

Like the personal care subgroup, this set of items represents a combination of commodities and services. None, however, can be considered as direct, low-cost substitutes for more preferred items. Except for newspapers, which have a relatively high purchase rate at all income levels, and movies, the recreation group contains "luxury" items of relatively minor importance in spending patterns at the lowest end of the income scale, such as purchase of television sets and television repair services. For the lowest income families, therefore, movement of the price index for the recreation group will depend primarily on changes in newspaper prices and movies; between 1936 and 1958, these prices advanced steadily, with an overall increase larger than the change shown in the subgroup total—a rather meaningless statement in view of the changes introduced into the CPI pricing list in 1952. Since 1952, television repair charges, one of the newly introduced items, went up the most, while prices of heavy appliances, television and radio sets and toys and sporting goods either declined or remained relatively stable. It would thus appear that an index of newspaper and movie prices would show a greater advance, in the short and long run, than an index based on the remaining items in the recreation subgroup (Table 13).

TABLE 13.—*Price Indexes for Selected Recreational Items 1936–58, U.S. Urban*

Date	Reading and recreation total [1]	Newspapers	Item: Movies	Item: Television set	Item: Table radio	Item: Television repairs
	1936=100		1952=100			
1936	100	100	100			
1942	115	116	118			
1950	174	178	174			
1952	181	191	178	100	100	[2] 100
1955	180	204	209	85	91	117
1958	197	239	233	90	88	136
PERCENTAGE INCREASES, SUCCESSIVE DATES						
1936–42	15	16	18			
1942–50	48	53	47			
1950–52	3	7	2			
1952–55	0	5	17	[3] 15	[3] 9	17
1955–58	9	17	11	7	[3] 8	16

[1] From 1936 to 1949, includes newspapers, motion picture admissions (adults and children), radios (changing models): table radio substituted in 1950; television sets added in 1951. Toys, sporting goods, and television repairs in 1953.
[2] December 1952=100.
[3] Decrease.

SOURCE.—See footnote to Table 10.

Summary: Expected Variations In Living Costs of Consumers At Different Economic Levels

The work thus far undertaken has been exploratory rather than comprehensive in nature, and the empirical studies are not sufficiently detailed to illustrate conclusively the extent to which indexes for special classes of consumers will vary at successive stages of the business cycle. The results obtained, while limited, perhaps are adequate to indicate the type of model that could be established for further detailed analysis. One suggested model is described below.

Stages of the Business Cycle

A. RECESSION, PRICES FALLING

1. The supply of commodities important in low-income budgets remains relatively stable, while that of middle and upper income budgets declines slightly.
2. Supply of all skilled services remains stable, while supply of unskilled services (not purchased by low-income groups) increases slightly.
3. Prices of commodities of inferior goods and other goods of major importance to low-income groups decline slowly, relative to prices of commodities most important to middle-income classes, while prices of the highest cost and highest quality goods remain relatively stable.
4. Prices of skilled services in low-income budgets decline slowly, relative to middle-income items, while high-income services remain stable.
5. Unskilled services, purchased by middle and upper income groups only, decline in price.

B. DEPRESSION, CONTINUED PRICE DECLINES

1. Supply of low-income goods increase in response to rising demand, and supply of middle and upper income items declines.
2. Supply of low-income skilled services relatively stable, since they are largely public facilities, while supply of other skilled services increases.
3. Prices of low-income commodities and services decline, in response to decline in the general price level, but fall relatively less than prices of other items. Middle-income items experience the largest price decline.

C. RECOVERY, RISING PRICES

1. Supply of low-income commodities and services relatively stable, supply of skilled services decline slightly, other supplies expand.
2. Prices of low-income commodities and services recover more rapidly than other items. Prices of high income items are the most sluggish.

D. FULL EMPLOYMENT, RISING PRICES

1. Supply of low-income items decline slowly, while supplies of middle and upper income items continue to expand.
2. Prices of low-income items rise with the general price level, but more rapidly than other items. Prices of high-income items rise the slowest.

This model assumes that prices of low-income items lead during periods of upswing, and lag during downswings. And, high-income items lag both during upswings and downswings. No inferences are made concerning the relative magnitudes of changes over a complete cycle; it is possible, in terms of the model, for middle-income items to show the greatest overall fluctuations.

It also assumes that low income items, and to a lesser degree, high income items are relatively inelastic in the short run. Low income prices are "sticky" during downswings as demand is sustained during the expansion of the low income group. High income prices are relatively inelastic, due to sustained demand on short downswings and, during periods of both falling and rising prices, to the greater prevalence of longer term contractual prices and advance purchasing of this income group.

Many low income commodities, particularly in such categories of consumption as clothing and house furnishings, represent the lowest qualities on the market, and are produced by low wage labor in small plants. In recent years, relatively large wage increases in wage rates have accrued to this labor group. Greater increases in the wage bill of producers of low quality goods, relative to that of other producers, may explain in part why prices of low cost goods could rise more rapidly than prices of the more preferred items. In similar vein, it is suggested that such items are most generally sold in the smaller outlets in the low income neighborhoods. With small sales volume and low inventories, rising production and distribution costs would tend to be quickly reflected by price increases in such outlets. Moreover, all retailers tend to follow income changes of the population they serve.

It has sometimes been argued that indexes for high income consumers would rise faster, in periods of upswing than indexes for low income consumers because the former place a heavier weight on services, which have more volatile price movements than the general run of commodities. On the other hand, in commodities typically purchased by low income groups, labor costs form an unusually large proportion of total production costs, and the labor employed is largely unskilled or semiskilled—the groups that have received the greatest increases in wage rates. The labor services supported by the low income groups thus are the services whose prices have advanced the most. It also has been shown, in preceding sections, that among some of the services (final products) purchased by all income groups, such as rent, those purchased by low income families have shown the greatest price increases.

As contrasted to low income families, middle and upper income families are the purchasers of new products which typically show a downward price movement. The presence of such items in these family budgets in periods of general price advances thus has a retarding effect on indexes for these income groups.

Special Classes of Consumers: The CPI Population vs. Other Groups

Certain aspects of the conceptual framework of the CPI and the related pricing program raise some questions as to the meaning of differences in the movement of this index and others that might be calculated for a more limited population. The population to which the CPI relates is defined in terms of occupational status of heads of urban families of two or more persons, with the exception that an upper limit of family income of $10,000 (1950 dollars) excludes families with incomes in excess of this amount.[22] Since about 70 percent of all urban families are included in the index group of families of "wage earners and lower salaried workers," the index population is extremely heterogeneous in all characteristics affecting patterns of consumption. It is impossible to determine, on the basis of data now available, the extent to which cost of living indexes for homogeneous and relatively small subgroups within this broad population base would vary from one to another and from the CPI. It seems possible, however, that such indexes could show as much variation from the CPI as indexes for "low" or "high" income families.[23]

Since the CPI population coverage is so broad, it is inevitable that there would be some overlap of population if indexes were to be prepared for many of the special classes of consumers for which indexes are desired. Such double representation would tend to dampen real variations in changes in living costs of these groups and the rest of the CPI population. There is something to be said for the argument that if special indexes are calculated for relatively small and homogeneous classes of consumers, it would be more meaningful to compare such indexes (i.e., for the aged, the one-parent families, and other low income families, single working women, the wealthy retired, etc., etc.), with a comprehensive index that is based on the total universe, however defined—the United States (including or excluding the 49th and 50th states), or all urban, etc. Lacking a comprehensive index, it seems inevitable that the CPI as the best approximation available, would be substituted in evaluating the relative movement of indexes for smaller population subgroups. More correctly, in this connection the CPI should be regarded as an index relating to another, albeit broadly defined, subgroup in the total population.

Interpretation of Differences in the CPI and Indexes for Special Classes of Consumers

The CPI, and presumably indexes for other classes of consumers, differ from what index theory describes as the "true" index, in that in the long run it does not attempt to measure time-to-time changes in a constant level of satisfaction. Rather, its continuing purpose is to measure changing living costs of a specific population—a population, moreover, that has experienced a rising standard of living. Only in the short run is the effort made to price a constant level of satisfaction, empirically defined for the index as a relatively fixed market basket, as contrasted to budget changes that satisfy marginal utility functions. On this account, interpretation of sets of indexes will vary

[22] Presumably, this maximum may be raised at the next index revision period.

[23] George Stigler has brought to my attention an article that presents cost of living indexes for 3 components of a population that is somewhat similar to the CPI families. These indexes relate to West Germany, for the period since 1948 to October 1952 (also projected backwards in time to 1938). Separate indexes were prepared for four-person families of wage earners ("low income"), clerical workers ("middle income"), and lower salaried workers ("upper income"). It is my understanding that in the index calculations, the same set of prices was applied to the three different sets of weights. Over this period, the wage earner index showed the largest rise, 15 percent, the middle group the next largest increase, 11 percent, and the higher income index the smallest advance, 7 percent. See "Der neue Preisindex fur die Lebenshaltung," Dr. Gerhard Furst and Dr. Peter Deneffe, *Wirtschaft und Statistik*, 1953.

according to whether short run or long run comparisons are being made. Since the real incomes of components of a particular population universe change at varying rates, indexes for components would incorporate the longer run effects of such differences. Assuming that if the level of living and hence the market basket of a particular group rises or declines, it is clear that if any difference exists in average price trends of the old and new market basket, the revised index will not follow the same path in time as would have been followed if the index level of living had remained unchanged. And a comparison of an index for this group with that of another would measure the combined effects of price changes and the differences resulting from the level of living changes.

To illustrate: it could well be true that as the relative income position of the aged has been raised as a result of deliberate public policy (OASI, expanded public assistance, etc.) during the past 25 years, a price index for the aged, if one had been calculated, might increasingly tend to converge on the CPI. This possibility can be presented graphically; it should be remembered, however, that the relationships that are charted are completely hypothetical and no inference as to the true relationships can be drawn from the graphs (Chart 2).

Chart 3 indicates what might have occurred if separate indexes had been calculated in the past for both types of families, and if, following a period in which new weights were linked into the index, indexes were calculated using both new and old weights.

The diagram assumes that if the CPI, following major revision periods such as 1952, had been carried forward on both the old and the new weights, the index with the older weights would have increased more rapidly since it represents a lower level of living. This assumption of relative change, of course, with the present stage of knowledge remains merely an assumption.

Uses of Indexes for Special Classes of Consumers

Requests for indexes for particular population subgroups originate, in the first instance, from a belief that the movement of such indexes will differ from the changes shown by the CPI for wage earners and clerical workers. Information concerning the direction and level of variation is sought for a variety of reasons and by a variety of individuals and organizations. In brief, questions such as the following are asked most frequently:

1. How do changes in the retail market affect the low-income group (or any other population class) as compared with the changes shown by the CPI?
2. How will a specific change in Government policy (such as introduction of or a change in excise taxes, retail sales taxes, public service fees and charges, etc.) affect the price of living of one population as opposed to another?
3. What are are the causes for the apparently differing trends in rate and level of retail price changes between communities or areas? Are the differences due to variation in the structure of demand or supply, or in the components of price?
4. Would the availability of a hierarchy of consumer price indexes improve current estimates and short- or long-run forecasts of changes in the population by levels of welfare; changes in supply and de-

mand of consumption goods and services; in aggregative and subaggregate estimates of consumption expenditures and gross national product?

The generality of the types of questions asked almost inevitably precludes definitive answers derived solely from price indexes. Those interested in comparing time-to-time changes in living costs of low income families as compared with those of other economic groups, for example, are primarily concerned with changes in the relative economic position of specific economic classes and with relative and absolute changes in their real income over specified periods of time.

These are two separate problems that can be further decomposed. Let us consider first the changes in the relative income position of the aged, a class that currently is receiving a considerable amount of public attention. It appears that in current dollars, of the families with incomes under $2,000, the proportion with aged heads is steadily increasing, rising from 25 percent in 1948 to 36 percent in 1958. And, 37 percent of families with aged heads had incomes under $2,000 in 1958, and 50 percent in 1948. By contrast, 10 percent of all other families had incomes below $2,000 in 1958, and 30 percent in 1948. Thus, measured in current dollars, the income position of aged families had risen less rapidly than that of other families.[24] At the present time, however, it is not known what changes have occurred in terms of real income; lacking appropriate price deflators, this measurement cannot be designed. Formulation of public policy and programs dealing with the aged are thus hampered by lack of appropriate quantitative information.

The second question—what are the changes in real income of the aged from one period to the next?—actually is only partially stated. Old age is commonly thought of as concomitant with low income. A consumer price index pertaining to all aged families and individuals probably would possess only limited application in public welfare analysis. Indexes for the aged generally are wanted to assist in making policy decisions, in assessing and administering welfare programs, and in evaluating unmet needs of this segment of the low income population. The aged as such represent too broad a group for those most in need of special price indexes; in this connection, for example, there is little public interest in the aged with adequate incomes. (Such an index would be useful, of course, in economic analysis of the type exemplified by studies of income-age distributions at constant dollars.)

Thus, we find that one classification of population—by age—overlaps another—by income. This, I think, brings us to the crux of the problem of indexes for special groups in the total population. There are many requests for indexes relating to the low income population, but it appears that what would be most meaningful, in terms of use value, would be a rather detailed stratification of the total low income group that distributes this population by a series of diverse characteristics. Conceivably, a classification plan such as the following could be set up and indexes calculated for all or some of the specified population groups.

[24] But, this may be due in part to undoubling, and refraining from doubling-up with other family units because of the increasing importance of OASI and other retirement income. It is probable that the number of aged families appearing in Census family tabulations has increased more than the actual number of all aged families.

THE LOW INCOME POPULATION, CLASSIFIED BY—

1. Location: urban, rural nonfarm, farm.
2. Size of community.
3. Region.
4. Size of family.
5. Family type.
6. Income level.
7. Age of head, sex, occupation, earnings of head.

These seven classification variables do not represent the totality of the factors that presumably could produce variations in the relative importance of consumption goods and services purchased by each of the specified subgroups within the low income population. If variations in price index weights would produce a different movement in the all-items index, it could be argued that such a battery of indexes is required to answer the questions that are asked relative to differential price changes. To take a simple illustrative case: medical care needs of the aged increase with age. A person aged 65 to 70 years, on the average, requires less medical care, and smaller expenditures on medical care than the average person aged 80 years or over. Not only is the older person typically in poorer health, it is also true that the type of treatment required tends to be more costly. Thus, if medical care costs increase more rapidly than other items, the price index for the very aged, other things being equal, would go up faster than a comparable index for the less aged. But this argument assumes that for persons at the same level of income there is a direct correlation between need and level of expenditures such that a single indifference map and budget line holds for all persons with the same age and income, other variables held constant. It would be difficult to prove such an assumption empirically.

A further problem arises from the fact that need sometimes is negatively correlated with income. Again considering the aged population, what welfare analysts and administrators really want to know is whether this group is disadvantaged in terms of relative changes in living costs that adequately reflect basic needs. If medical care needs of the aged are four times as great, say, as that of another, and the average cost of medical care doubles over a specified period of time, the overall price index of the aged, other things being equal, would show a larger change. In actuality, however, average expenditures of the bulk of the aged, except for those with the highest incomes, are not commensurate with basic needs, so that indexes with base weights equal to actual expenditures would not show as much divergence as indexes that did reflect basic requirements. In this situation price indexes for the aged might be the same as for other population groups but inferences drawn from such a comparison would foster false conclusions. There are significant differences in concepts, structure, functions, and appropriate uses of a cost of living index based on actual spending patterns of a given population, and a normative price index relating to the same population but based on weights designed to describe a specified level of adequacy—a level that could well be somewhat remote from that which the group actually achieves. If additional cost of living indexes are prepared for special classes of consumers, it is essential that the public understands their purposes and their valid applications and uses. Any expansion of the Federal price index program that entails development of additional indexes for special classes of consumers that are comparable in methodology to the CPI inevitably will create new problems—not only of interpretation of possible divergences in movement of the separate indexes, but also of the measurement and interpretation of economic factors other than price that are underlying causes of the price differences that are shown by the indexes. Expanding the price program thus undoubtedly will require expansion of other statistical and analytical programs as well. It is clear, however, that there exists an urgent need for further basic research on price movements of goods and services purchased by various classes of consumers, and logically this research should precede expansion of the index program.

CHART 2

Hypothetical Illustration of Time-to-Time Changes in the Average Level of Living of Two Population Groups During a Period of Rising Incomes

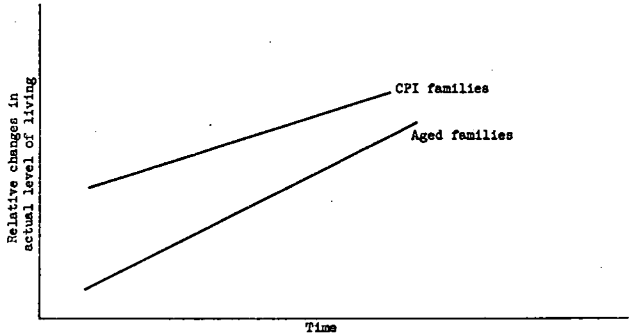
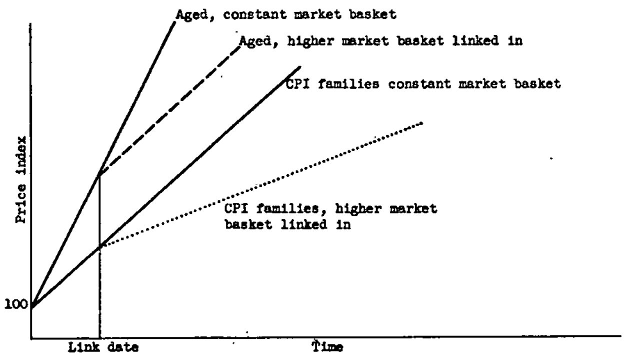


CHART 3

Hypothetical Indexes for Two Population Groups During a Period of Rising Income and Prices, Calculated Assuming No Change in Level of Living and Assuming a Rise in Level of Living



STAFF PAPER 8

STATISTICAL FACTORS AFFECTING THE STABILITY OF THE WHOLESALE AND CONSUMERS' PRICE INDEXES

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Three facets of the behavior of the Wholesale Price Index or its constituent prices are studied in the present paper. First is considered the effect that changes in coverage have upon the cyclical sensitivity of the index. The two following parts deal with the effects of changes in the number of price reporters and the source of price quotations upon the behavior of the individual price series.

I. The Effect of Changes in Coverage upon the Stability of the Wholesale Price Index and the Consumers' Price Index

This study examines the effect of coverage changes upon the movements of the Wholesale Price Index (WPI) and the Consumers' Price Index (CPI). While the techniques and analysis are general and apply to all price indexes, for purposes of clarity the presentation will deal with only these two indexes and for only one coverage change for each index. Some additional data will, however, be given for the Wholesale Price Index.

A. THE WHOLESALE PRICE INDEX

In 1931 the BLS increased the number of commodities included in the WPI from 550 to 784, and revised the index back to 1926 based on prices collected during the period but not used in the former index. Similarly in 1952 the WPI was revised back to 1947 based on about 1,900 items instead of the previous 900. As Tables 1.1 and 1.2 show for the overlapping periods, the new index in each case was more stable than the old in its cyclical swings. By putting the results of these two tables together, it can be inferred that the current 1,900-

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The Division of Prices and Cost of Living of the Bureau of Labor Statistics cooperated to the fullest in making their data and techniques known. In particular, Arnold Chase, Sidney Jaffe, Vincent Covins, Allen Searle, and Buford Paschal of the Division must be mentioned.

A special acknowledgment is due to Geoffrey Moore and George Stigler for substantial suggestions made at an early stage of the study as well as for additional valuable suggestions made as it progressed.

Many industry personnel contributed by supplying price information that was used in the third part of the report.

Miss Dorothy Suchman and Sam Peltzmann diligently and carefully assisted in various phases of the study.

item index would show cyclical swings roughly a third smaller than the same swings shown by the old 550-item index.[1]

TABLE 1.1.—*The Effect on Amplitude of the Changed Sample for the All-Commodity Wholesale Price Index, 1926–31*

Date	Position of index	550-item index (1926=100)	784-item index (1926=100)
January 1926	High	103.6	103.2
June 1927	Low	93.8	94.1
September 1928	High	100.1	98.6
December 1931	Low	66.3	68.6

	Change, 550-item index		Change, 784-item index		Ratio of col. 4 to col. 2 (percent)
	Index points (1)	Percent (2)	Index points (3)	Percent (4)	(5)
January 1926 to June 1927	−9.8	−9.5	−9.1	−8.8	93
June 1927 to September 1928	+6.3	+6.7	+4.5	+4.8	72
September 1928 to December 1931	−33.8	−33.8	−30.0	−30.4	90
Average, 3 swings					85

SOURCE.—550-item index: Bureau of Labor Statistics, *Wholesale Prices*, Bulletin 543; 784-item index: *Monthly Labor Review*, February 1932; *Wholesale Prices*, Bulletin 572.

TABLE 1.2.—*Amplitude Comparisons Between the Old and New All-Commodity Wholesale Price Indexes, 1947–51*

Date	Position of index	900-item index (1947–49=100)	1,900-item index (1947–49=100)
January 1947	Low	90.2	92.3
August 1948	High	107.9	106.2
December 1949	Low	96.1	97.7
March 1951	High	116.9	116.5
September 1951	Low	112.8	113.4

	Change, 900-item index		Change, 1,900-item index		Ratio of col. 4 to col 2 (percent)
	Index points (1)	Percent (2)	Index points (3)	Percent (4)	(5)
January 1947 to August 1948	17.7	19.6	13.9	15.1	77
August 1948 to December 1949	−11.8	−10.9	−8.5	−8.0	73
December 1949 to March 1951	20.8	21.6	18.8	19.2	89
March 1951 to September 1951	−4.1	−3.5	−3.1	−2.7	77
Average, 4 swings					79

SOURCE.—900-item index: *Survey of Current Business*, 1951 Supplement; *Monthly Labor Review*, April 1952. 1,900-item index: *Survey of Current Business*, March 1952.

Turning to the evidence for 1926–31 when the sample was expanded from 550 to 784, we find that of the 234 items added 1 was a raw material, 31 were semimanufactured goods, and 202 were finished products. National Bureau cyclical analysis shows that the average rise

[1] The shift from 550 to 784 items brought an average reduction in relative amplitude of 15 percent. The corresponding average reduction in the shift from 900 to 1,900 items was 21 percent. Excluding the effect of the shift from 784 to 900 items, the combined effect is (0.85) (0.79) = 0.67, or a reduction of one-third.

and fall of finished goods prices during four cycles, 1922–39, was only 0.5 percent per month, compared to 1.0 percent per month for semimanufactured goods and 0.9 percent for raw materials during approximately the same period. One would therefore expect the index to become more stable as the proportion of semimanufactured and finished goods included in the index increased. The question that now arises can be stated as follows: Was the increased stability due to the fact that the economy was actually producing more semimanufactured and finished goods or to the fact that the sample was enlarged, particularly in these two sectors.[2]

To test whether the behavior of the new sample reflected the changing importance of semimanufactured and finished goods only or whether additional influence could be attributed to the enlargement of the sample, the following test was made: The percentage change for raw materials, for semimanufactured goods, and for finished goods during the cyclical swings was noted for the 550-item sample. Each of these percentages was then weighted by the proportion that each category represented of the 784-item sample. In other words, the new structure of the economy as represented by the new weights was applied to the old sample to see if the increased stability could be attributed solely to the change in weights. Table 1.3 reports the basic data by stage of processing for the turning points of the 550-item All-Commodity Index and Table 1.4 shows the effect of applying the new weights to the stage-of-processing components of the old and new indexes.

TABLE 1.3.—*Magnitude and Change by Subperiods and Stage of Processing for Components of the WPI, 550-Item Index, 1926–31*

Date	Position of index	Raw material index	Semimanufactured goods index	Finished goods index
January 1926	High	105.9	104.0	102.1
June 1927	Low	94.1	95.6	93.4
September 1928	High	100.5	96.9	100.5
December 1931	Low	60.2	62.2	71.0

	Change, raw material index		Change, semimanuf. goods index		Change, finished goods index	
	Index points	Percent	Index points	Percent	Index points	Percent
January 1926 to June 1927	−11.8	−11.1	−8.4	−8.1	−8.7	−8.5
June 1927 to September 1928	6.4	6.8	1.3	1.4	7.1	7.6
September 1928 to December 1931	−40.3	−40.1	−34.7	−35.8	−29.5	−29.4

SOURCE.—Bureau of Labor Statistics, *Wholesale Prices*, Bulletin 543; *Survey of Current Business*, January 1932.

[2] Another closely related question but one with which this paper does not deal is how representative was the sample of the universe for this period of time.

TABLE 1.4.—*Effect of Weighting Stage-of-Processing Components of the Old and New Indexes by the Weights of the New Sample, 1926–31*

Stage of processing	(550 items) Old weight (percent)	(784 items) New weight (percent)	January 1926–June 1927		June 1927–September 1928		September 1928–December 1931	
			Percentage change	Weighted change	Percentage change	Weighted change	Percentage change	Weighted change
A. Old Sample (550 items):								
Raw materials	36.11	29.23	−11.1	−3.2	6.8	2.0	−40.1	−11.7
Semimanufactured	7.74	8.86	−8.1	−0.7	1.4	0.1	−35.8	−3.2
Finished goods	56.15	61.91	−8.5	−5.3	7.6	4.7	−29.5	−18.2
Total	100.00	100.00		−9.2		6.8		−33.1
B. New Sample (784 items):								
Raw materials		29.23	−10.6	−3.1	6.8	2.0	−40.1	−11.7
Semimanufactured		8.86	−9.7	−0.9	1.0	0.1	−32.3	−2.9
Finished goods		61.91	−7.5	−4.6	4.4	2.7	−25.4	−15.7
Total		100.00		−8.6		4.8		−30.3

SOURCE.—*Wholesale Prices*, Bulletin 493 and 572, Bureau of Labor Statistics. Weights computed from these bulletins.

If the weighted change totals of the two samples are computed, it can be seen whether the changed structure of the economy accounts for the differences noted in table 1.1. For ease of comparison the summary figures of table 1.4 are put into the following table 1.5.

TABLE 1.5.—*Comparison of the Movements of the Old and New Sample Indexes of the WPI When Changes in Industry Structure Are Allowed for*

Period	Percentage change in all-commodity index			
	Old index with old weights (1)	Old index with new weights (2)	New index weighted by stage-of-processing components (3)	New index weighted in regular way [1] (4)
January 1926–June 1927	−9.5	−9.2	−8.6	−8.8
June 1927–September 1928	6.7	6.8	4.8	4.8
September 1928–December 1931	−33.8	−33.1	−30.3	−30.4

[1] See table 1.1.

SOURCE: Tables 1.1 and 1.4.

In computing the new index in the regular way, individual items are weighted separately and the weighted components are summed. The percentage change figures that one would derive from this index are shown in column 4. Column 3 shows the percentage change figures for the various periods of Table 1.5 that one would get if one separated the new index into stage-of-processing components and weighted the percentage change for each stage by its percentage of the total weight in the overall index. Because of the different methods involved, it would be expected that the small differences between the two indexes that are observed in comparing columns 3 and 4 would exist.

More important to the analysis, however, are the differences found between columns 2 and 3 or 4. These differences show rather clearly that the effects of increased coverage are more important than the change in economic structure [3] in accounting for the reduced fluctuations in the index. The changed industry structure as represented by the new weights when applied to the old index still leaves a relatively large discrepancy unaccounted for. This is evident from the relatively small differences between columns 1 and 2 as compared to the differences between columns 2 and 3 or 4. The change in the weighting of the old index altered it but little, whereas changes other than weighting apparently altered it a substantial amount. Factors other than the weighting which changed between the old and new index were the increased coverage and some increase in the number of reporters. The change in the number of reporters [4] was not large however; the predominant influence effecting change must be attributed to the different coverage. The nature of the extended coverage and its effects will be considered next.

As previously mentioned, the raw materials component of the index was changed by one item, the semimanufactured element was increased by 31 items (a 50-percent increase), and the finished goods part of the total was enlarged from 380 to 582 items (a 53 percent increase). What effect does this changed coverage have on the index and what is the effect of each stage-of-processing component? Table 1.6 shows the percentage amounts that each stage-of-processing com-

TABLE 1.6.—*Comparative Importance of the Stage-of-Processing Components in Stabilizing the New WPI Sample, 1926–31*

Stage of Processing and Sample Size	January 1926–June 1927 (percentage change)	June 1927–September 1928 (percentage change)	September 1928–December 1931 (percentage change)
Raw materials:			
550-item index	−3.2	2.0	−11.7
784-item index	−3.1	2.0	−11.7
Difference	−.1	0	0
Semimanufactured:			
550-item index	−.7	.1	−3.2
784-item index	−.9	.1	−2.9
Difference	.2	0	−.3
Finished goods:			
550-item index	−5.3	4.7	−18.2
784-item index	−4.6	2.7	−15.7
Difference	−.7	2.0	−2.5
Total difference	−.6	2.0	−2.8

RATIO OF PERCENTAGE CHANGE IN NEW INDEX TO PERCENTAGE CHANGE IN OLD INDEX

	January 1926–June 1927 (percent)	June 1927–September 1928 (percent)	September 1928–December 1931 (percent)
Raw materials	97	100	100
Semimanufactured	129	100	91
Finished goods	87	57	86

SOURCE.—Table 1.4.

[3] "Change in economic structure" as used here refers to the shifts in relative importance of the three major groups, and not to the shifts within groups.

[4] The effect of the changes in the number of reporters is analyzed in the second study.

ponent contributes to the total change between the old and new index and brings out rather forcibly the dominant influence of the finished goods category in damping the fluctuations of the WPI. In the swing from January 1926 to June 1927, it contributed to most of the difference; in fact it contributed more than the total because it had to overcome the opposite movement of the semimanufactured element which fluctuated more in the new sample than in the old. A similar influence upon the upward movement of June 1927 to September 1928 and the decline from September 1928 to December 1931 can be noted. The finished goods component accounts for all of the difference between the old and new indexes in the 1927–28 rise and for 89 percent of the difference in the 1928–31 decline.

In summary, it is clear that the increasing coverage of the wholesale price index has had the effect of making wholesale prices appear more stable than they are if one compares fluctuation between the old and new coverage. Increasing the size of sample and increasing the proportion of the more stable finished goods and semifinished goods prices both contributed to minimizing its fluctuations. While the BLS should continue its practice of revising the index to reflect structural change in the economy, analysts should recognize that problems in economic analysis are created by such revision.

B. THE CONSUMERS' PRICE INDEX

In accord with changing expenditure patterns of consumers, the Bureau of Labor Statistics periodically revises the Consumers' Price Index (CPI) so that it may reflect changed economic conditions. However, the revised index may reflect more than just the new expenditure pattern and it may, in fact, also reflect certain factors such as new coverage, new imputing, the correction of previous bias (such as new unit bias in the rent index), and new items included in the index.

Since the CPI is used as a measure of inflation and deflation in the consumer sector of the economy these influences should be investigated.

The New Index of 1935–39.—In 1939 the Consumers' Price Index was revised. The coverage, weighting, base period, imputing, and substitution of new items for old were factors that made the old index differ from the new. The index was revised back to 1935, hence there exist two indexes for 1935–39, one on the old basis and one on the new. The differences in coverage of the two indexes are shown in Table 1.7.

TABLE 1.7.—*Coverage of Old and New CPI Indexes, 1935–39*

Item	Number of items in 1939 coverage	
	Old index	New index
Food	84	54
Clothing	63	48
Fuel, electricity, and ice	6	10
House furnishings	16	26
Miscellaneous	33	60
Total	202	198

SOURCE.—*Changes in Cost of Living in Large Cities in the United States*, Bulletin 699, U.S. Department of Labor, Bureau of Labor Statistics, p. 15.

One effective difference between the new index and the old one is its increased sensitivity. Evidence of this difference is illustrated in table 1.8. The table shows the index numbers and their changes for two lows and a high over the period 1935–39 (based on quarterly observations). Column 5 in the lower part of the table shows that the percentage amplitude of the new index in the upswing from July 1935 to September 1937 was 21 percent above that for the old, while in the downswing from 1937 to 1939 the decline was 41 percent larger in the new index.

TABLE 1.8.—*The Effect on Amplitude of Changes in Construction of the Consumers' Price Index (All Items), 1935–39*

Date	Position of index	202-item index (1923–25=100)	198-item index (1935–39=100)
July 1935	Low	80.4	97.6
September 1937	High	85.0	104.3
June 1939	Low	81.7	98.6

	Change, 202-item index		Change, 198-item index		Ratio of col. 4 to col. 2 (percent)
	Index points (1)	Percent (2)	Index points (3)	Percent (4)	(5)
July 1935–September 1937	4.6	5.7	6.7	6.9	121
September 1937–June 1939	−3.3	−3.9	−5.7	−5.5	141

SOURCE.—202-item index: *Monthly Labor Review*, April 1940; 198-item index: *Survey of Current Business*, May 1941.

Tables 1.9 through 1.13 provide data for analyzing why the index increased in sensitivity, 1.9 and 1.10 providing the basic data on initial magnitude and change by commodity groups, and 1.11, 1.12, and 1.13 showing the effects of weighting the percentage changes of these commodity groups by the weights of the new sample.

TABLE 1.9.—*Magnitude and Changes by Subperiods for the Old Index by Commodity Components of the CPI, 1935–39*

[Date and position of index (1923–25=100)]

Commodity group	July 1935, low	September 1937, high	June 1939, low
Food	80.2	85.8	76.3
Clothing	77.8	84.0	80.9
Rent	62.7	68.1	69.5
Fuel and light	84.9	86.0	85.4
House furnishings	76.2	86.7	83.2
Miscellaneous	96.7	98.1	98.5

Commodity groups	July 1935–September 1937, change		September 1937–June 1939, change	
	Index points	Percent	Index points	Percent
Food	5.6	7.0	−9.5	−11.1
Clothing	6.2	8.0	−3.1	−3.7
Rent	5.4	8.6	1.4	2.1
Fuel and light	1.1	1.3	−.6	−.7
House furnishings	10.5	13.8	−3.5	−4.0
Miscellaneous	1.4	1.4	.4	.4

SOURCE.—*Monthly Labor Review*, April 1940.

TABLE 1.10.—*Magnitude and Change by Subperiods for the New Index by Commodity Components of the CPI, 1935–39*

[Date and position of index (1935-39=100)]

Commodity group	July 1935, low	Sept. 1937, high	June 1939, low
Food	99.4	107.9	93.6
Clothing	96.7	105.1	100.3
Rent	94.1	102.1	104.3
Fuel and light	99.0	100.0	97.5
House furnishings	94.5	106.7	100.6
Miscellaneous	98.2	101.7	100.4

Commodity group	July 1935–September 1937, change		September 1937–June 1939, change	
	Index points	Percent	Index points	Percent
Food	8.5	8.6	−14.3	−13.3
Clothing	8.4	8.7	−4.8	−4.6
Rent	8.0	8.5	2.2	2.2
Fuel and light	1.0	1.0	−2.5	−2.5
House furnishings	12.2	12.9	−6.1	−5.7
Miscellaneous	3.5	3.6	−1.3	−1.3

SOURCE.—*Survey of Current Business*, May 1941.

TABLE 1.11.—*Effect of Weighting Commodity Components of the Old and New Indexes by the Weights of the New Sample, 1935–39*

Commodity group	New weight (percent)	July 1935–September 1937		September 1937–June 1939	
		Percentage change	Weighted change	Percentage change	Weighted change
A. Old sample (202 items):					
Food	33.9	7.0	2.4	−11.1	−3.8
Clothing	10.5	8.0	.8	−3.7	−.4
Rent	18.1	8.6	1.6	2.1	.4
Fuel and light	6.4	1.3	.1	−.7	[1] −0
House furnishings	4.2	13.8	.6	−4.0	−.2
Miscellaneous	26.9	1.4	.4	.4	.1
Total	100.0		5.9		−3.9
B. New sample (198 items):					
Food	33.9	8.6	2.9	−13.3	−4.5
Clothing	10.5	8.7	.9	−4.6	−.5
Rent	18.1	8.5	1.5	2.2	.4
Fuel and light	6.4	1.0	.1	−2.5	−.2
House furnishings	4.2	12.9	.5	−5.7	−.2
Miscellaneous	26.9	3.6	1.0	−1.3	−.3
Total	100.0		6.9		−5.3

SOURCE.—Weights from *Changes in Cost of Living in Large Cities in the United States*, Bulletin 699' Bureau of Labor Statistics.

TABLE 1.12.—*Comparison of the Movements of the Old and New Sample Indexes When Changes in Weighting Are Allowed for, 1935–39*

Period	Old index with old weights (1)	Old index with new weights (2)	New index weighted by commodity groups (3)	New index weighted in regular way (See table 1.8) (4)
July 1935–September 1937	5.7	5.9	6.9	6.9
September 1937–June 1939	−3.9	−3.9	−5.3	−5.5

SOURCE.—Tables 1.8 and 1.11.

TABLE 1.13.—*Comparative Importance of the Commodity Group Components in Accenting the Fluctuations in the New CPI Sample, 1935–39*

Commodity group and sample size	Percentage change	
	July 1935–September 1937	September 1937–June 1939
Food:		
New index	2.9	−4.5
Old index	2.4	−3.8
Difference	.5	−.7
Clothing:		
New index	.9	−.5
Old index	.8	−.4
Difference	.1	−.1
Rent:		
New index	1.5	.4
Old index	1.6	.4
Difference	−.1	0
Fuel and light:		
New index	.1	−.2
Old index	.1	−.0
Difference	0	−.2
House furnishings:		
New index	.5	−.2
Old index	.6	−.2
Difference	−.1	.0
Miscellaneous:		
New index	1.0	−.3
Old index	.4	.1
Difference	.6	−.4
Total difference	1.0	−1.4

SOURCE.—Table 1.11.

In Table 1.11 the percentage changes for each commodity group of the index are multiplied by the respective weights of the new index for the 1935–37 upswing and for the 1937–39 downswing. The effects for the total old index as compared with the new index are noted in table 1.12 for ease of comparison. The comparison of columns 1 and 2 show that the new weighting had little effect for the 1935–37 period and none for the 1937–39 period. The discrepancy between the indexes as shown by comparison of columns 2 and 3 or 4 must rest largely on other causes.

Table 1.13 pinpoints the importance of the various components in effecting the percentage changes shown for the two all-commodity indexes. It is apparent upon examination of this table that the food and miscellaneous elements were dominant in making the new index more flexible than the old.

It appears reasonable to attribute this increased flexibility in the food component to the shift in weights away from cereals and baking products and to the increased emphasis upon fruits and vegetables as well as the effect of a smaller sample. In the miscellaneous element the greater sensitivity would appear to be caused by the fact that automobiles and their operation, a more sensitive subelement, constitute nearly one-fifth of the new miscellaneous category whereas previously they were not represented.

While it is clear that the new commodities and weighting give a more representative index and the new structure of consumer expenditures is better represented by the new index, there still remains an arbitrary element of change induced by the change in the size in the sample similar to that shown by the previous analysis of the WPI. The mathematical section that follows shows clearly why and how the change in sample size affects the variance of the new sample. While it is true that the overall sample changed but little (202 to 198), there were substantial changes in the samples taken from the various groupings. The decrease in the food component for example, from 84 to 54, undoubtedly contributed a great deal to the increased sensitivity noted in this element, an element which accounted for about half the change in the 1935–37 and 1937–39 cyclical swings.

General Effects of Increased Sample Size.[5]—A more exact analysis of the elements affecting the variance of an index when its coverage is increased can be noted if the elements are set up and analyzed as an equation.

Let z=the new index, x=the old index, y=the added items index, w=the weight of the old index, $(1-w)$=the weight of the added items index, and r=the correlation between the old and the added items index.

Then:

$$z=wx+(1-w)y, \text{ and} \tag{1}$$

$$\sigma_z^2=w^2\sigma_x^2+(1-w)^2\sigma_y^2+2w(1-w)r\sigma_x\sigma_y \tag{2}$$

Case I

$$\sigma_x^2=\sigma_y^2,\ r=1$$

$$\sigma_z^2=w^2\sigma_x^2+(1-w)^2\sigma_x^2+2w(1-w)\sigma_x^2$$

Then

$$=\sigma_x^2[w^2+(1-w)^2+2w(1-w)]=\sigma_x^2. \tag{3}$$

Thus, if we add to an index a group of items whose indexes are perfectly positively correlated with the old indexes, and if the variance of each subindex is identical, the new variance will be identical with the old.

Case II

Given: $\sigma_x^2=\sigma_y^2$, $r=-1$, then the new variance, $\sigma_z^2=\sigma_x^2[2w-1]^2$.

In this case where the old variance is weighted by a perfect square whose only variable is the weight of the old index w, symmetrical results are derived for each (w) and its consequent $(1-w)$. The more that (w) and $(1-w)$ diverge, the closer will be the new variance to the old.

If the added items had the same weight as the old items, the variance of the new sample would be zero.

Case III

Given:

$$\sigma_x^2=\sigma_y^2,\ 0<r<1.$$

[5] I am indebted to Zvi Griliches for suggesting this approach to the problem.

Then:

$$\sigma_z^2 = \sigma_x^2[1 + (2w^2 - 2w) + (2w - 2w^2)r]. \quad (4)$$

Since $0<w<1$, the closer r is to 1, the closer will be the variances of the old and the new combined sample (with case I as a limit). Since $0<r<1$ and $0<w<1$, it follows that $-1<[2w^2-2w]<0$ and $0<[(2w-2w^2)r]<1$. Also $/2w^2-2w/>(2w-2w^2)r/$. The addition of the last two elements in the bracket of (4) will always result in some proportion p where $0<P<1$. Therefore, the given condition will always result in $\sigma_z^2<\sigma_x^2$.

Case IV

Given:

$$\sigma_x^2 = \sigma_y^2,\ r=0.$$

Then:

$$\sigma_z^2 = \sigma_x^2[2w^2 - 2w + 1]. \text{ Since } 0<w<1, \quad (5)$$

$$0<[2w^2-2w+1]<1, \text{ and } \sigma_x^2<\sigma_z^2.$$

Case V

Given:

$$\sigma_y^2 = k^2\sigma_x^2,\ k^2<0,\ r=1.$$

Then:

$$\sigma_z^2 = \sigma_x^2[w + (1-w)k]^2 \quad (6)$$

Here the relationship between the old and new variance depends fundamentally upon the value for k. If $0<k<1$ the new variance will be less than the old; if $k>1$ the new variance will be greater than the old.

Given:

$$\sigma_y^2 = k^2\sigma_x^2, k^2>0,\ 0<r<1.$$

$$\sigma_z^2 = \sigma_x^2[w^2 + (1-w)^2k^2 + 2w(1-w)rk] \quad (7)$$

Since

$$0<r<1 \text{ and } 0<w<1 \quad 0<[2w(1-w)]<1.$$

$\sigma_z^2>\sigma_x^2$ only when $k>1$ by some amount that can be determined for given values of r and w.

Stated verbally, the variance of the added items has to exceed the variance of the items already in the index in order for the variance of the new index to exceed that of the old. It is possible for the added items variance to exceed that of the old and have the new variance be less than the old. However, the ratio of the variances

$$\left(\frac{\sigma_y^2}{\sigma_x^2}\right)$$

would, with the usual relationships of r and w, probably be quite close to unity for this phenomenon to occur.

While cases other than the ones above can be examined, these furnish enough evidence to point up the effect that adding to the number of items in an index will have on the variance of that index. Only in the special case where there is perfect correlation between the old and the

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new item indexes and where the variance of the added items index is equal to the variance of the old items index will the variance of the new index be the same as the old. The closer the correlation is to one and the closer the variances to each other, the closer the two index variances will compare. Any departure of the correlation from one tends to make the new index have a smaller variance than the old. If the added items index has less variance than the old index the effect is to decrease the variance of the new index as would be expected. Should the added items index have more variance, the variance of the new index will tend to be increased but will be counterbalanaced, the lower the correlation between the old and the new items index and the more than the values of (w) and ($1-w$) diverge.

Some idea of the numerical amount by which the variance of the new sample will be changed relative to the old variance (σ_x^2) is shown in column 4 of Table 1.14. Each of the coefficients of σ_x^2 shows the proportion that the variance a new sample would be of that of an old sample with given values of w, r, and k^2 substituted into the case VI formula.

TABLE 1.14.—*Numerical Effects of Various Values for w, r, and k^2 on the Variance of the New Sample*

	w (1)	r (2)	k^2 (3)	Coefficient of σ_x^2 (4)		w (1)	r (2)	k^2 (3)	Coefficient of σ_x^2 (4)
(1)	0.2	1.0	1.0	1.00	(3)—Continued	0.2	0.5	0.8	0.69
	.5	1.0	1.0	1.00		.5	.5	.3	.47
	.2	0	1.0	.68		.5	.5	.8	.67
	.5	0	1.0	.50	(4)	.2	.9	1.5	1.35
(2)	.2	.5	1.0	.84		.2	.9	2.0	1.72
	.5	.5	1.0	.75		.5	.9	1.5	1.17
(3)	.2	.5	1.5	1.19		.5	.9	2.0	1.38
	.2	.5	2.0	1.54		.2	.9	.3	.39
	.5	.5	1.5	.93		.2	.9	.8	.81
	.5	.5	2.0	1.10		.5	.9	.3	.58
	.2	.5	.3	.32		.5	.9	.8	.85

Table 1.14 and the formulae discussed above show that there are "sample effects" when one changes the size of an index. These "sample effects" can have the effect of making an index more or less stable quite apart from the respective variances of the old and the new items. The magnitude of this effect can and should be investigated empirically so that incorrect inferences regarding the meaning of an index whose sample size is changed over time are not made.

II. EFFECT OF NUMBER OF REPORTERS ON THE NUMBER OF PRICE CHANGES

A great deal has been written in the past twenty years about the subject of price flexibility and "administered prices." One piece of information not heretofore available on the basic data and in these studies is the effect of the number of reporting firms (reporters) and the nature of the quotations which they report. These topics form the subject of this study.

It was pointed out in a 1959 price flexibility study by the Bureau of Labor Statistics[6] that the steady general increase in the number of reporters has had the effect on the average of increasing the number of price changes shown for the various items for which data were shown. This study confirms this statement and shows the effect of the number of reporters by various classifications of the data.

In order to put the data into a framework of comparison with the BLS price flexibility study, it was decided to take a sample from the same time period used in that study. Every third item in the Wholesale Price Index was taken from the list which was arranged in order by the 15 commodity groups used by the BLS.

Items were considered as part of the sample only if they continued to be reported throughout the entire period December 1953 through December 1956. Classifications were set up according to the number and type of reporters and whether they had been in the sample prior to the 1952 revision of the Wholesale Price Index. One difficulty in classifying the data by number of reporters was that for some items the number would shift back and forth. For example, an item might have two reporters one month, then shift to three the following month. A question then arose as to how this series should be classified. It was decided that it should be classified as a two-reporter item for the months it had two reporters and a three-reporter item for the months it had three reporters. To take account of the shift, all changes were computed as the number of changes per month.

RESULTS FROM TOTAL SAMPLE

Table 2.1 shows the results secured from the total sample on the changes per month by number of reporters, by type of reporting, and by stage of processing and pre- and post-1952.

TABLE 2.1.—*Number of Price Changes per Month by Stage of Processing and by Type of Reporter, 1953–56*

Type of reporter	Stage of processing		
	Crude	Intermediate	Finished
AVERAGE NUMBER OF PRICE CHANGES PER ITEM			
All classes of reporters	0.515	0.270	0.246
Company reporters	.490	.211	.176
Government reporters	.870	.847	.833
Publication reporters	.259	.294	.364
Pre-1952 items	.498	.345	.373
Items added 1952 or after	.536	.232	.202
NUMBER OF ITEMS PER CELL			
All classes of reporters	79	405	443
Company reporters	16	277	378
Government reporters	27	18	28
Publication reporters	36	110	37
Pre-1952 items	50	124	112
Items added 1952 or after	29	281	331

[6] *Frequency of Change in Wholesale Prices, A Study of Price Flexibility,* United States Department of Labor, Bureau of Labor Statistics, 1959, pp. 2 and 21.

Several facts become clear upon examination of the table. The well-known tendency for the prices of crude materials to vary more than intermediate goods and for the latter to vary more than finished goods is confirmed. In addition, the table makes clear some facts that are not generally obvious: that prices reported from government sources exhibit greater variability than those reported from technical publications (as say *Oil Paint* and *Drug Reporter*) and from companies. Also prices reported by publications show greater variability than those reported by companies. Lastly, the number of price changes has declined since the 1952 revision of the WPI as the prices of the items added have a substantially smaller variability. To a considerable extent this last effect comes about due to the fact that added items have largely come from companies rather than from government or publications (see Tables 2.2 and 2.3). In considering the above facts it becomes clear than an attempt to find the effect of a varying number of reporters upon price changes without cross classification by stage of processing and type of reporter runs the risk of falling into the statistical fallacy of incomplete classification. For example, a proportionately greater number of government reporters in the one-reporter series could make it appear more variable than a two- or three-reporter series even if in fact it were not. As a means of analyzing the effect of the number of reporters then, Table 2.4 is cross-classified by type of reporter and stage of processing.

TABLE 2.2.—*Reporter Sample Classified by Date of Entry into WPI, Type of Reporter, and Stage of Processing*

Type of reporter and stage of processing	Pre-1952		1952 and after		Entire sample	
	Nonrepeat	All [1]	Nonrepeat	All [1]	Nonrepeat	All [1]
1. Company:						
(a) Crude	10	10	6	6	16	16
(b) Intermediate	51	58	214	219	265	277
(c) Finished	56	79	200	299	256	378
Total	117	147	420	524	537	671
2. Government:						
(a) Crude	16	16	11	11	27	27
(b) Intermediate	8	9	7	9	15	18
(c) Finished	3	17	0	11	3	28
Total	27	42	18	31	45	73
3. Publication:						
(a) Crude	24	24	12	12	36	36
(b) Intermediate	39	57	47	53	86	110
(c) Finished	1	16	0	21	1	37
Total	64	97	59	86	123	183
4. All reporters:						
(a) Crude	50	50	29	29	79	79
(b) Intermediate	98	124	268	281	366	405
(c) Finished	60	112	200	331	260	443
Total	208	286	497	641	705	927

[1] Shows the number of observations under each designation even though they have been previously included. For example, some items appear in "finished" goods that appear also in "intermediate" goods.

TABLE 2.3.—*Reporter Sample Classified by Date of Entry into WPI, Type of Reporter, and Economic Classification*

Type of reporter and economic classification	Pre-1952		1952 and after		Entire sample	
	Nonrepeat	All [1]	Nonrepeat	All [1]	Nonrepeat	All [1]
1. Company:						
(a) Materials—food	5	5	4	4	9	9
(b) Materials—nonfood	56	56	216	216	272	272
(c) Finished goods—food	6	10	8	12	14	22
(d) Consumer finished goods other than food	44	65	111	167	155	232
(e) Producer finished goods	6	39	81	165	87	204
Total	117	175	420	564	537	739
2. Government:						
(a) Materials—food	22	22	15	15	37	37
(b) Materials—nonfood	2	2	3	3	5	5
(c) Finished goods—food	3	17	0	11	3	28
(d) Consumer finished goods other than food						
(e) Producer finished goods						
Total	27	41	18	29	45	70
3. Publication:						
(a) Materials—food	8	8	3	3	11	11
(b) Materials—nonfood	55	55	56	56	111	111
(c) Finished goods—food		6		1		7
(d) Consumer finished goods other than food	1	10	0	20	1	30
(e) Producer finished goods						
Total	64	79	59	80	123	159
4. All reporters:						
(a) Materials—food	35	35	22	22	57	57
(b) Materials—nonfood	113	113	275	275	388	388
(c) Finished goods—food	9	33	8	24	17	57
(d) Consumer finished goods other than food	45	75	111	187	156	262
(e) Producer finished goods	6	39	81	175	87	214
Total	208	295	497	683	705	978

[1] Shows the number of observations under each designation even though they have been previously included. For example, some items appear in "finished goods—food" that appear also in "materials—food."

Due to the small number of cases in the cells, one would have to say that the number of price changes in crude materials for company reporters do not appear to differ significantly from one another for the five classifications established in the table. However, if one compares the one-reporter average with that for two or more, a significant difference does appear in the direction of showing greater variability the greater the number of reporters. For companies reporting goods that fall within the intermediate and finished goods category, the case is clear: the series with the greatest number of price reporters show the greatest variability in price changes.

Evidence to show that an increased number of reporters increases the number of price changes is also available for government reporters in the intermediate and finished goods categories (by comparing one with the two and over case). Not enough observations are available to establish the case for crude materials under the government classification of publications. An examination of the reporters, however, shows that each reporter, for government and for publication, is in effect a composite of several reporters. Hence, it appears that the greater number of price movements for government and publication

TABLE 2.4.—*Number of Price Changes per Month by Stage of Processing and by Number and Type of Reporter*

Type of reporter and stage of processing	Number of reporters					
	1	2	3	4	5 and over	2 and over
AVERAGE NUMBER OF PRICE CHANGES PER ITEM						
Company:						
Crude	0.474	0.470	0.526	0.500	0.480	0.499
Intermediate	.096	.143	.212	.207	.392	.229
Finished	.106	.112	.196	.215	.276	.189
Government:						
Crude	.862	.972				.972
Intermediate	.806	.972	.991			.986
Finished	.806	.972	.991			.986
Publication:						
Crude	.254				.444	.444
Intermediate	.294					
Finished	.361				.444	.444
NUMBER OF ITEMS PER CELL						
Company:						
Crude	5	2	4	2	3	11
Intermediate	48	47	89	52	41	229
Finished	70	82	125	56	45	308
Government:						
Crude	26	1				1
Intermediate	14	1	3			4
Finished	24	1	3			4
Publication:						
Crude	35				1	1
Intermediate	110					
Finished	36				1	1

reporters is at least in part due to the fact that these represent several actual reporters for each one shown.

For some types of price analysis, an economic classification other than "crude," "intermediate," and "finished" is desirable. One such classification breaks the WPI into two major groupings rather than three: materials and finished goods, with the first group being further subdivided into food and nonfood, while the latter is subdivided into consumer—food, consumer—other than food, and producer.[7] Table 2.5 gives a summary of the results for this five-way classification.

It becomes clear upon analyzing Table 2.5 and comparing it with Table 2.1 that some sharply divergent price series are combined in the three-way classification. Food items for example are put into both the crude materials and the finished goods categories. It is immediately apparent that food items, either material or finished goods, are higher and more like each other in price movements than like the major classification under which they fall. Although some of this correspondence is illusory because many items are the same under the two classifications, nevertheless when all duplicating items are excluded, the correspondence still holds. It is also useful to observe that the nonfood materials, producer finished goods, and consumer finished goods follow in descending order of variability with significant differences between each classification. While this ordering and signifi-

[7] For arguments in favor of this classification, see "Observations on Economic Groupings of the Wholesale Price Index," Clayton Gehman and Murray Altmann, mimeographed.

TABLE 2.5.—*Number of Price Changes per Month by Economic Classification and by Type of Reporter*

Type of reporter	Economic classification				
	Materials, food	Materials, nonfood	Finished goods, food	Consumer finished goods, other than food	Producer finished goods
AVERAGE NUMBER OF PRICE CHANGES PER ITEM					
1. All classes of reporters	0.820	0.232	0.637	0.170	0.186
2. Company reporters	.350	.212	.276	.157	.186
3. Government reporters	.901	.488	.833	----------	----------
4. Publication reporters	.909	.260	.862	.246	----------
5. Pre-1952 reporters	.847	.281	.667	.219	.268
6. Added 1952 or after reporters	.775	.210	.599	.150	.169
NUMBER OF ITEMS PER CELL					
1. All classes of reporters	57	388	57	262	204
2. Company reporters	9	272	22	232	204
3. Government reporters	37	5	28	----------	----------
4. Publication reporters	11	111	7	30	----------
5. Pre-1952 reporters	35	113	33	75	39
6. Added 1952 or after reporters	22	275	24	187	175

cance is not unexpected, the exclusion of food gives a better evaluation of the differences of variability between the series.

The data in table 2.6 provide an opportunity to test further the effect of increasing the number of reporters for a price series. Again the evidence is solidly in favor of series with greater numbers of reporters mechanically showing greater variability apart from the true variability of the series.

It could be argued that certain types of industry tended to have certain numbers of reporters and that differences shown in the number of price changes stemmed directly from the type of industry rather than the number of reporters, since the type of industry determined the number of reporters. To a limited extent the argument is true, that is, the reporting on food tends to be largely by government reporters, which fall largely into the one-reporter class; and the reporting on nonfood materials items tends to fall largely into the one-reporter classification of publications.

In order to test the previous findings that showed the number of price changes increasing as the number of reporters increased, the basic data for companies were analyzed again on a somewhat different basis.

One company was selected by use of a table of random numbers from the companies reporting for each individual item. Items with but one reporter were excluded. Each item then had a one-reporter case as well as an n-reporter case. The number of reporters was then shown from 1 to 5 and over as before for four of the five classifications shown previously. Classification I, "materials—food," was excluded because there were too few items for reliability.

TABLE 2.6.—*Number of Price Changes per Month by Economic Classification and by Number and Type of Reporter*

Type of reporter and economic classification	Number of reporters					
	1	2	3	4	5 and over	2 and over
AVERAGE NUMBER OF PRICE CHANGES PER ITEM						
Company:						
Materials, food	0.250	0.725	0.610	----	----	0.668
Materials, nonfood	.103	.143	.206	0.207	0.392	.227
Finished goods, food	.225	.167	.469	.342	.472	.362
Consumer finished goods other than food	.056	.101	.170	.200	.287	.177
Finished goods, producer	.088	.129	.208	.230	.288	.202
Government:						
Materials, food	.885	.971	.990	----	----	.982
Materials, nonfood	.488	----	----	----	----	----
Finished goods, food	.806	.971	.990	----	----	.985
Consumer finished goods other than food	----	----	----	----	----	----
Finished goods, producer	----	----	----	----	----	----
Publication:						
Materials, food	.909	----	----	----	----	----
Materials, nonfood	.258	----	----	----	.444	.444
Finished goods, food	.862	----	----	----	----	----
Consumer finished goods other than food	.239	----	----	----	.444	.444
Finished goods, producer	----	----	----	----	----	----
NUMBER OF ITEMS PER CELL						
Company:						
Materials, food	7	1	1	----	----	2
Materials, nonfood	44	47	88	52	41	228
Finished goods, food	14	2	3	2	1	8
Consumer finished goods other than food	43	51	74	30	34	189
Finished goods, producer	34	41	78	33	18	170
Government:						
Materials, food	32	2	3	----	----	5
Materials, nonfood	5	----	----	----	----	----
Finished goods, food	24	1	3	----	----	4
Consumer finished goods other than food	----	----	----	----	----	----
Finished goods, producer	----	----	----	----	----	----
Publication:						
Materials, food	11	----	----	----	----	----
Materials, nonfood	110	----	----	----	1	1
Finished goods, food	7	----	----	----	----	----
Consumer finished goods other than food	29	----	----	----	1	1
Finished goods, producer	----	----	----	----	----	----

A summary of findings using the above procedure is shown in Table 2.7. The previous findings that show increased price movement for an individual commodity in the Wholesale Price Index as the number of companies reporting prices on this item is increased are confirmed.

TABLE 2.7.—*Number of Price Changes per Month for Commodities Reported by Companies, by Economic Classification and Number of Reporters, with Allowance for Effect of Type of Industry*

Economic classification	Number of reporters					
	1	2	3	4	5 and over	2 and over
AVERAGE NUMBER OF PRICE CHANGES PER ITEM						
Materials—nonfood	0.111	0.150	0.209	0.213	0.424	0.251
Consumer finished goods—food	.197	.236	.458	.333	.472	.379
Consumer finished goods—nonfood	.068	.098	.177	.187	.322	.195
Producer finished goods	.076	.128	.201	.233	.342	.214
All above classifications	.089	.126	.200	.214	.371	.224
NUMBER OF ITEMS PER CELL						
Materials—nonfood	185	38	86	46	53	223
Consumer finished goods—food	6	2	3	1	1	7
Consumer finished goods—nonfood	144	42	70	26	44	182
Producer finished goods	131	32	75	32	25	164
All above classifications	466	114	234	105	123	576

Table 2.8 contains a comparison of the basic data of the two preceding tables. Little difference is noted between the findings of the two different methods. Clearly, the number of price changes varies directly with the number of reporters regardless of industry structure.

TABLE 2.8.—*Comparison of Number of Price Changes per Month for Commodities Reported by Companies, by Economic Classification and Number of Reporters, With (Table 2.7) and Without (Table 2.6) Allowance for Type of Industry*

Number of reporters	Materials, nonfood		Consumer finished goods, food		Consumer finished goods, nonfood		Producer finished goods	
	Table 2.6	Table 2.7	Table 2.6	Table 2.7	Table 2.6	Table 2.7	Table 2.6	Table 2.7
	Average number of price changes per item							
1	0.103	0.111	0.225	0.197	0.056	0.068	0.088	0.076
2	.143	.150	.167	.236	.101	.098	.129	.128
3	.206	.209	.469	.458	.170	.177	.208	.201
4	.207	.213	.342	.333	.200	.187	.230	.233
5 and over	.392	.424	.472	.472	.287	.322	.288	.342
2 and over	.227	.251	.362	.379	.177	.195	.202	.214

SOURCE.—Tables 2.6 and 2.7.

The average percentages of price change from December 1953 to December 1956 for the four classifications shown in Table 2.7 were also computed. The deviations from 100 for each item were then arrayed and the medians chosen for each economic classification. The results are shown in Table 2.9.

Of the four classifications, producer finished goods showed the greatest fluctuation over the period. Following in order of magnitude were nonfood materials, nonfood consumer finished goods, and food consumer finished goods.

It is of importance to note that the pattern for the magnitude of price fluctuation did not correspond to the pattern shown in the previous analysis of the average number of price changes per month. Food finished goods, for example, showed the greatest average number of price changes per month but the lowest average price fluctuation of any of the four economic classifications examined. Producer finished goods, which, on the other hand, showed one of the smallest average number of price changes, showed the greatest average amount of price fluctuation.

The data in Table 2.9 also offer comparisons between the fluctuation for the one-reporter case and that of the two and over case. Little significant difference exists between the medians both by economic classes and overall. It would be expected, however, that the two or more reporters would tend to average out their movements more and give a generally smaller average fluctuation. The operation of two types of upward bias on the two and over series probably prevents the expected from occurring.

TABLE 2.9.—*Amplitude of Price Change and Its Dispersion and Skewness, December 1953 to December 1956, by Economic Classification*

Economic classification	Absolute percentage change, December 1953 to December 1956, median		
	Number of items	1 reporter	2 or more reporters
II. Materials, nonfood	177	10.9	11.0
III. Consumer finished goods, food	6	3.9	2.2
IV. Consumer finished goods, nonfood	132	7.9	8.0
V. Producer finished goods	121	17.3	16.4
All four classifications	[1] 329	10.9	11.3

Economic classification	Dispersion [2]		Skewness [3]	
	1 reporter	2 or more reporters	1 reporter	2 or more reporters
II. Materials, nonfood	63.4	62.2	0.114	0.112
III. Consumer finished goods, food	62.4	72.6	.365	.739
IV. Consumer finished goods, nonfood	75.9	70.0	.274	.111
V. Producer finished goods	51.5	40.5	.195	.147
All four classifications	67.5	63.8	.129	.077

[1] Not including items repeated in two or more groups. These total as follows: II–0, III–0, IV–40, V–67.

[2] Coeff. dispersion $=\left(\frac{Q_3-Q_1}{Q_3+Q_1}\right)100$

[3] $Sk_Q=\frac{(Q_3-Q_2)-(Q_2-Q_1)}{Q_3-Q_1}$

The first type of upward bias enters in because of full price changes appearing in the data at the time of linking. These price changes would appear in every average but would not appear in every single item. In the second type of bias, the two or more case gives *average* behavior while the one-company case reflects the behavior of that company only. To be on a comparable basis, the one-company case should be averaged for all companies to compare with the two and over average.

In summary, in studying the price movements of commodities one must take into account the source of reporting, the number of reporters, and changes in composition of the sample as well as economic classification. Some care must be employed with the type of economic classification as well.

III. The Validity of Using WPI Data for Measuring Short-Term Fluctuations in Prices

An increasing interest in the study of the behavior of prices in the short run has focused attention upon the evidence provided about this phenomenon by the data of the Wholesale Price Index. At the same time the validity of these prices for this type of analysis is coming under closer examination.

It is our purpose here to examine the validity of the WPI quotations as suitable data for the study of these movements. The topic will be divided into two sections: the first will set forth a comparison of the indexes of prices of individual commodities reported by primary market sellers (to the Bureau of Labor Statistics) with those of primary market buyers; the second will deal with a comparison of WPI prices with Census unit values.

That so-called list prices are not likely to reflect properly short-term changes in prices is clear. Constant evidence of this fact is provided in trade journals and other current periodicals. A few examples from the *Wall Street Journal* follow:

In a story on plumbing fixtures of September 20, 1957, it was stated that price lists had not changed but prices had dropped 10 to 20 percent under quoted list for big orders. In the December 12, 1957 issue, a story discussed the selling of acetate rayon under list. Again in June 20, 1958, it was said of sales in chemicals that salesmen find their competition underselling them "by almost 20 percent, although the publicly posted price remains untouched." A recent issue (June 16, 1960) noted that in the area of building equipment, although published prices were 3 percent higher than a year ago, the actual selling prices were about the same. It was stated that there were price cuts to about 6 percent below list.

While it appears that list prices are not likely to be good indications of short-term changes, it is not clear that the BLS index is dominated by such prices. The agency, on the contrary, asks reporting companies to give actual prices along with discounts and allowances. Should the prices actually gathered tend toward list, this phenomenon would most likely be due to the difficulties of voluntary reporting plus the complications involved for companies computing their true average prices.

A. Comparative fluctuations in WPI and company "prices paid" indexes

The BLS describes the prices in the WPI as representing items sold in "primary markets" in "quantities" and relating to "the first commercial transaction in the United States." [8]

In an effort to test the short-term movements of these prices, data were collected by the author from large companies which regularly

[8] *Wholesale Prices and Price Indexes, 1958,* Bulletin 1257, U.S. Department of Labor, Bureau of Labor Statistics, pp. 4–5.

bought items in large quantities that met the same or substantially the same specifications as those forming part of the Wholesale Price Index data.[9] Personal interviews were conducted with buyers in the purchasing department of the various companies. In each instance company records were examined by company personnel for buying prices which were given directly to the author in terms of prices or as indexes with January 1957=100. Data were collected for the 36-month period from January 1957 through December 1959.

Comparison of the indexes of prices paid with those of the BLS offers difficulties in interpretation. An individual company might, for example, represent such a small part of the total market that even if its price did differ from that of the WPI item, it could be argued that such a price could exist and the WPI figure could still be correct. On the other hand, it might be argued that a company buying a very small percentage of the total volume offered in the market might buy "at the market" and reflect quite well the price movements of that item with a possible lag for price cuts and a possible lead for price increases.

In Appendix Table A.1, 43 items were considered that showed price stability for the BLS series for six consecutive months or more during the 1957–59 period. For 12 of these 43 products, the company experience was identical with that for the BLS—no price changes were observed. The others did, however, show differences in their movements with the company series exhibiting on the average about twice as many price changes and an amplitude about 40 percent greater (Table 3.1).[10]

A further computation based on these same items reveals that the company series fluctuated on the average about 5.7 percent during the periods when the BLS series were completely rigid (Table 3.2), with an average period of BLS rigidity of 13.7 months. For this average period there were approximately 2.4 price changes for the company or companies compared to no movement in the BLS series.

A classification of the above 43 items into BLS commodity groups reveals that nine different groups were represented, with dominant representation being found in the Chemicals and Allied Products Classification.

[9] As stated, the analysis to follow was performed using price information for commodities that met BLS specifications. However, purchasing agents bargain on packaging and transportation costs as well as the cost of the commodity itself in the buying of items. A change in any one of these three elements of cost is considered by the puchasing agent to be a price change. It would therefore be an improvement in the measurement of price change if some practical way could be found for the "price data" to reflect those packaging and transportation differences that were a part of the true changes in prices.

[10] A more severe test of the BLS data than that of this table would make comparisons on the basis of price changes relative to the number of price quotations.

TABLE 3.1.—*Comparative Fluctuations of Company and BLS Prices, 1957–59 (series selected on basis of BLS data constant for six months or more but not over entire three-year period)*

Commodity, BLS Code and name		Direction and number of price changes						Amplitude H to L, or L to H (percent)	
		Plus		Minus		Total			
		Co.	BLS	Co.	BLS	Co.	BLS	Company	BLS
*052003	Coke, Milwaukee	3	1	1	0	4	1	9.1	4.9
052004	Coke, Indianapolis	5	1	4	1	9	2	−5.7	−.8
								8.1	5.0
055401	Fuel oil, N.Y.	1	1	8	8	9	9	0	8.2
								−35.5	−28.2
*061109	Sulphuric acid	5	0	2	0	7	0	−1.7	0
061111	Aluminum sulphate	0	1	1	0	1	1	−10.0	[1] 8.1
*061126	Calcium chloride	1	1	0	0	1	1	3.2	6.9
*061133	Carbon dioxide	1	0	0	0	1	0	25.0	0
*061157	Salt	2	2	1	0	3	2	.8	3.7
061161	Silver nitrate	6	4	6	1	12	5	−3.0	−.8
								3.1	8.7
*061169	Sodium hydroxide	1	1	1	0	2	1	11.6	11.7
*061214	Ethyl alcohol	1	1	1	0	2	1	9.0	7.7
*061231	Carbon disulfide	1	0	0	0	1	0	1.4	0
061233	Carbon tetrachloride	9	1	1	0	10	1	5.2	4.5
*061263	Furfural	1	0	1	0	2	0	5.5	0
								−2.7	0
061265	Glycerine, natural	2	1	1	0	3	1	−8.1	0
								13.7	5.3
*061289	Styrene	9	3	1	3	10	6	−25.0	−33.0
061291	Toluene	0	0	2	2	2	2	−26.5	−7.8
*063135	Glycerine	2	1	2	0	4	1	−1.1	0
								5.5	5.3
*063173	Vitamin C	0	0	2	1	2	1	−33.3	−16.7
067311	Phenolics	3	2	3	1	6	3	.3	12.0
								−4.2	−9.3
*072101	Passenger car tires	4	2	5	3	9	5	8.2	3.1
								−12.7	−20.4
*072131	Tractor and implement tires	3	3	1	1	4	4	3.0	6.0
*072201	Tubes, passenger cars	4	2	5	2	9	4	4.3	2.7
								−7.4	−1.3
081412	Gum, No. 2, common	2	2	2	1	4	3	10.4	4.0
								−2.8	−1.8
102230	Platinum	6	3	9	5	15	8	−38.6	−32.5
								55.9	48.1
*103011	Steel barrel	4	3	0	1	4	4	5.8	6.4
*117314	Electric motor	0	1	3	5	3	6	−18.9	−9.6
*117633	Welding electrode	2	1	0	0	2	1	16.0	3.4
*117801	Storage battery	8	7	15	2	23	9	3.8	3.7
								−16.0	−.8
								7.6	5.6
*132230	Portland cement	5	4	6	3	11	7	2.0	.9
								−2.9	[1] +2.4
All items:									
Total		91	49	84	40	175	89	461.7	330.8
Average		3.0	1.6	2.8	1.3	5.8	3.0	11.0	7.9
Starred items:									
Total		57	33	47	21	104	54	240.6	153.8
Average		2.8	1.6	2.4	1.0	5.2	2.7	9.3	5.9

[1] If the company and BLS indexes move in opposite directions the amplitude figures are omitted in the totals and averages.

*Identical specifications for company and BLS.

Source: Appendix Table A.1.

For these items of Table A.1 it is clear that the prices paid diverge from the BLS reported prices. Whether they diverge enough to affect the individual item index and not be "rounded off" is not clear for most of the items.[11]

TABLE 3.2.—*Fluctuation of Company Prices Paid During Periods That Prices Reported to the Bureau of Labor Statistics Remained Constant*

Commodity, BLS Code and name	Number of months BLS price was con-stant	Company price changes			Amplitude of company change *H* to *L* or *L* to *H* (percent)
		Increases	Decreases	Total	
*052003 Coke, Milwaukee	19	2	1	3	4.5
052014 Coke, Indianapolis	22	3	3	6	6.6
	8	2	1	3	10.0
055401 Fuel oil, New York	8	1	1	2	6.1
*061109 Sulphuric acid	36	5	2	7	2.0
061111 Aluminum sulphate	25	0	1	1	10.0
*061126 Calcium chloride	29	1	0	1	3.2
*061133 Carbon dioxide	21	1	0	1	25.0
*061157 Salt	10	1	0	1	.5
	10	1	1	2	.6
061161 Silver nitrate	6	1	3	4	1.9
*061231 Carbon disulfide	26	1	0	1	1.4
061233 Carbon tetrachloride	32	8	1	9	4.6
061263 Furfural	13	1	0	1	5.5
	12	0	1	1	2.7
061265 Glycerine, natural	12	1	0	1	8.1
*061289 Styrene	6	2	0	2	1.0
	8	3	0	3	1.0
061291 Toluene	7	0	1	1	19.4
*063135 Glycerine	32	1	2	3	1.1
*063173 Vitamin C	20	0	1	1	20.0
067311 Phenolics	9	2	1	3	3.6
*072101 Passenger car tires	6	0	1	1	1.4
	11	0	3	3	10.2
*072131 Tractor and implement tires	14	2	0	2	2.0
*072201 Tubes, passenger cars	6	1	0	1	2.6
	9	2	1	3	3.5
081412 Gum, No. 2, common	6	0	1	1	1.2
	11	1	0	1	9.7
102230 Platinum	9	4	1	5	9.1
*103011 Steel barrel	7	2	0	2	2.0
*117314 Electric motor	16	0	3	3	18.9
*117633 Welding electrode	9	2	0	2	16.0
*117801 Storage battery	10	1	5	6	10.1
	6	0	3	3	2.5
	6	0	4	4	5.2
*132230 Portland cement	6	0	1	1	.4
	6	0	2	2	1.1
All items:					
Total	509	52	45	97	234.7
Average per fluctuation	13.4	1.4	1.2	2.6	6.2
Starred items:					
Total	329	28	30	58	136.2
Average per fluctuation	13.7	1.2	1.2	2.4	5.7

*Identical specifications for company and BLS.

SOURCE: Appendix Table A.1.

[11] For example, suppose that an individual prices-paid item shows a 10 percent increase while its counterpart in the BLS index shows no change. Suppose also that the buying firm for the prices paid item buys 0.6 percent of the total amount marketed. Then we have the following:

	Beginning index	Weight	Ending index	Weighted ending index
Individual company	100.0	0.006	110.0	0.660
Rest of industry	100.0	.994	100.0	99.400
Weighted index at end of the period				100.060

When rounded to one decimal place, this would give 100.1. Following the supposition of this example, any one firm whose buying price moved up 10 percent while the rest of the firms had a constant buying price would have to buy 0.6 percent or more of the total in order not to be "rounded off" in the industry average.

Of the 31 items showing a divergence from the BLS indexes, the market share bought was determined for six of them. In every case the market share was large enough so that this company's or these companies' experience should have moved the index.

It cannot be said categorically from the evidence provided by the above data that the overall Wholesale Price Index or that even its broader segments are unsuitable for the study of short-term price change. The whole question of the effect of weighting by components has, for example, not been mentioned. Dozens of items of small weight might move in a way substantially different from the BLS data and still be too unimportant to affect the overall index.

Neither can it be said that a random sample was taken and that its results provided evidence of inadequacy of the WPI for the study of short-term movements.

However, the evidence is clear that in the particular industrial areas in which data were gathered important divergencies of prices paid from BLS data do appear and that weighting or other procedural steps do not explain these divergencies.

B. COMPARATIVE FLUCTUATIONS IN WPI PRICES AND CENSUS UNIT VALUES FOR SELECTED COMMODITIES

Another method of testing the allegation that WPI prices are too sluggish for the proper study of short-term price changes is to take indexes from WPI data and compare them with unit value indexes made from the imputed prices secured by dividing the value of shipments by volume of shipments for individual products from data of the Bureau of the Census. The unit values should include divergences from list prices and therefore should be more flexible than the WPI prices if the WPI figures are slow in noting price changes as alleged.

It is almost impossible for price series to adequately reflect all the short-term changes that it would be useful to know in analyzing economic change and relationships. The difficulty of proper allowance for changes in quality is one such change that is discussed in other studies of the Price Statistics Review Committee Report. In addition, there are for some items almost as many prices as there are buyers. No less important are the various terms of sale and concessions that are not reflected in the transactions price at all, but in effect represent real price changes. Changes in credit terms, quality guarantees, and various special services provide examples. It should be emphasized in the comparisons that follow that neither series will reflect these changes.

Despite the difficulties of getting all the economic change reflected in given price series, it is still possible to test the validity of other price changes of the WPI prices by comparing them with the Census unit value series.

The Census data are taken from figures published currently under the title of *Current Industrial Reports* and previously under the title *Facts for Industry*. The data as published represent the total value of shipments including interplant transfers as well as the aggregate volume of these shipments by types of product. While data were available on an annual basis, these were not deemed a fair test of short-term fluctuations, and were excluded from examination with the exception of steel products. With this exception, only monthly series were used.

To get the basic data, the entire list of commodities reported in the monthly Census reports for which value and the number of units shipped monthly were available was checked to see if commodities could be matched with similar items from the WPI (6-digit WPI items were matched with 7-digit Census items). Only nine monthly series in the entire list were deemed close enough in specifications to warrant close comparison. Data for a tenth item, however, was gathered for use on a somewhat different basis than for the other nine.

Despite the careful matching, a comparison of the Census unit values with the WPI series is not exact for several reasons. One distortion is caused by the fact that interplant transfers are not excluded from the unit value data.[12] Presumably, some portion of these transfers do not enter the market at all since they are used within a company. However, the amount of distortion from this source should be small as the Census instructs that for these interplant transfers the "nearest approximation to commercial values" be reported. Also the WPI series represent a small sample of particular items while the Census data represent either a large sample or all the items. In addition, the specifications for an individual product are likely to be somewhat broader in the Census figures. Both sets of figures are given as f.o.b. plant.

1. *Steel Mill Products.*—As previously mentioned, one comparison of WPI and Census data was made using annual data. This comparison for steel mill products follows.

A composite index of 49 steel mill products was made for each of the two types of data shown in Table 3.3. Individual product prices were matched for the two series so that product mix and specifications were as close as possible. The same 1954 weights were used for each series. Differences remaining in the two sets of prices would be due to the following factors: changes by customers from one specification to another, freight absorption, and price concessions. Neither series had cash discounts deducted. The following are some effects of these factors that would be likely to obscure comparisons: omitting cash discount would omit a factor which would bring greater fluctuation to the unit value series; changes by customers from one specification to another would be in the direction of minimizing costs and would bias the unit value (UV) series downward in relation to the WPI series, especially in a period of slackening demand.

To some extent an upswing would reverse the process with the Census series reflecting "trading up." However, industrial users would not likely fully reverse their position unless supply pressures were severe.

From Table 3.3 it is evident that there is an upward trend in both series, a factor which probably obscures to some extent their cyclical differences. Despite this factor for "togetherness," substantial differences in prices due to the WPI method of pricing would still obtain if there are true differences. Due to the use of annual data, the short-term differences would have to be substantial, however, in order to show distinction in the series.

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[12] This bias from inclusion of interplant transfers is almost entirely absent from the steel mill products data.

TABLE 3.3.—*Test Indexes for 49 Steel Mill Products Based on WPI Prices and Census Unit Values with 1954 Weights, 1947, 1949–58*

Year	WPI index 1947=100 [1] (1)	Unit value index 1947=100 [1] (2)	Steel industry (percent of capacity) [2] (3)	Percentage of previous year			(4) ÷ (5) (7)
				WPI (4)	UV (5)	Capacity (6)	
1947	100.0	100.0	93.0			128.3	
1949	122.9	122.9	81.1	[3] 122.9	[3] 122.9	[3] 87.2	100.0
1950	129.9	128.7	96.9	105.7	104.7	119.5	101.0
1951	139.3	139.4	100.9	107.2	108.3	104.1	99.0
1952	142.5	142.7	85.8	102.2	102.4	85.0	99.8
1953	153.1	150.0	94.9	107.4	105.1	110.6	102.2
1954	159.4	152.9	71.0	104.1	101.9	74.8	102.2
1955	166.7	158.7	93.0	104.6	103.8	131.0	100.8
1956	180.5	172.3	89.8	108.3	108.6	96.6	99.7
1957	197.5	186.5	84.5	109.4	108.2	94.1	101.1
1958	204.3	192.4	60.6	103.4	103.2	71.7	100.2

[1] Indexes prepared by Division of Prices and Cost of Living, Bureau of Labor Statistics. The second of these indexes was a specially computed index.
[2] *Statistical Abstract*, 1959, p. 820.
[3] Percent 1949 is of 1947.

Columns 1 and 2 of the table show indexes computed for WPI prices and census unit values respectively for the same products with the same 1954 weights for both series. Column 3 shows the percentage of capacity at which the steel industry was operating in a given year. Columns 4 and 5 show the percentage that each index was of the previous year and column 6 the percentage that capacity was of its previous year figure. Column 7 shows the ratio that percentages of previous year changes for the WPI index are of comparable changes of the unit value index.

Unless there are influences other than those previously mentioned, one would expect (in the face of a rising trend in both series) that the UV series would accelerate more when the demand for steel increased and accelerate less when it decreased. Hence, a ratio (R) of the percentage changes from the previous year for the two series expressed as WPI/UV should be less than one as conditions of demand improve and be greater than one as conditions of demand worsen. If the capacity data are taken to represent the conditions of demand, the ratio (R), as it should be and was, is as follows:

	Should be—	Was—	Agree with theory?	
			Directly	Qualified
1947–49	$R>1$	$R=1$	No	
1949–50	$R<1$	$R>1$	No	
1950–51	$R<1$	$R<1$	Yes	
1951–52	$R>1$	$R<1$	No	Yes.
1952–53	$R<1$	$R>1$	No	
1953–54	$R>1$	$R>1$	Yes	
1954–55	$R<1$	$R>1$	No	
1955–56	$R>1$	$R<1$	No	Yes.
1956–57	$R>1$	$R>1$	Yes	
1957–58	$R>1$	$R>1$	Yes	

According to the above preliminary analysis, the movements of the two indexes behaved according to the hypothesis four times and contrary to it six times. However, there were three times during this period when capacity probably did not indicate the state of demand.

These occasions were during the strike years of 1949, 1952, and 1956. One would expect that the effect of the strike would make conditions of demand more favorable to the seller except as prices were held down by contracts in existence. Following this assumption, the change in capacity from 1951 to 1952 reflected the strike of 1952 and not demand, and conditions of demand should have caused the column 7 ratio to be less than one, which it was. The 1949–47 ratio should have been greater than one but was exactly one and *R* for 1955–56 should have been less than one and was. If the true nature of demand has been properly reflected in the above analysis, the evidence shifts slightly in favor of the UV series being more sensitive than the WPI series though the results are far from being conclusive. In any event further investigation appears warranted at the single product level.

An analysis of 25 different individual steel products, matched as closely as possible for WPI and Census data, gives the average agreement per product (with the hypothesis just formulated above) of 5.2 times out of a possible 10 times. Clearly, the data as analyzed in the above fashion do not substantiate the hypothesis that the unit values are more flexible on an annual basis than the WPI prices. It is not clear from the data available for steel products whether there is no significant difference between the WPI and the UV series or whether putting the data on an annual basis obscures the difference. Unfortunately, monthly data are not available for the UV series.

2. *Standard Typewriter (Nonelectric)*.—In the comparisons to follow, the census data represent indexes of derived prices that are secured by dividing dollar sales volume by the number of items shipped. For standard typewriters a different type of comparison is available. In each case, that is for the BLS and for the Census, their respective series are derived by using prices stated by manufacturers. The comparison 1956–59 is shown in Chart 3.1. While the specification appears to be the same for both series, the broader sample used by the census generally results not only in a greater number of reporters but also in a widening to some degree of the specifications. Since, as shown previously, increasing the number of reporters tends to increase the number of price changes, it would be expected that the Census series would be more variable than that of the BLS.

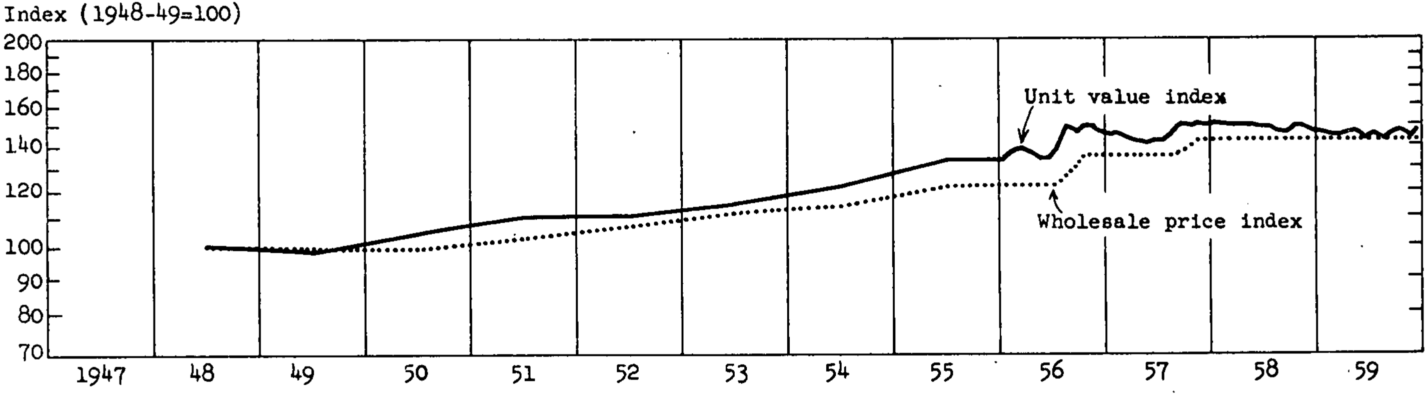
The difference in level on a 1947 base at the beginning of the period and the gradual convergence of the two series is puzzling.

Based on the data for this item where the data are collected by each agency on as nearly a comparable basis as is consistent with their collection procedures, it appears that a greater consistent variability of the Census series can be expected, due to the fact that it represents a larger number of reporters and also with a greater number of reporters there is some tendency for slight specification differences between reporting manufacturers to arise. However, with the close matching of items, the differences in fluctuation should not be extreme. Also the general movements for a given year or over a period of several years should be approximately the same.

3. *Clay Building Brick*.—Comparative movements in monthly indexes for the WPI and unit value (UV) data for clay building brick are shown in Chart 3.2 for 1947–49. Both series show a generally rising trend in prices over the period, the WPI rising by 56 percent and

CHART 3.1

Standard Typewriter (Non-electric)



Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

the UV series by 61 percent. The UV series is a more flexible one in its movements, rising higher and falling lower during the ups and downs of the business cycle. For example, it started down a month before the cyclical peak of November 1948, while the WPI continued its upward climb. During the depression year 1949, it went lower and averaged lower in its index. The impact of the Korean War in 1950–51 saw it rise more rapidly at first and then fluctuate moderately while the WPI remained nearly constant. Again in 1953 the UV index reflected the peak reached in business that year while the WPI changed very little. In 1954 it again declined while the WPI did not. Also it reflected the peak activity of 1957 and the 1958 trough while the WPI remained relatively stable. In addition, the UV data exhibit for part of the period a definite seasonal pattern, rising during the summer months and falling toward the end of the year. Clearly, the UV index is more sensitive than its comparative WPI series.

4. *Structural Clay Facing Tile.*—The unit value and WPI series for this commodity show a generally upward trend as was noted for clay building brick (see Chart 3.3). However, in this case the two indexes diverged more in their movements, with the WPI index rising 34 percent over the 1947 to 1959 period compared to 65 percent for the unit value index.

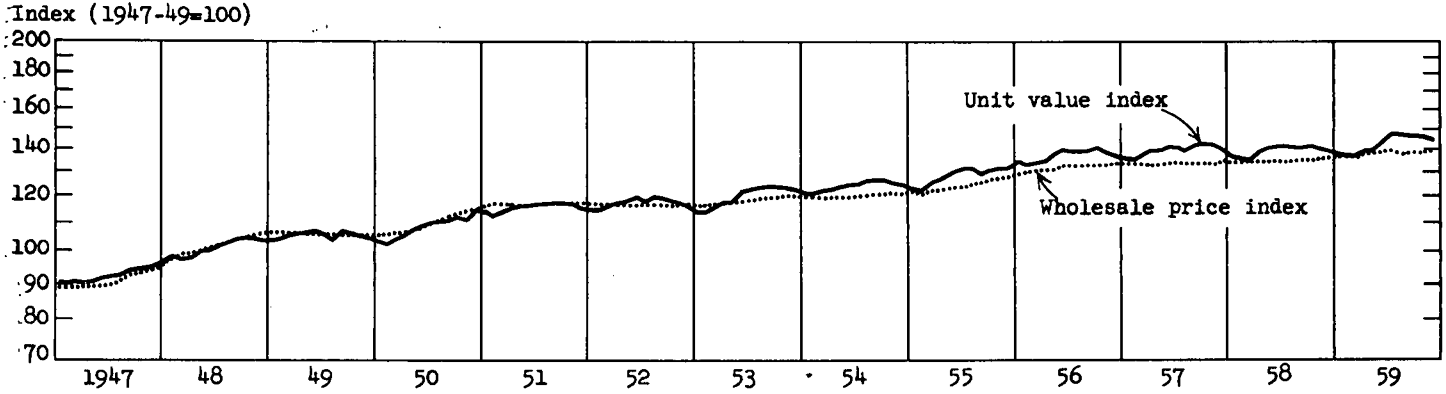
Again, as noted for the previous series, the UV series is more sensitive cyclically although the presence of some seasonal influence tends to obscure these movements. During the upward swing of 1951–53 this tendency is particularly in evidence; the UV series fluctuates seasonally while evidencing a sharp upward trend, while the WPI index remains constant over the entire period. Again in the 1948–49 and the 1957–58 recessions the UV index declines while the WPI data remain nearly constant in the first downturn and entirely so in the second. In fact, it is generally characteristic of the WPI series that it tends to remain constant over fairly long periods. As was the case for clay building brick, the differences in the variation of the two series appears greater than would be warranted according to their composition.

5. *Clay Drain Tile.*—As in the previous cases, the UV series for this item shows greater variability than that of the WPI (Chart 3.4). There appears to be seasonal movement in the UV that is not found in the other series but it tends to be obscured somewhat by the rising trend of the series. Also the seasonal pattern does not appear to be definite from month to month, it appears only as a general tendency to rise during the summer and fall in the late months of the year.

Neither series shows much of a tendency to conform to the NBER reference dates of the business cycle. There is an overall tendency for the WPI series to show periods of rigidity not found in the other series.

Chart 3.2

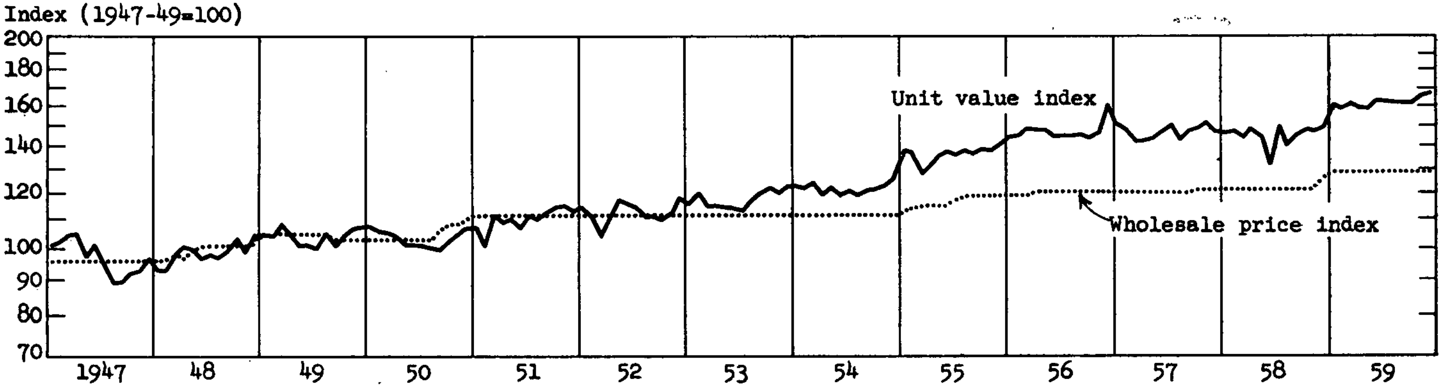
Clay Building Brick



Source: WPI - *Wholesale Prices and Price Indexes*, BLS
U.V. - *Facts for Industry*, Census Bureau

CHART 8.3

Structural Clay Facing Tile (Hollow), Ceramic Glazed*

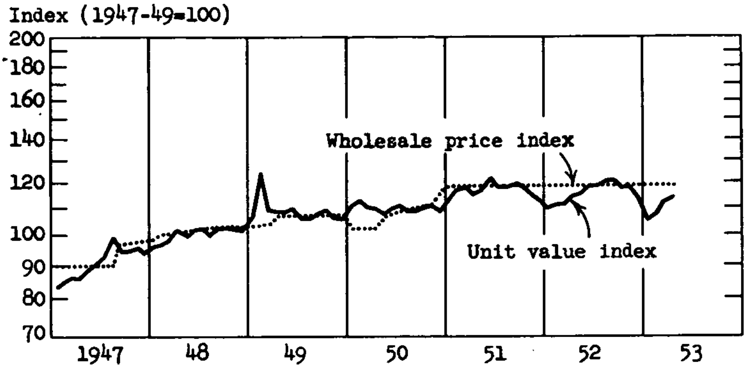


*Data July 1947 through 1954 include unglazed tile which represents about 5 per cent of total quantity and 10 per cent of total value in 1954.

Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

CHART 3.4

Clay Drain Tile



Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

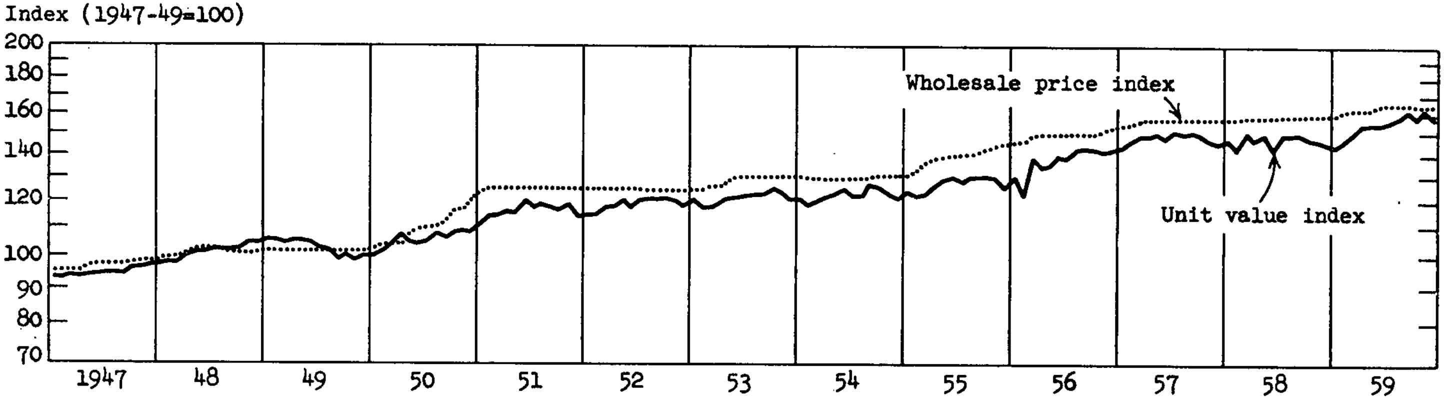
6. *Vitrified Clay Sewer Pipe.*—The Census series for this item showed considerably more conformity to general cyclical movements than the BLS series (Chart 3.5). The general level of the two series was nearly the same from 1947 through 1949 but diverged rather sharply in 1950, with the WPI being at a higher level through 1959. In this year the two series did come closer together toward the end of the year, however.

Again, a comparison of the series shows some seasonal for the UV and none for the WPI. Also the WPI shows long periods of stability in price where the UV series is fluctuating.

7. *Domestic Gas Cooking Range.*—While the BLS series for this commodity shows more variation than similar series for other items, again the census data shows substantially more (Chart 3.6). Generally, greater cyclical flexibility is shown for the Census UV series, with the WPI data remaining relatively rigid. The 1949 and 1954 declines of general business were followed much more by the UV than the WPI data. In fact, while the WPI data did decline to a small degree in 1949 (compared to a more substantial fall in the UV data), it actually showed an overall rise for the year 1954 instead of a decline. Also to be noted is the divergence of level in the two indexes. Since about 1950 they have tended to diverge, with the WPI pulling away to a higher and higher level.

CHART 3.5

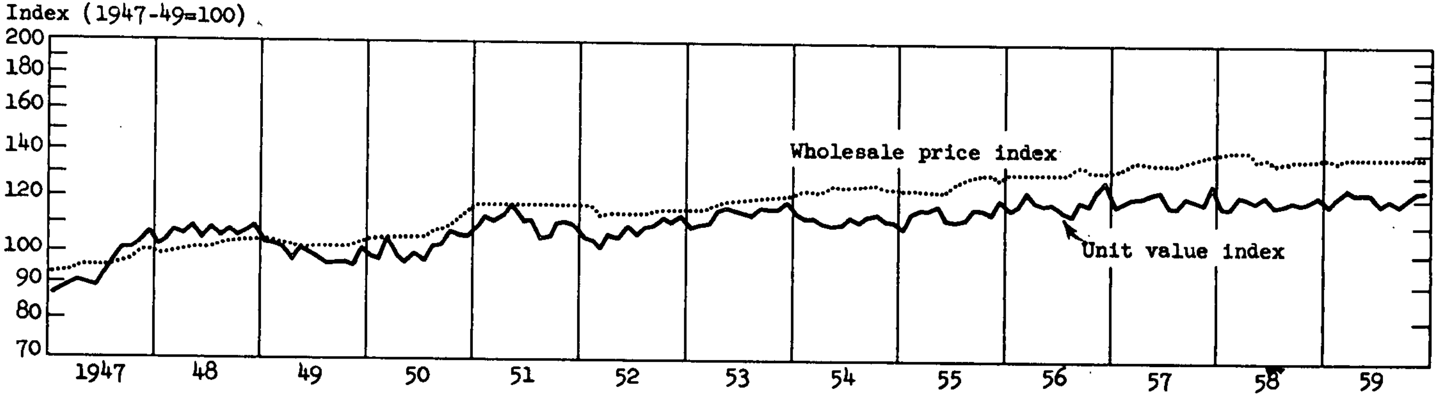
Vitrified Clay Sewer Pipe



Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

CHART 3.6

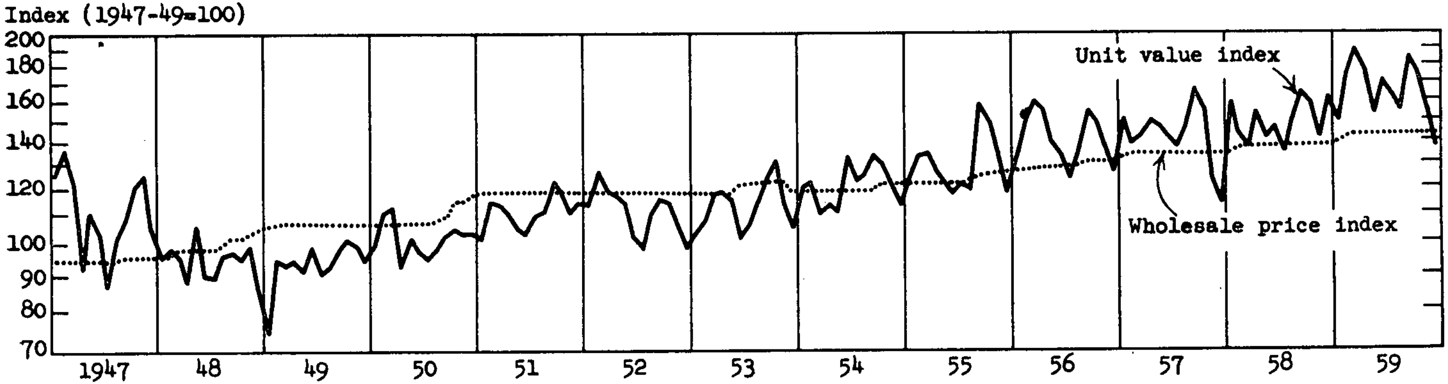
Domestic Gas Cooking Range, Standard Size



Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

CHART 3.7

Domestic Gas Heated Stove (Vented)



Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

8. *Domestic Gas Heating Stove (Vented)*.—The number of plants reporting to the Census is considerably smaller for this item than for the previous products discussed (see Table 3.4). Consequently, the UV series fluctuates much more sharply than it would with a large number of items included (Chart 3.7). Under these circumstances the relative stability of the WPI series is even more striking than for the other commodities discussed. A great deal of the difference, however, is due to the fact that seasonal changes appear in the UV series where they do not in the BLS data. Adjustment of the Census series for these changes would still leave a pattern of cyclical change of greater magnitude than for the BLS statistics. In addition, a divergency in trend with the UV series rising more rapidly has appeared since 1956.

TABLE 3.4.—*Average Number of Plants Reporting Facts for Industry*

[Data for Given Year]

Commodity	1947	1948	1949	1950	1951	1952	1953
Clay building brick	630	619	639	633	612	595	578
Structural clay facing tile	*29–66	56	66	64	64	63	58
Clay drain tile	164	163	197	189	178	177	180
Vitrified clay sewer pipe	76	76	77	73	72	71	72
Domestic gas cooking range	55	56	N.A.	N.A.	N.A.	N.A.	N.A.
Domestic gas heating stove (vented)	27	29	N.A.	N.A.	N.A.	N.A.	N.A.
Domestic gas heating stove (unvented)	25	26	N.A.	N.A.	N.A.	N.A.	N.A.

*Number for glazed tile only is 29; 66 for glazed and unglazed.

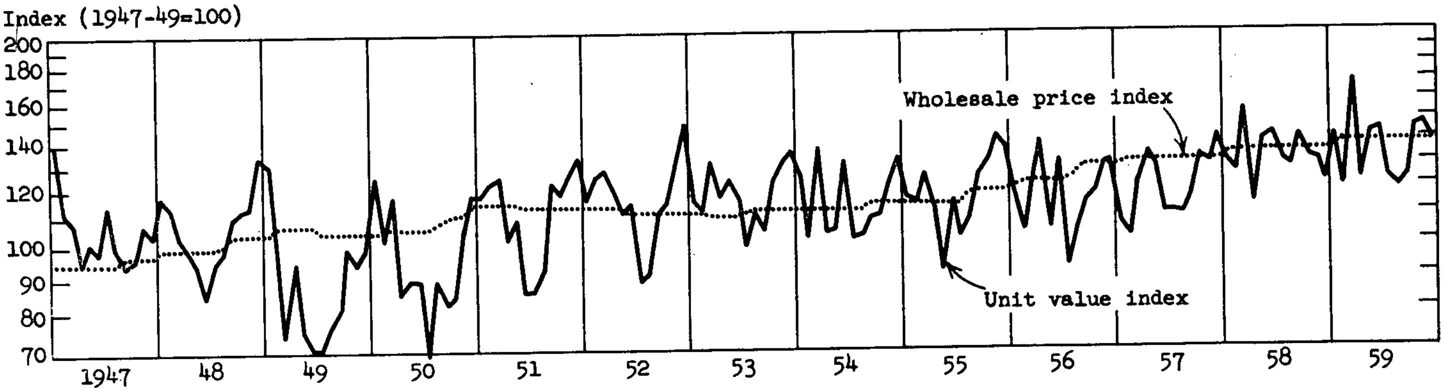
SOURCE.—*Facts for Industry*, U.S. Bureau of the Census.

9. *Domestic Gas Heating Stove (Unvented)*.—For this commodity a relatively small number of items (see Table 3.4) for the Census data tends to give this series relatively wider swings than most of the other series (except for the one in the immediately preceding discussion which has about the same number of items).

Again, as with the previous commodity, a seasonal pattern is exhibited that tends to somewhat obscure the cyclical movements of the data (Chart 3.8). However, cyclical variation is much more apparent in the Census than in the BLS data. The WPI series moved largely upward or downward in small steps and stays constant over long periods of time, while the UV series shows more conformity to change as during the downswing of 1948–49.

CHART 3.8

Domestic Gas Heating Stove (Unvented)

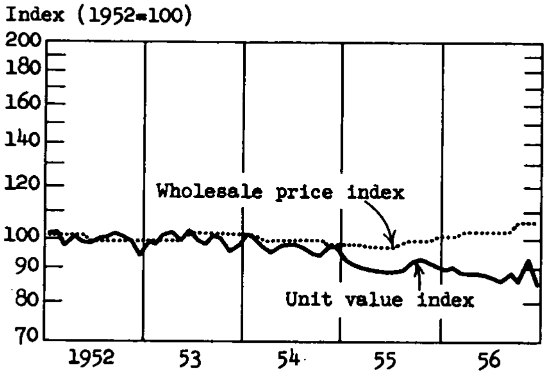


Source: WPI - <u>Wholesale Prices and Price Indexes</u>, BLS
U.V. - <u>Facts for Industry</u>, Census Bureau

10. *Water System, Deep Well, Jet Type, ½ H.P.*—Data were available on a comparative basis for only the five years 1952–56. The general pattern of greater stability for the WPI series is again evident, though in this case the fluctuations in the UV series are not as wide as those noted for other commodities (Chart 3.9). In addition to the difference in relative fluctuations, however, there is a disturbing difference in the trend of the two series, the WPI data exhibiting an upward and the UV data showing a downward trend.

CHART 3.9

Water System, Deep Well, Jet Type, 1/2 h.p.



Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

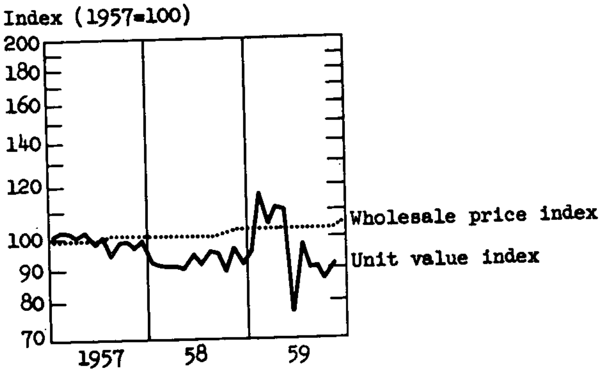
11. *Bed Springs (Coil Type)*.—Only three years of monthly data were available for this comparison. The comparison is similar to the general pattern of all the items: general stability of the WPI, wider fluctuation of UV (Chart 3.10). As in the case of the deep-well water system, the UV shows an overall downward movement compared to a small upward one for the WPI item.

Again, as was evident in the prices-paid comparison, the compared series showed greater short-term flexibility than their BLS counterparts. Part of this greater flexibility is attributable to the greater number of reporters that the Census has. However, with a greater number of reporters the magnitude of the flucuation should be less for the Census data and it is not. Also, the probably slightly wider classification of the Census data should have these same effects—that is more changes but with lessened fluctuations.

Despite all these factors operating in the direction of a smaller magnitude of fluctuation for the unit value data of the Census, it clearly varies more than the BLS series. It is difficult to find any logical explanation for this phenomenon that does not include more accurate short-term pricing in the sales data of the Census. Possibly, manufacturers' greater concern with the accuracy of the sales figures than the BLS reporters' concern with the accurate reporting of specified items may account for this difference.

CHART 3.10

Bed Springs (Coil Type)



Source: WPI - Wholesale Prices and Price Indexes, BLS
U.V. - Facts for Industry, Census Bureau

In conclusion, the two sources of information used to compare with the BLS prices indicate that these prices are likely too rigid in the short-term and hence are not suitable for an examination of short-term economic change.

APPENDIX

TABLE A.1.—*Comparison of Monthly Indexes of Company Prices Paid with Indexes of Prices Reported to the BLS, 1957–59*

[January 1957=100.0]

A. THE FOLLOWING ITEMS WERE STABLE[1] OVER THE 1957-59 PERIOD BOTH FOR THE COMPANIES' SERIES AND THOSE OF THE BLS

BLS code	Name	BLS code	Name
1. 028411	Flavoring syrup.	7. 061257	Ethylene glycol.
2. 061103	Hydrochloric acid.	8. 061277	B-Napthol.
3. 061135	Chlorine.	9. 095611	Typewriter ribbon.
4. 061165	Sodium carbonate.	10. 095641	Adding machine rolls.
5. 061167	Sodium bichromite.	11. 102251	Magnesium, pig ingot.
6. 061173	Sodium silicate.	12. 114131	Rotary pump.[2]

[1] Some of these items such as typewriter ribbons and adding machine rolls, were probably not bought in large enough quantities to be a good test of their WPI counterparts.
[2] This item changed to 100.2 in the BLS series October 1957. There were no other changes.

TABLE A.1.—*Comparison of Monthly Indexes of Company Prices Paid with Indexes of Prices Reported to the BLS, 1957–59*—Continued

B. THE FOLLOWING ITEMS WERE NOT STABLE OVER THE ENTIRE 3-YEAR PERIOD BUT DID EXHIBIT STABILITY FOR 6 MONTHS OR MORE CONSECUTIVELY IN THE BLS DATA

BLS code	Name and specification difference, if any	Date of price change	Price index	
			Company	BLS
13. *052003	Coke, Milwaukee	February 1957	104.1	100.0
		May 1957	104.5	100.0
		September 1958	103.5	100.0
		February 1959	109.1	104.9
14. 052004	Coke, Indianapolis. (Different delivery point about 20 miles distant.)	March 1957	100.9	99.2
		October 1957	98.2	99.2
		January 1958	94.2	99.2
		March 1958	95.8	99.2
		July 1958	98.2	99.2
		January 1959	96.4	99.2
		February 1959	96.4	104.2
		April 1959	98.2	104.2
		July 1959	101.8	104.2
		Oct. 1959	91.6	104.2
15. 055401	Fuel oil, New York. (Different delivery point about 30 miles distant.)	February 1957	100.0	108.2
		April 1957	96.3	108.2
		May 1957	96.3	104.9
		June 1957	96.3	101.6
		July 1957	90.2	101.6
		August 1957	90.2	100.0
		September 1957	90.2	96.8
		October 1957	85.4	96.8
		January 1958	79.9	96.8
		February 1958	79.9	90.2
		March 1958	79.9	86.9
		April 1958	77.0	86.9
		May 1958	77.0	84.3
		July 1958	74.6	84.3
		October 1958	68.8	77.7
		January 1959	64.5	77.7
		June 1959	64.6	77.7
16. *061109	Sulphuric acid	January 1957	100.0	100.0
		June 1957	100.2	100.0
		September 1957	98.0	100.0
		October 1957	98.4	100.0
		August 1958	98.3	100.0
		December 1958	98.6	100.0
		October 1959	98.8	100.0
		November 1959	99.2	100.0
17. 061111	Aluminum sulfate (carload, bags, freight not equalized.)	June 1957	100.0	108.1
		July 1959	90.0	108.1
18. *061126	Calcium chloride	March 1957	100.0	106.9
		August 1959	103.2	106.9
19. *061133	Carbon dioxide	January 1957	100.0	100.0
		September 1958	125.0	100.0
20. *061157	Salt	April 1957	100.0	102.0
		February 1958	100.5	102.0
		March 1958	100.5	103.7
		August 1958	100.2	103.7
		January 1959	100.8	103.7
21. 061161	Silver nitrate, slightly better grade	June 1957	97.0	99.2
		August 1957	99.0	99.8
		November 1957	98.8	99.8
		December 1957	98.0	99.8
		January 1958	98.2	99.8
		February 1958	97.1	99.8
		March 1958	97.1	101.4
		October 1958	98.9	106.2
		November 1958	98.7	106.2
		December 1958	98.5	106.2
		January 1959	98.7	106.2
		February 1959	98.9	106.2
		March 1959	100.0	107.8
22. 061169	Sodium hydroxide:			
	1st company*	January 1957	100.0	100.0
		April 1958	100.0	111.7
		April 1959	111.6	111.7
	2d company*	January 1957	100.0	100.0
		April 1958	111.7	111.7
	3d company, solution	January 1957	100.0	100.0
		February 1957	98.2	100.0
		July 1957	96.4	100.0
		April 1958	96.4	111.7
		January 1959	95.5	111.7

*Starred items have the same specifications for the company as for the BLS; other items differ as noted.

TABLE A.1.—*Comparison of Monthly Indexes of Company Prices Paid with Indexes of Prices Reported to the BLS, 1957–59*—Continued

B. THE FOLLOWING ITEMS WERE NOT STABLE OVER THE ENTIRE 3-YEAR PERIOD BUT DID EXHIBIT STABILITY FOR 6 MONTHS OR MORE CONSECUTIVELY IN THE BLS DATA—Continued

BLS code	Name and specification difference, if any	Date of price change	Price index	
			Company	BLS
23. *061214	Ethyl alcohol:			
	1st company*	January 1957	100.0	100.0
		February 1957	99.0	100.0
		October 1958	109.0	107.7
	2d company, tank car	January 1957	100.0	100.0
		June 1957	101.5	100.0
		November 1957	102.1	100.0
		October 1958	102.1	107.7
		March 1959	102.8	107.7
		July 1959	103.1	107.7
24. *061231	Carbon disulfide	February 1959	101.4	100.0
25. 061233	Carbon tetrachloride, tank car	April 1957	100.6	104.5
		July 1957	101.1	104.5
		October 1957	101.9	104.5
		January 1958	103.0	104.5
		April 1958	103.5	104.5
		July 1958	103.6	104.5
		October 1958	104.2	104.5
		January 1959	104.6	104.5
		April 1959	105.2	104.5
		October 1959	104.2	104.5
26. *061263	Furfural	January 1958	105.5	100.0
		January 1959	102.7	100.0
27. 061265	Glycerine, natural:			
	1st company, tank car	January 1957	100.0	100.0
		January 1958	99.1	100.0
		October 1959	104.4	105.3
	2d company, tank wagon	January 1957	100.0	100.0
		January 1958	91.9	100.0
		January 1959	99.1	100.0
		October 1959	104.5	105.3
28. *061289	Styrene	January 1957	100.0	100.0
		July 1957	77.5	78.0
		October 1957	77.9	78.0
		January 1958	78.5	78.0
		February 1958	78.5	70.7
		April 1958	78.8	70.7
		July 1958	78.9	70.7
		October 1958	79.2	70.7
		January 1959	79.4	70.9
		February 1959	75.0	70.9
		March 1959	75.0	67.0
		July 1959	75.2	67.2
		October 1959	75.5	67.5
29. 061291	Toluene. (Some freight equalization to April 1958, thereafter, delivered.)	August 1957	91.2	96.9
		September 1957	91.2	92.2
		April 1958	73.5	92.2
30. *063135	Glycerine	January 1957	100.0	100.0
		February 1958	99.4	100.0
		September 1958	98.9	100.0
		August 1959	99.4	100.0
		October 1959	104.3	105.3
31. *063173	Vitamin C	October 1957	83.3	83.3
		June 1959	66.7	83.3
32. 067311	Phenolics, general purpose. (Different delivery point about 20 miles distant; delivered price)	February 1957	100.0	105.2
		April 1957	99.7	105.2
		November 1957	99.7	112.0
		January 1958	100.3	112.0
		April 1958	96.5	112.0
		July 1958	96.5	101.6
		October 1958	99.7	101.6
		January 1959	96.1	101.6
		April 1959	96.5	101.6

*Starred items have the same specifications for the company as for the BLS; other items differ as noted.

TABLE A.1.—*Comparison of Monthly Indexes of Company Prices Paid with Indexes of Prices Reported to the BLS, 1957–59*—Continued

B. THE FOLLOWING ITEMS WERE NOT STABLE OVER THE ENTIRE 3-YEAR PERIOD BUT DID EXHIBIT STABILITY FOR 6 MONTHS OR MORE CONSECUTIVELY IN THE BLS DATA—Continued

BLS code	Name and specification difference, if any	Date of price change	Price index: Company	Price index: BLS
33. *072101	Passenger car tires	February 1957	100.0	100.1
		April 1957	101.4	100.1
		July 1957	108.2	100.1
		August 1957	108.2	103.1
		October 1957	106.5	103.1
		January 1958	106.7	102.7
		July 1958	105.2	102.7
		August 1958	105.2	101.4
		January 1959	103.2	101.4
		March 1959	97.7	101.4
		July 1959	94.5	101.4
		August 1959	94.5	82.1
		October 1959	98.6	82.1
34. *072131	Tractor and implement tires	February 1957	100.0	100.1
		August 1957	100.0	103.1
		October 1957	102.0	103.1
		January 1958	101.0	102.9
		August 1958	101.0	106.0
		January 1959	102.0	106.0
		October 1959	103.0	106.0
35. *072201	Tubes, passenger cars	February 1957	100.0	100.1
		April 1957	97.4	100.1
		July 1957	104.3	100.1
		August 1957	104.3	102.7
		October 1957	103.4	102.7
		January 1958	101.7	102.5
		July 1958	104.3	102.5
		January 1959	99.1	101.4
		April 1959	96.6	101.4
		July 1959	97.4	101.4
		October 1959	100.0	101.4
36. 081412	Gum, No. 2, common. (1″ rather than 4″ by 4″)	March 1957	101.8	100.0
		September 1957	100.6	100.0
		November 1957	100.6	102.1
		April 1958	100.6	104.0
		March 59	110.4	104.0
		December 1959	107.3	102.1
37. 102230	Platinum (January 1958=100). (Better quality)	February 1958	89.6	100.0
		March 1958	88.3	93.5
		May 1958	82.2	87.0
		July 1958	76.1	77.9
		August 1958	76.1	79.2
		September 1958	69.9	79.2
		October 1958	69.9	74.0
		November 1958	66.3	74.0
		December 1958	63.2	67.5
		January 1959	61.4	67.5
		February 1959	63.8	74.0
		March 1959	87.7	100.0
		April 1959	92.0	100.0
		May 1959	94.5	100.0
		September 1959	93.9	100.0
		November 1959	94.5	100.0
		December 1959	95.7	100.0
38. *103011	Steel barrel	March 1957	101.6	103.2
		January 1958	101.6	101.6
		September 1958	101.6	104.4
		October 1958	103.7	106.4
		November 1958	105.7	106.4
		May 1959	105.8	106.4
39. 108131	Cap screws. (9/16″ by 1¾″ instead of ⅜″ by 2″)	March 1957	100.0	101.9
		April 1957	100.0	105.7
		May 1957	104.6	105.7
		July 1957	104.6	108.2
		August 1957	111.6	113.2
		June 1958	94.8	113.2
		September 1958	94.8	119.5
		November 1958	97.7	122.7
		October 1959	97.7	128.7
		December 1959	97.7	114.9

*Starred items have the same specifications for the company as for the BLS; other items differ as noted.

TABLE A.1.—*Comparison of Monthly Indexes of Company Prices Paid with Indexes of Prices Reported to the BLS, 1957–59*—Continued

B. THE FOLLOWING ITEMS WERE NOT STABLE OVER THE ENTIRE 3-YEAR PERIOD BUT DID EXHIBIT STABILITY FOR 6 MONTHS OR MORE CONSECUTIVELY IN THE BLS DATA—Continued

BLS code	Name and specification difference, if any	Date of price change	Price index: Company	Price index: BLS
40. *117314	Electric motor, ½ hp	April 1957	100.0	100.3
		June 1957	100.0	98.6
		July 1957	100.0	94.9
		September 1957	100.0	93.2
		November 1957	96.2	93.2
		January 1958	88.7	93.2
		January 1959	81.1	93.2
		June 1959	81.1	91.2
		August 1959	81.1	90.4
41. *117633	Welding electrode	January 1958	100.0	103.4
		March 1958	112.0	103.4
		October 1958	116.0	103.4

BLS code	Name and specification, difference, if any	1957 Company	1957 BLS	1958 Company	1958 BLS	1959 Company	1959 BLS
42. 117801	Storage battery:						
	1st company:						
	January	100.0	100.0	97.4	103.7	92.9	104.9
	February	103.8	102.6	93.3	103.7	92.9	104.9
	March	103.8	102.6	93.3	103.7	92.0	104.9
	April	103.8	102.6	93.0	102.9	89.1	104.9
	May	103.8	102.6	92.9	102.9	88.6	104.9
	June	103.8	103.7	89.4	103.8	88.1	104.9
	July	98.4	103.7	89.4	103.8	89.9	102.6
	August	99.5	103.7	88.2	103.8	91.1	102.6
	September	98.7	103.7	87.6	103.8	91.1	106.9
	October	98.7	103.7	87.2	103.8	91.8	106.9
	November	98.7	103.7	87.2	103.8	93.8	108.7
	December	97.9	103.7	91.8	104.2	93.8	108.7
	2d company (Plastic separators):						
	January	100.0	--------	100.0	--------	100.0	--------
	February	100.7	--------	99.3	--------	100.0	--------
	March	102.4	--------	99.3	--------	99.1	--------
	April	102.0	--------	99.1	--------	96.6	--------
	May	102.0	--------	98.8	--------	96.3	--------
	June	100.5	--------	96.3	--------	95.7	--------
	July	98.0	--------	94.4	--------	97.4	--------
	August	97.2	--------	93.7	--------	97.6	--------
	September	97.2	--------	92.5	--------	102.3	--------
	October	97.2	--------	92.3	--------	101.6	--------
	November	96.4	--------	92.3	--------	104.1	--------
	December	96.4	--------	96.5	--------	104.1	--------

BLS code	Name and specification difference if any	Date of price change	Price index: Company	Price index: BLS
43. *132230	Cement, portland	April 1957	102.0	100.9
		October 1957	101.6	100.9
		January 1958	101.9	103.1
		April 1958	101.6	103.4
		June 1958	101.6	103.3
		August 1958	99.2	103.3
		October 1958	99.0	103.3
		November 1958	99.9	103.2
		January 1959	100.5	104.3
		April 1959	99.7	104.3
		July 1959	99.4	104.3
		September 1959	99.4	104.2
		October 1959	99.5	104.2

*Starred items have the same specifications for the company as for the BLS; other items differ as noted.

TABLE A.1.—*Comparison of Monthly Indexes of Company Prices Paid with Indexes of Prices Reported to the BLS, 1957–59*—Continued

C. THE FOLLOWING ITEMS WERE ADDED AFTER THE TEXT WAS WRITTEN

BLS code	Name and specification difference, if any	Date of price change	Price index	
			Company	BLS
*061185	Sulfur	September 1957	100.0	88.6
		October 1957	88.9	88.6
		June 1958	86.1	88.6
		October 1958	84.2	88.6
		August 1959	69.9	88.6
*061281	Pentaerythritol	September 1957	98.7	100.0
		February 1958	91.0	92.2
		April 1959	95.6	96.9
092031	Wastepaper, No. 1, mixed. (Delivered about 20 miles from New York).	February 1957	100.0	92.9
		March 1957	100.0	85.7
		April 1957	83.3	50.0
		May 1957	83.3	35.7
		July 1957	81.5	50.0
		October 1957	85.2	50.0
		January 1958	90.7	50.0
		March 1958	90.7	42.9
		April 1958	85.2	42.9
		July 1958	74.1	64.3
		August 1958	74.1	71.4
		September 1958	74.1	142.8
		October 1958	138.9	142.8
		December 1958	138.9	114.3
		January 1959	118.5	114.3
		June 1959	118.5	157.1
		July 1959	146.3	157.1
102211	Pig lead. (Each company index weighted by number of days a given price was in effect.)	May 1957	96.2	96.8
		June 1957	89.6	87.5
		July 1957	87.6	87.5
		October 1957	85.7	84.4
		November 1957	84.5	84.4
		December 1957	81.4	81.2
		April 1958	75.2	75.0
		May 1958	73.4	75.0
		June 1958	70.3	68.8
		July 1958	68.9	68.8
		August 1958	68.0	68.8
		September 1958	68.3	67.2
		October 1958	79.3	81.2
		November 1958	81.4	81.2
		January 1959	78.9	81.2
		February 1959	72.6	71.9
		March 1959	71.6	71.9
		April 1959	70.2	68.8
		May 1959	74.6	75.0
		June 1959	75.2	75.0
		August 1959	76.9	75.0
		September 1959	81.4	81.2
		December 1959	78.4	78.1
102246	Mercury, 76-lb. flask. (Prices kept monthly but item bought quarterly; delivered 20 miles from New York.)	February 1957	100.4	100.0
		April 1957	102.0	100.0
		August 1957	99.8	98.1
		September 1957	97.2	96.3
		November 1957	90.1	89.3
		December 1957	87.9	88.5
		January 1958	86.1	87.3
		February 1958	87.7	85.6
		March 1958	87.7	91.2
		April 1958	90.4	91.0
		May 1958	90.4	89.5
		June 1958	92.9	89.5
		August 1958	93.7	94.6
		September 1958	93.8	94.2
		October 1958	92.9	91.6
		November 1958	90.3	89.7
		December 1958	90.3	86.9
		January 1959	90.3	85.8
		February 1959	87.6	85.8
		March 1959	88.9	87.5
		April 1959	95.6	94.8
		May 1959	97.2	96.5
		June 1959	97.2	94.2
		July 1959	97.2	91.8
		August 1959	97.2	90.3
		September 1959	88.8	87.5
		October 1959	88.4	87.9
		November 1959	88.3	84.4
		December 1959	85.0	84.0

*Starred items have the same specifications for the company as for the BLS; other items differ as noted.

TABLE A.2.—*Possible Effects of Different Specifications on the Items of Appendix Table A.1*

052004 Delivery point about 20 miles apart. There is a possibility that different freight quotations might have caused the company index to move differently apart from price changes.

055401 Different delivery points about 30 miles apart. A possibility of different freight quotations affecting the company index.

061161 The company buys a better grade than the BLS prices. Company buyer stated that the two grades showed the same movements.

061214 One company bought this by the tank car rather than by drum. Comparative variation of the two company prices shows the tank car price to be substantially more variable while the company price for the same item, as specified by the BLS, moved very similarly to the BLS item index.

061233 The index used here represents a tank car price rather than a drum price. In the opinion of the buyer, there existed a constant differential between the two prices over the 1957–59 period.

061265 Again tank wagon prices were used instead of drums. In the opinion of the buyer of one company, there was a constant differential between the two types of prices.

061291 In the company index "there was some freight equalization from January 1, 1957, through April 14, 1958. Thereafter, a delivered price was quoted." Additional variation beyond that found in the BLS index would be expected here.

067311 The company price is a delivered price. Additional variation in the company index beyond that shown for the BLS index would be possible but not necessary.

081412 Company was buying 1" items rather than 4 x 4". Uncertain of likely price effect.

102230 Company bought a better quality item. Price variations should have been similar.

108131 9/16" x 1¾" instead of ⅝" x 2" on these cap screws. Price variations should have been similar.

117801 There were plastic separators in the batteries bought by the company as compared to wood separators for the BLS. Price variations were similar for two reporting companies, one reporting data for wood and one for plastic separators.

STAFF PAPER 9

A STUDY IN VALIDITY: BLS WHOLESALE PRICE QUOTATIONS [1]

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> I believe these tables will be found, not only confirmatory of the aphorism that "the world is much ruled by the belly," but strongly suggestive of the conclusion that the history of prices . . . may, in the order of practical importance to mankind, take precedence of the history of politics.—J. T. DANSON, *JRSS*, 1850.

Every since Fleetwood [2] in 1703 became concerned with measuring the purchasing power of the English pound and Dutot [3] in 1738, using a more refined total sum method, compared the prices of two periods (reigns of Louis XII and Louis XIV), the precision of index numbers has been seriously questioned. The controversy has ranged from David Ricardo, who expressed doubt about ever being able to measure changes in the average price level, to Irving Fisher, who in 1922 felt the total error of the U.S. Bureau of Labor Statistics Wholesale Price Index was "usually within one or two percent." [4]

The BLS itself has had little to say about the overall precision of the WPI except to invoke the strong law of large numbers [5] or conspicuously to avoid the subject. Such an omission ought to be warning enough as to the complexity of the problem.

Clearly the precision of a price index number depends in part on the validity of the actual price data. It is with this most important problem, the validity of the individual price observations, that this paper deals.

Upon first note, the importance of this problem may not be realized or at least be greatly underestimated. Fisher himself felt that collected price data might err very little from the actual transaction price, "say, less than 1/10 of 1%" [6] in the case of the WPI.

Wesley C. Mitchell, on the other hand, in a 1915 BLS Bulletin stated that the collection of accurate price data was not only the most "perplexing" step in constructing an index but also the most important

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[1] This is part of a study done as a Fellow of the Walgreen Foundation at the University of Chicago.

[2] W. Fleetwood, *Chronicon Preciosum* (London, 1707).

[3] Dutot, *Reflexions Politiques sur les Finances et le Commerce* (Hague, 1738).

[4] Irving Fisher, *The Making of Index Numbers* (Cambridge, 1922), p. 344.

[5] "The Bureau is currently experimenting with several approaches to the problem of measuring the reliability of this index, but results . . . will not be available for some time. However, experience with the index over a long period of time suggests that the index becomes increasingly reliable as the group of prices covered is larger." Bureau of Labor Statistics, Department of Labor, *Techniques of Preparing Major BLS Statistical Series*, Bulletin 1168, December 1954, p. 92.

[6] The errors of the Bureau of Labor Statistics Wholesale Price Index "are probably the same as for the War Industries Board": (1) formula—"usually less than ¼ of 1% and at most, say ½ of 1%"; (2) assortment—"say, less than 1%"; (3) numbers of commodities—"say, less than 1%"; (4) data—"say, less than 1/10 of 1%." Fisher, *op. cit.*, pp. 342–344.

irrespective of the quantity of the literature dealing with the other two areas (weighting and form of the index function).[7]

Uses and Collection of the WPI

The BLS has claimed three main uses of the index: first, as a measure of general price movements at other than the retail level; second, as a measure of price movements in particular markets or commodities, whereby its utilization as a deflator of certain components of the gross national product estimates and as an escalator in long-term contracts (construction contracts, production contracts, commercial leases, or supply contracts); third, as an indicator of market prices of specific commodities for both buyers and sellers.[8]

From an academic standpoint the WPI, or at least components of it, find great use not only as deflators of many different time series, but also as a measure of the flexibility of prices. This has been the case in some studies of monopoly power. Therefore, any attempt by an industrial group to present a more stable picture of its prices than actually exist might ironically result in strong public policy being directed against the industry.

In 1891 when Professor Roland Falkner, at the behest of the Senate Finance Committee, set out to see if wages or prices had fallen since the Civil War, he not only collected price data from trade journals and manufacturers but also from merchants. Hence it appears he collected both prices offered and prices paid.

By January 1958, the price quotations used in constructing the index were as far as possible taken from "the first significant commercial transaction in the U.S.," by the following methods:

	Percent of Price Quotations
1. Company reports	87.85
2. Trade publications	7.76
3. Government agencies	4.22
4. Trade associations	0.17

A company report is a detailed confidential price questionnaire which is mailed monthly from the producer or manufacturer (seller) to the BLS.

Trade publications are supposedly those which are recognized as "reliable" by the industry in question, and the BLS further mentions that "some" independent spot checks are made of the trade publications' printed prices. Nothing is said as to the frequency of these checks. No indication is given as to the method (if any) utilized in checking trade associations. In the case of some commodities (agricultural products, fish, etc.) other government agencies are already officially collecting and publishing prices.

[7] "The reliability of an index number obviously depends upon the judgment and accuracy with which the original price quotations were collected. This field work is not only fundamental, it is also laborious, expensive, and perplexing beyond any other part of the whole investigation. Only those who have tried to gather from the original sources quotations for many commodities over a long series of years appreciate the difficulties besetting the task. . . . To judge from the literature about index numbers, one would think that the difficult and important problems concern methods of weighting and averaging. But those who are practically concerned with the whole process of making an index number from start to finish rate this office work lightly in comparison with the field work of getting the original data." BLS Bulletin 173, *Index Numbers of Wholesale Prices in the U.S. and Foreign Countries,* Department of Labor, 1915, p. 27.

[8] BLS Bulletin 1168 pp. 82–83; and H. E. Riley, "The Price Indexes of the Bureau of Labor Statistics," 82nd Congress, 2nd Session Compendium, *The Relationship of Prices to Economic Stability and Growth,* March 31, 1958, p. 114.

Hence, the BLS collects prices as quoted by the sellers themselves, their trade associations, or trade journals. The prices are supposedly samples of quotations which have been extended to public and private enterprises, regional governments, and the Federal Government.[9]

List Prices and Departures

Of the two prime sources of price quotations, buyers and sellers, one might expect that there would be no systematic difference between price quotations due to source. However, if sellers quote list prices [10] and buyers quote actual transaction prices, the resulting difference (as will be shown) may be large for many commodity categories.

Rationale for the existence of list prices might take one or more of the following forms:

1. Many areas of the primary market (loosely defined as the first large-volume transaction) are noticeably marked by a high degree of homogeneity of product, relatively little advertising, and relatively few (2–10) sellers. If price changes on the part of one firm have no significant effect upon the prices of other firms in the industry, then the firm faces a demand curve of high elasticity with small changes in price having large effects on sales. If the firms in the industry are involved in a cartel arrangement, it usually pays for a member of the cartel to "shade" prices a bit lower than the cartel (list?) price. In these situations, the use of a list price allows sellers to inform buyers as to their presence in the market, to present a frame of reference (usually an upper bound) from which possible deductions (or in a few cases, additions) may occur, and to achieve these ends without actually disclosing their present transaction price or prices to competitors.

2. On grounds of price discrimination one might justify the use of list prices. By setting a price for some time period equal to or above the highest expected future price, the seller can clandestinely discriminate between individual buyers by the use of discounts, rebates, etc., with no fear of adverse customer repercussions due to comparison with published prices. The seller of course still bears the risk of buyers comparing prices.

3. In attempting to secure collusive action of sellers, a detailed schedule of list prices (either delivered or f.o.b. list prices with rules for determining freight) may be used. While this method of cartelizing has the advantages of simplicity and low operation costs, it encounters the difficulty (except in public auctions) of policing the participants.

4. The use of list prices may be based on costs. In markets where sellers have many agents in widely dispersed areas, the costs of contacting the "price makers," costs of repetitive price calculations for every possible combination of products, services, and terms, and the resultant costs of informing the selling agents of today's price may be prohibitive. Costs of changing list prices are relatively low, as all selling agents are merely notified of new discount terms. Additional discounts may be granted on factors best assessed by the selling agents themselves (i.e., services, likelihood of complaints, promptness of payment, etc.).

[9] "Normal purchases of civilian goods by the Government (including the military departments), which are produced in the private sector, shall be included in the weight universe." BLS Memorandum, *WPI Universe*, Nov. 18, 1957.

[10] I define list price to be a seller's price which is either publicly announced through trade journals, associations, newssheets, or given in a price schedule circulated to a customer in advance of an actual transaction.

In the above rationales, list prices are usually an upper bound (and not necessarily a least one) on actual transaction prices, the latter varying greatly from the former, as will be seen later. Methods of concealing actual transaction prices are numerous and manifold.

One method is that sellers will quote the highest price they received during the period in question, and usually these prices will apply to small-lot sizes which may or may not be specified. Also the nonstipulation of delivery terms (freight equalized, freight allowed, freight prepaid on specified amounts, f.o.b. destination) allows variability in the actual f.o.b. plant transaction price. Evidence of these practices was brought to public attention by the BLS in its "Supplementary Inquiry on the WPI Price Reports." [11]

Another common method in steel, petroleum, and no doubt other markets is to ship more than the invoiced quantity, thereby reducing the actual transaction price per unit.[12]

In the chemical industry, the use of different trade names for the exact same commodity allows price discrimination to go undetected.[13]

Apparently the most popular and widely used method is to offer discounts of varying degrees (depending on the market supply and demand situation) from the list price which is quoted in trade journals, newspapers, by trade associations, and, unfortunately for many commodities, the WPI. For discounting appears to be very common in normal markets, rampant in weak (buyers') markets, and zero or negative in strong (sellers') markets. Examples of these practices are legion:

> Gasoline is going through a period of "watchful waiting," refiners say. There are unconfirmed reports that most grades would find sellers to bids of "0.5¢ off" (per gallon). One source declares buyers' bids for quantities for shipment over balance of the year likely could get even wider discounts.—*Platts Daily Oilgram*, March 10, 1958.

A petroleum trade journal gives details of discounting:

> "One can no longer pretend that present postings even remotely reflect the true market price," mentions an important oil executive. . . . It would still be foolhardy, of course, to predict an actual imminent cut in world crude postings—if only because no large oil company has any real desire to take such a lead. . . . Nor is anyone anxious to face the uproar such a move would undoubtedly precipitate in the producing countries of the Middle East and in Venezuela. . . .
>
> Sales at substantial discounts below posted prices are nothing new at either of these two main world oil export centers. Offerings at 75¢ to 85¢ a barrel off postings in Venezuela have become routine. So have discounts of 20¢ to 35¢ at the Persian Gulf. . . . Sharp discounting is no longer confined

[11] "For about 9% of the reports covered by the special questionnaire, minor changes, corrections, or clarifications were reported in the terms of sale, principally by the description of the lot size to which the reported price applied and in the description of the delivery terms." BLS, *Wholesale Prices and Price Indexes 1958*, Bulletin 1257, p. 10.

[12] "Don't buy at discounts off a large sellers' published barge or cargo price. Big sellers are fed up with being undercut this way. They will keep customers alive by methods that don't show up on the invoice." *Platts Daily Oilgram*, July 31, 1958.

[13] One large Eastern chemical company, when faced with the imminent possibility of losing a very large buyer of Synthetic Resin A2 to a competitor, established another product class, Synthetic Resin D1, which differed from the former in only two important aspects—price and trade name.

largely to sellers with limited sources of supply. New, and bigger, cut-price forces have entered the market. And everybody is now getting into the act, even major suppliers, in an ever-sharpening fight for outlets. . . .

At least two major oil companies have made deals for delivery of Middle East crude to Italy at discounts of 58¢ and 91¢ per barrel, respectively (that is, below Middle East postings plus Afra tanker rates).

Or look at Japan, by far the biggest crude market in the Far East. A tremendous amount of discounting is going on there now . . . the size of the discounts can no longer be kept secret (or hidden in "free transportation" and other gimmicks). The net result is that each new, bigger discount almost automatically starts with a new round of cuts. "If it was still just a case of price cuttings by some independents with limited crude supplies, it would be one thing, but when discounts are being offered openly by just about all major companies with unlimited supplies of crude at the Persian Gulf, the situation is altogether different." And in India after Russia offered crude "at a price substantially below the level at which these companies were importing from their parent companies" . . . as of mid-week, at least one major supplier had offered to reduce the delivered cost of its Middle East crude by an average of 27¢ a barrel.—*Petroleum Week*, July 22, 1960, p. 14.

In the chemical industry:

Chemical executives report greater price firmness even where there are no actual list price changes. This takes the form of fewer price discounts, freight rebates and similar arrangements. . . . Sulfuric acid, for example, "is firmer at its base price than it has been in 18 months," declares the president of one major producer. He doesn't anticipate an increase in the base price, but he makes no secret of the fact that selling the acid at list price is an "improvement over the situation several months ago."—*Wall Street Journal*, February 2, 1960. [All this time, in fact since June 1953, the WPI quoted sulfuric acid unchanged at $22.35 per ton, no doubt the seller's list price.]

Another interesting example in the chemical field was fumaric acid, which during the steel strike became greatly reduced in supply due to the fact that it was a joint product of steelmaking. "One fumaric acid buyer says that at the end of 1959 he was offered 'spot' fumaric at 70¢ a pound, against a list price of 28.5¢. . . . Ironically, on January 1, the base price of fumaric was cut 4 to 4.5 cents a pound, despite the short supply and high spot prices. This price cut was viewed by many chemical industry observers as an attempt on the part of established producers to keep new competitors from entering the field."—*Wall Street Journal*, *loc. cit.*

Listing only a portion or none of a special discount or allowance is another method of disguising the actual transaction price.[14]

Still another scheme, which involves either an affiliate, agent, or "trusted" partner, seems to be widely used in the oil, coal, and steel industries. In a weak market, the steel producer merely finds a "trusted" warehouser who is willing to purchase the rest of a product run at a large discount, holding to sell in a more "profitable" market. In the oil industry the method is a bit different,[15] but the result is again that the true transaction price is hidden.

In the coal industry and possibly in others, the agent device is sometimes employed to conceal transaction prices. For not only does the agent bear the onus of selling substantially below list price, but he probably submits no price data to the BLS.

And finally, there is always the possibility that the price quotation given to the BLS resembles neither actual transaction price nor seller's list price, but rather is a price *sans fond.*

No doubt other methods of hiding actual transaction prices exist, but these few examples should suffice to illustrate the point—that actual transaction prices can be well hidden and may differ from the seller's list prices.

One becomes concerned about the validity of seller's list prices when he looks back through the individual price indexes (Chart 1) and discovers either years of no change, as in the case of crude petroleum, cigarettes, synthetic rubber, cigars, typewriter ribbons, and many organic and inorganic chemicals; or at least very orderly step functions, as in the case of all the steels, billets, slabs, pig iron, anthracite coal, gasoline, coke, paints, drugs and pharmaceuticals, woodpulp, tires, tubes, power transformers, incandescent lamps, plate and safety glass, golf balls, baseball gloves, and even ball point pens, to mention only a few.

The BLS supplied evidence of the possible difference between sellers' quoted and actual transaction prices in a study of steel prices for the OPA and WPB in 1943. This study showed that actual delivered prices frequently deviated from delivered list prices and that base prices alone were not adequate measures of steel prices on account of the large "extra" costs present today in steel products.[16] Despite its own findings, the BLS today still publishes only base prices for steel.

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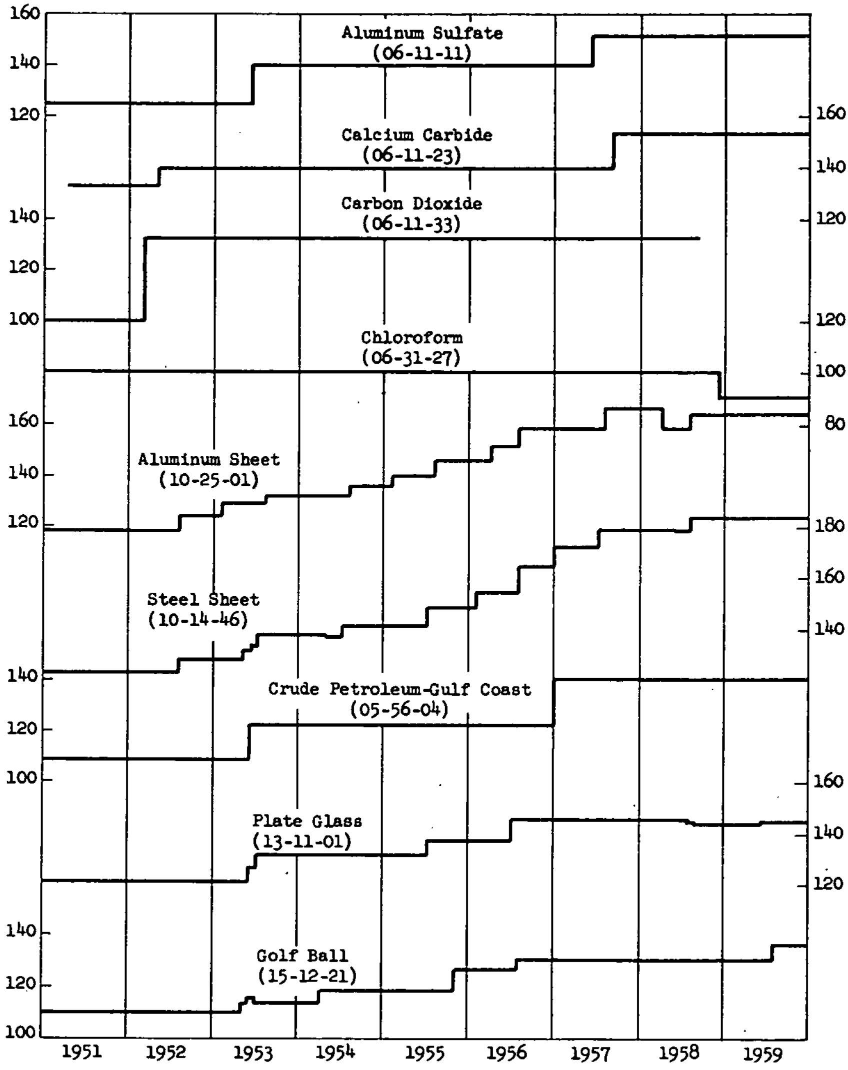
[14] This is reported in the BLS's 1957 "Supplementary Inquiry on WPI Price Reports." "An interesting example of a pricing practice which has not been reflected in current indexes is a volume rebate system, under which a seller credits his customers at the end of a year with amounts which depend upon the customer's cumulative purchases during the year. Only at the end of the year is it possible to know the price reduction effected under such a system." BLS Bulletin 1257, p. 11.

[15] "Price discounting has been restricted to third parties, while crude sales to wholly owned affiliates have been maintained at full posted prices. This system of selling crude to affiliates at full posted prices has been essential in holding up these postings in the current weak market." *Petroleum Week, loc. cit.*

[16] "Actual delivered prices paid by steel consumers deviate frequently from published delivered prices. . . . Actual prices varied from 50 to 135% of April 1942 published delivered prices during the period covered, while published prices remained stable. . . . The BLS used certain base prices to represent steel mill products in its WPI. However, base prices alone are neither good measures of the price of steel nor adequate indicators of the relative prices of different steel products. . . . Today, when extras are an important part of the price of steel, sometimes more important than the base price itself, base prices have lost much of their sensitivity as measures of steel prices. . . . The extent of price concessions shown by this survey is probably understated. First, it is likely that certain big customers, not included in the study, receive large concessions, and second, the price series obtained, with few exceptions, do not include those concessions which take the form of rebates based upon the volume of steel purchased during a given period." "Labor Department Examines Consumer's Prices of Steel Products," *Iron Age,* Vol. 157, April 25, 1946, p. 118.

CHART 1

Individual BLS Commodity Indexes, 1951-1959



APPLICABILITY OF THE DATA

In order to form an estimate of the difference between transaction and list prices, and the manner in which this difference changes over time, data have been collected on a considerable number of commodities purchased by the Federal Government or its agencies.[17] These

[17] I am greatly indebted to the following organizations from which price data were collected: General Services Administration, General Stores Supply Office (U.S. Navy), Military Petroleum Supply Agency (U.S. Navy), Naval Fuel and Supply Office, and Argonne National Laboratories.

purchasing organizations all presently employ a competitive bid process in awarding spot and term contracts (excluding negotiated contracts which are less than 1 percent of the total): this means the organization solicits for bids, receives offers, compiles them, and then accepts one of the offers—the lowest, if all other conditions are fulfilled.

Although the BLS includes in the weight universe of the WPI "normal purchases of civilian goods by the government,"[18] the basic question as to the relevance of these price data is whether price quotations to the government under competitive bidding are representative of a large number of commodity transaction prices at the first "large-volume stage" as intended to be measured by the BLS. Differences might arise due to one or more of the following reasons:

1. Commodity difference. It is possible that commodities purchased by the government differ significantly from the standard commercial commodities due to advertising, services, or quality itself. However, the level of transactions that the BLS is attempting to measure (first significant commercial transaction or "primary market") is characterized by very little advertising. Services may vary slightly among classes of customers, but, in general, the Federal Government is considered a more difficult customer with which to deal than private firms. Furthermore, an attempt was made to take account of any quality differences that exist between government purchased and standard commercial commodities as described in the WPI. Thus, steel sheet and plate have been adjusted to conform with WPI quality specifications. In many cases it is stated that the government purchases standard commercial commodities. Only where commodities have wide quality ranges, and where the WPI gives no indication of quality content, is there a serious possibility of price reflecting quality differences. But even in such cases, if the quality differential does not change rapidly over time, comparisons of flexibility should still be valid.

2. Distress sales. Distress sales to government or its agencies at prices less than marginal cost do not appear to be important. Not only is the Federal Government a continuous buyer but, due to the procedure of identifying and publicly posting all prices offered to the Government, there appears to be less incentive to sell at distress prices in the government market than in the private market. This is in full accord with the "trusted" (no price disclosure) customers mentioned earlier.[19]

3. Entry attempts. New firms seeking to establish businesses and possibly lacking distribution systems or established products might use the government market where (other conditions fulfilled) only price is important. However, upon checking both the companies that offer price quotations and those whose bids are accepted, one finds that not only are the large corporations of the various industries represented but they also are heavily represented among the successful bidders. Very few successful bidders appear to be new entrants in an industry.

4. Competitive bidding. It could be argued that the government's procedure of competitive bidding results in lower prices than nongov-

[18] BLS Memorandum, *WPI Universe*. See footnote 9 above.

[19] Numerous companies in widely different industries have stated to government purchasing officers that lower prices could be offered provided prices were not publicly posted.

ernment buyers achieve. But a claim of this sort simply denies the profit motive in private business.

5. Order quantity. The government often purchases smaller lots of those commodities for which the BLS stipulates minimum lot sizes.[20] For all commodities, the BLS gives no indication of an upper limit on the number of lots (order quantity). Surely whether one purchases 1 or 100 carloads of a commodity should have some effect on price. Since most government transactions are for smaller quantities than many private transactions at this level (i.e., steel, aluminum, chemicals, plate glass, plywood, linoleum, auto storage batteries, etc.), the bias is often upward relative to the average market transaction price.

6. Primary producers. Because almost anyone can submit a price offer to a government purchasing organization irrespective of level of supply, some price quotations come from levels other than the "primary market." Only in cases where all primary producers or suppliers are known can nonprimary market quotations be separated.[21] This again produces an upward bias in the mean ($\bar{X}$) of government price quotations as compared with average transaction prices from the private market.

Hence it appears that if government price quotations are biased at all, they are probably biased upward with respect to the average of the population of market transaction prices at the "primary level." Table C–1 offers some support of this conclusion. Note that the relative rankings, from highest to lowest, are usually in this order: Bureau of Census price, offered contract price, and BLS price. For oxygen and acetylene, the BLS data are in the form of index numbers [22] and cannot be directly compared with the price quotations in the other two series. Nonetheless, it may be noted that the movements of the latter are usually in accord and both differ from that of the BLS series. Calcium carbide comparisons involve delivered prices, and again the relative movements of the first two series are similar and different from the BLS series. These particular commodities were chosen so as to minimize product and quality differences between the price series.

Results

The major results of the simple statistical comparisons of the BLS wholesale price and index series with the prices bid on government contracts (henceforth called contract prices)[23] are:

a. The average levels of the BLS series are above those of the contract price series (Tables 2 and 3),

b. The BLS series change less frequently than the contract price series (Table 1),

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[20] The BLS specifications on quantity lots are not very precise. Many minimum lot sizes are given (30,000 lbs. for aluminum sheet; base quantity, 40,000 lbs., for steel sheet; car lots for calcium carbide; minimum, 20,000 bbl., for gasoline Gulf Coast, etc.), but in too many areas (all of processed foods, farm products, apparel, coal, drugs, hardboard, handtools, machinery and motive products, furniture and other household durables, etc.) lot sizes are seldom given. And even when minimum lot size is given, no maximum number of lots (order quantity) is given.

[21] Such an example in steel is A. M. Castle, which is well known to be only a warehouser and not a producer. Unfortunately few such obvious cases exist.

[22] Note that the BLS publishes both a Wholesale Price Index for all commodities and Average Wholesale Prices for some commodities.

[23] The designation "contract price" has been selected because price bids to the government are offers to contract at a particular price and under a competitive bid system cannot be withdrawn after they are publicly stated.

c. The BLS series change by smaller magnitudes in the short run than the contract price series (Table 1).

Table 1 demonstrates that in 22 out of 30 commodities the number of price changes between successive monthly observations was greater for the contract price series than for the BLS series. This finding is all the more impressive in that our procedure exaggerates the number of price changes in the BLS series on two counts. First, to compare government term contract prices with BLS prices, the means of the BLS monthly prices for the term contract period are calculated. If prices are constant during term 1, rise during term 2, and are constant during term 3, the method of averaging will show two price changes in the BLS series when in effect only one has occurred. Second, the same problem occurred in the basic BLS series when a monthly price was an average of weekly prices. Also, the BLS method of collecting prices of particular firms at particular moments can show as many price changes as there are firms.[24]

Adjusting coke and anthracite (buckwheat No. 1) for the first source of overstatement would result in both commodities showing more price changes in the contract price series than in the BLS series. There are 13 commodities which have term contract price data.

In commodity areas such as chemicals, nonferrous metals, pulp, paper, rubber and rubber products, etc., where BLS prices are given as f.o.b. shipping point, freight allowed, absorbed, or equalized, one would not expect BLS prices to be good indicators of short-run price flexibility, for no deduction is made by the BLS from the f.o.b. price for the allowed, absorbed, or equalized freight. This seriously limits the BLS series as a reliable measure of short-run price change magnitudes.

Table 1 exhibits 60 out of 64 cases where the contract price series showed greater mean magnitude of change than the BLS series. In only two cases out of 64 (steel plate and anthracite chestnut) did the BLS series show greater mean magnitude of movement. Two cases showed no change. Note that in all cases the mean percentage decrease of the data surpassed that of the BLS. This would certainly be an important characteristic of a comparison between list and transaction prices. Magnitude differences may be due in some part to differences in quantities purchased. Although some minimum quantity limit is often given in the BLS specifications (unfortunately there are numerous commodities where none is given), no maximum quantity limit is stated for any commodity. And even if maximum limits were given, some difference in prices might be expected because of variations in quantity within the stated limits. Tables B–2, B–10, B–14, B–23, and B–26 all present excellent examples of quantity-price difference in the same month.

The comparisons in Table 2 document the fact that on the average the BLS series are higher than the contract price series. For not only in 31 out of 32 commodities are the BLS series on the average above the mean of the contract series, but for all commodities the BLS series

[24] This second point is stated by George Stigler in "The Kinky Oligopoly Demand Curve and Rigid Prices," *Journal of Political Economy,* Vol. LV, Oct. 1947, p. 442.

TABLE 1.—*Flexibility and Magnitude Comparisons of Price Changes Between Successive Observations*

Commodity	Period of comparison	Number of observations [1]	Number of price changes		Mean ($\bar{X}$) number of months between BLS price changes	Mean percent DATA	Increase (+) [2] BLS	Mean percent DATA	Decrease (−) [2] BLS
			DATA	BLS					
1. Aluminum sulfate	July 1949 to November 1956	16	15	2	27.3	10.468	1.111	10.050	+1.732
2. Calcium carbide (a and b)	April 1951 to September 1954	14	13	1	13.5	13.134	.455	16.703	.714
3. Calcium hypochlorite	February 1949 to March 1956	11	6	2	24.0	4.972	1.302	4.250	+4.488
6. Xylene	December 1954 to February 1957	5	4	0	38.0	2.190	.000	2.117	.000
7. Acetylene	November 1953 to October 1957	4	3	2	34.6	4.807	3.145	7.212	.000
8. Carbon dioxide (gas)	November 1954 to October 1957	4	3	0	30.0	8.985	.000	26.531	.000
9a. Oxygen [3]	November 1954 to October 1957	3	2	2	22.0	9.886	5.033	5.735	.000
9b. Oxygen	July 1954 to July 1960	3	2	1	22.0	12.308	8.547	7.397	.000
10. Laundry soap (bar)	July 1954 to December 1959	21	20	7	5.5	26.268	.769	10.913	.695
11. Laundry soap (powder)	March 1949 to December 1955	18	17	15	1.67	21.674	11.428	18.643	12.940
12. Paint interior	March 1951 to February 1959	19	18	12	3.31	4.799	1.186	6.267	+.928
13. Enamel	December 1956 to June 1957	4	3	1	1.75	14.010	.000	8.161	+.490
14. Gasoline	April 1954 to April 1958	10	9	3	4.9	6.188	−1.173	6.236	.243
15. Anthracite, buckwheat No. 1	April 1951 to April 1959	17	16	16	2.04	9.429	5.440	11.034	3.005
16. Anthracite, chestnut	April 1951 to April 1959	19	18	18	1.69	3.239	3.586	6.392	3.641
17. Anthracite, pea	April 1953 to May 1955	3	2	2	2.12	.000	.000	12.053	5.393
18. Bituminous coal, egg	March 1953 to June 1960	7	6	6	1.09	13.866	4.128	5.682	+2.044
19. Coke (Birmingham)	July 1957 to June 1960	3	1	2	15.0	2.830	2.567	.000	.000
20. Aluminum alloy sheet	January 1955 to June 1959	12	10	5	7.0	15.805	2.833	11.502	+1.025
21. Aluminum ingot	December 1953 to May 1956	5	4	4	5.6	8.601	4.644	1.724	+5.172
22. Brass bar	January 1954 to September 1959	12	11	9	1.703	12.642	8.987	10.203	7.250
23a. Steel sheet [3]	February 1949 to August 1954	14	13	5	6.8	5.951	3.051	6.513	+1.108
23b. Steel sheet	July 1954 to April 1955	3	2	1	6.0	.858	−.205	1.815	.000
24. Steel plate	May 1955 to June 1957	3	2	1	4.8	10.827	13.102	.224	.000
25. Plywood A-C	January 1952 to May 1957	17	16	13	2.24	4.352	4.344	9.037	6.815
26. Plywood A-D	December 1951 to August 1955	16	15	8	2.00	5.098	4.161	8.308	7.271
27. Gummed tape	September 1951 to January 1959	22	21	9	4.00	15.819	−1.400	10.650	+.387
28. Auto tubes	April 1956 to December 1959	6	4	4	10.00	.335	.083	.297	+1.868
29. Storage batteries	February 1949 to February 1959	6	5	5	3.32	5.086	−.589	11.829	+6.367
30. Linoleum	August 1950 to November 1959	16	15	10	4.72	4.953	1.130	5.765	+1.137
31. Glass, plate	July 1949 to February 1959	15	14	10	15.57	9.985	3.994	6.370	+.687
32. Golf balls	June 1949 to February 1960	17	16	12	10.17	5.770	1.955	7.730	+1.787
Total		345	306	188					

Note.—Possible number of price changes, 312.

[1] This is the number of months in which there is at least one price observation. Months in which more than one price observation occurs are represented by mean prices in all calculations.

[2] This is the mean increase (decrease) between successive price observations (based on the data) as compared with the BLS series for the same period. Minus (−) and plus (+) are only used for movements contrary to the data series and signify decrease (−) and increase (+), respectively.

[3] The a, b designation specifies independently collected price series for the same commodity.

are above the low of the contract series. In any given contract, the low price in the distribution of prices is the actual transaction price, provided other conditions are fulfilled. Note that many of these comparisons are over a 7- to 9-year period.

TABLE 2.—*Average Level Comparisons of Price Series*

Commodity	Period of comparison	Number of observations	BLS / $\overline{X}$	BLS / Low
5b. Acetone	August 1958	1	1.061	1.174
1. Aluminum sulfate	July 1949 to November 1956	16	1.039	1.161
2. Calcium carbide (a and b)	April 1951 to September 1954	21	1.099	
3. Calcium hypochlorite	February 1949 to March 1956	11	1.206	
5a. Hydrochloric acid	July 1958	1	1.177	1.667
6. Xylene	December 1954 to February 1957	5	1.018	
8. Carbon dioxide	November 1954 to October 1957	4	1.907	2.039
10. Laundry soap (bar)	July 1954 to December 1959	21	2.838	
11. Laundry soap (powder)	March 1949 to December 1955	18	1.273	
12. Paint interior	March 1951 to February 1959	19	2.079	
13. Enamel	December 1956 to June 1957	4	2.236	2.566
14. Gasoline	April 1954 to April 1958	10	1.027	1.069
15. Anthracite, buckwheat No. 1	April 1951 to April 1959	17	1.135	1.190
16. Anthracite, chestnut	April 1951 to April 1959	19	1.192	1.279
17. Anthracite, pea	April 1953 to May 1955	3	1.219	1.230
18. Bituminous coal, egg	March 1953 to June 1960	7	1.363	1.450
19. Coke (Birmingham)	July 1957 to June 1960	3	1.097	
20. Aluminum alloy sheet	January 1955 to June 1959	12	1.137	
21. Aluminum ingot	December 1953 to May 1956	5	1.044	1.081
22. Brass bar	January 1954 to September 1959	12	1.054	
23a. Steel sheet	February 1949 to August 1954	14	1.084	
23b. Steel sheet	July 1954 to April 1955	3	1.050	1.137
24. Steel plate	May 1955 to June 1957	3	1.059	1.078
25. Plywood A-C	January 1952 to May 1957	17	1.082	
26. Plywood A-D	December 1951 to August 1955	16	1.045	
27. Gummed tape	September 1951 to January 1959	22	1.1488	

Because of the different time periods over which the commodities were sampled, a meaningful mean value calculation of the difference in level between the BLS and contract data for all commodities is unavailable. However, for 18 commodities in 1953, the average level ratio BLS/contract $\overline{X}$ was 1.187, and for a different set of 22 commodities the average level ratio was 1.281 in 1954.

The contract price series unfortunately include some nonprimary market prices, and if they could be excluded, the differences in level would be still larger. Furthermore, the government often purchases in smaller lot sizes than private market buyers and in some cases in lots smaller than the WPI lot specifications (i.e., aluminum alloy sheet, steel sheet, brass bar, aluminum ingot, laundry soap (bar), plate glass, etc.). This results in a smaller difference between the two series than would otherwise exist if no such deviations from the WPI specifications were present.

For those commodities for which the BLS provides only index series, the contract prices were transformed into indexes at the same level as the initial BLS indexes for comparison (Table 3). Again, on the average, the BLS level for the period of comparison is higher, which reflects a difference in magnitudes of the movements.

TABLE 3.—*Average Level Comparisons of Index Series, Selected Periods, 1949–60*

Commodity	Period of comparison	Number of observations [1]	BLS [2] / $\overline{X}$	BLS / Low
7. Acetylene	November 1953 to October 1957	4	1.062	1.298
9a. Oxygen	January 1956 to November 1959	5	1.058	1.344
9b. Oxygen	July 1954 to July 1960	3	1.005	1.404
31. Glass, plate	July 1949 to February 1959	15	.986	1.069
30. Linoleum	August 1950 to November 1959	16	1.110	
28. Auto tubes	April 1956 to December 1959	6	1.063	1.209
29. Storage battery	February 1949 to February 1959	6	1.456	1.558
32. Golf balls	June 1949 to February 1960	17	1.284	1.542

[1] This is the number of months in which there is at least 1 price observation. Those months in which more than 1 observation falls are represented by mean prices in all calculations.
[2] Mean of the BLS/DATA figures for the entire period of comparison. Due to different periods of comparison, no mean is calculated for all commodities.

Clearly, if over time the comparisons show the BLS series above the contract series, then on the average the short-run comparisons (month to month) will certainly exhibit the same difference.

The evidence of Tables 1 to 3 is of course limited in time, frequency of observations, and in commodity coverage. But within these limits there are important differences in level, frequency, and magnitude of change between the BLS series and the contract price series. That would be the difference between list and transaction prices.

Appendix A

CONSTRUCTION OF THE TABLES

The flexibility and magnitude comparisons were constructed in the following manner. For the period of comparison, the total number of contract price observations was tabulated. Then the number of price changes between successive monthly observations was noted (successive in time; June, October, not necessarily adjacent) and compared with the corresponding number of changes between BLS price quotations for the same period. In situations where more than one observation was present for the month, the mean of the observations was used as the month's price quotation.

The mean ($\overline{X}$) number of months between BLS price changes commences with the first price change in the comparison period and terminates with the end of the last run of identical prices started within the period, whether it extended 1, 2, or 36 months beyond the comparison period.

The measure of the magnitudes of fluctuation, mean percentage increase and mean percentage decrease (Table 1), was the mean of all successive percentage price changes for the comparison period. Increasing and decreasing price changes were segregated, then, if three increasing observations were present for the period of comparison, the mean of the two price changes expressed as percentages of their former value was tabulated as Mean Percentage Increase, Data. The mean of the price changes in the BLS for the same period was tabulated under BLS. The decreasing (−) price changes were handled similarly. Note that (+) and (−) refer to movements which were opposite those of the contract data.

In all comparisons between contract price observations and the BLS series, either delivered or f.o.b. data were used for the comparisons over time. No mixing of the two was tolerated.

Only on term contracts (delivery rate>150 days) were the means of the BLS monthly price quotations utilized.

For the average long-run level comparisons (Table 2), the sum of the applicable BLS monthly price quotations for the period of comparison was divided by the sum of the contract price observations. This comparison was made for both mean ($\overline{X}$) contract prices as well as low prices. In long-run level comparisons involving term contracts (delivery data>150 days), both the means and the lows of the contract series were compared to the BLS lows and means for the particular term contract periods.

In situations where the BLS reports only an index of price changes (Table 3), the original contract price series was transformed into an index based on the mean of the first year of comparison. The index was then adjusted to match the base of the BLS index and the comparisons then made as to long-run level for both the means and the low price observations.

Empirical support of the hypothesis concerning the bias of the contract price data is offered in Table C–1. The Bureau of Census yearly average price is calculated from the quantity and value data prepared by the Industry Division, Bureau of Census, as found in the *Facts for Industry* [25] series.

DATA ADJUSTMENTS

In order to present more meaningful comparisons between contract price data and the BLS data, some contract price series were adjusted to alleviate possible price differences due to commodity specification differences.

1. Aluminum sulfate (Table 1). The majority of the price quotations were f.o.b. plant. In a few cases the applicable freight (exact freight cost from plant to destination for the particular date as figured by the government) was deducted.

Also $.05 per 100 lbs. was deduced from all price quotations (as suggested by the sellers) to adjust for the special multiwall bag required by the Navy. Octagon was not considered a primary producer and hence its quotations, though included in the table, were not used.

2. Sulfuric acid (Table B–4). The majority of the price quotations were on a delivered basis. Hence exact freight costs from plant to destination as given by past rate schedules were needed, but, unfortunately, not available. Consequently, the commodity was *not* used in any comparison.

3. Gasoline (Table B–14). The government requires at *least* 86 octane and at times receives offers of 87 and 88 octane gas. Due to no systematic notification of the exact octane rating, *all* price quotations were subjected to the adjustment of $.002 per gal. by deduction from the WPI price series. This figure was twice the magnitude suggested by a large midwestern oil company.

4. Steel sheet (Table B–23 a and b). A deduction of $1.05 per 100 lbs. for quality and inspection extras was made for all price quotations in order to match the WPI specification. The adjustment and magni-

[25] Now called *Current Industrial Reports.*

tude were suggested by government steel buyers and specification experts. In Table B–23a, a further adjustment was suggested by the specification experts with respect to delivered prices. In f.o.b. plant purchases after 1952, the government added an average delivered transportation cost in order to compare the price quotations with other delivered prices. Adjustment 2 gives the price quotations after deducting the average delivered transportation cost. Prices under adjustment 2 were *not* used in this study. Only adjustment 1 was used.

5. Steel plate (Table B–24). A deduction of $1.10 per 100 lbs. for quality and inspection extras was again made at the suggestion of the government buyers and specification experts.

6. Plywood (Tables B–25 and B–26). Price quotations that contained an average delivered transportation cost added by the government were adjusted to their former f.o.b. basis by subtracting the government-calculated increment.

In regard to the other price series, a few general comments are desirable. In a few commodities (steel sheet, storage batteries, aluminum sulfate, etc.) *some* nonprimary market price quotations were recognized and did not enter into the final analysis. No doubt others still remained, for only the most obvious were segregated.

In some commodities (brass bar, xylene, linoleum, etc.) the WPI specifications were given as f.o.b. plant, whereas the price quotations were on a delivered basis. And in a few commodities (aluminum sheet, brass bar, calcium carbide, etc.) the quantities of the quotations were less than the WPI specified minimum quantity.

All these factors tended to minimize the difference in level between the WPI and the contract price data and possibly bias the flexibility comparisons.

Appendix B

Table B-1.—*Aluminum Sulfate, Hydrated, Technical, 100-Pound Bags, F.O.B. Plant*

Bid opening date	Delivery date	Number of bidders	Quantity (pounds)	Sellers offered prices (dollars per 100 pounds, no time discounts)			BLS prices from opening to delivery date		
				Low	$\overline{X}$	High	Opening	$\overline{X}$	Delivery
July 25, 1949	A, S, O, N, D	5	160,000	$1.375	$1.60	$1.70	$1.50	$1.50	$1.50
Feb. 7, 1951	60 days	2⅓	20,000	1.55	[1] 2.03 2.70	[1] 2.51 4.05	1.65	1.65	1.65
Apr. 16, 1951	30	2⅓	40,000	1.60	[1] 1.60 1.91	[1] 1.60 2.58	1.65	1.65	1.65
Oct. 17, 1951	O, N, D	2	200,000	1.35	1.47	1.59	1.65	1.65	1.65
June 6, 1952	J.A.S	2	240,000	1.60	1.60	1.60	1.65	1.65	1.65
Jan. 7, 1953	150	2⅓	50,000	1.10	[1] 1.40 1.72	[1] 1.70 2.35	1.65	1.65	1.65
Mar. 3, 1953	60	3	80,000	1.28	1.51	1.66	1.65	1.65	1.65
May 25, 1953	120	2	180,000	1.48	2.01	2.54	1.65	1.65	1.65
Mar. 8, 1955	60	2⅓	450,000	1.46	[1] 1.67 2.69	[1] 1.78 4.84	1.85	1.85	1.85
Sept. 30, 1955	45	3	80,000	1.45	1.56	1.78	1.85	1.85	1.85
Oct. 5, 1955	60 [2]	3	270,000	1.60	1.73	1.80	1.85	1.85	1.85
Apr. 3, 1956	45	3¼	84,000	1.60	[1] 1.78 2.18	[1] 2.00 3.37	1.85	1.85	1.85
May 9, 1956	60	2	231,000	1.60	1.71	1.825	1.85	1.85	1.85
July 19, 1956	30	3	518,000	1.60	1.80	1.90	1.85	1.85	1.85
Aug. 7, 1956	60	2¼	82,000	1.78	[1] 1.78 3.44	[1] 1.78 6.45	1.85	1.85	1.85
Nov. 6, 1956	60	6⅛	20,000–250,000	1.71	[1] 1.79 3.06	[1] 1.90 9.95	1.85	1.85	1.85
Nov. 14, 1956	60 [2]	1½	51,000	1.90	[1] 1.90 2.46	[1] 1.90 3.01	1.85	1.85	1.85

[1] Calculated by omitting most obvious nonprimary market producers.
[2] Delivery period assumed to be 60 days.

06-11-11 WPI Spec. 1949–56: Aluminum sulfate, commercial, bulk, carlots; f.o.b. works, freight equalized.

TABLE B-2(a).—*Calcium Carbide, Quarter, 100-Pound Drums, Delivered Various Destinations East of the Rocky Mountains*

Contract date	Delivery date	Destination area [1]	Company	Quantity (pounds)	Actual transaction price (dollars per ton, no time discount) [2]	BLS price as of contract date
April 1951	September 1951	Brooklyn, N.Y.	National Carbide	120,000	$116.60	$128.00
Do	do	do	Linde Air Products	240,000	[3] 106.00	128.00
June 1951	June 1951	Portsmouth, N.H.	Air Reduction	3,500	144.20	128.00
August 1951	September 1951	Brooklyn, N.Y.	National Carbide	200,000	117.60	128.00
October 1951	December 1951	do	do	240,000	[3] 97.00	128.00
Do	October 1951	do	Shawinigan	20,000	125.93	128.00
February 1952	August 1952	do	do	400,000	97.00	128.00
Do	do	do	Pacific Carbide	1,000,000	110.00	128.00
June 1952	do	do	Linde Air Products	595,000	117.20	134.40
Do	do	do	Shawinigan	295,000	114.80	134.40
Do	July 1952	do	National Carbide	300,000	115.20	134.40
October 1952	March 1953	do	do	190,000	117.60	134.40
Do	do	do	Linde Air Products	350,000	116.00	134.40
January 1953	April 1953	do	National Carbide	120,000	120.80	134.40
September 1953	September 1953	Charleston, S.C.	Shawinigan	80,000	97.00	134.40
October 1953	October 1953	do	National Carbide	15,000	122.00	134.40
Do	November 1953	do	Shawinigan	330,000	97.00	134.40
March 1954	March 1954	Great Lakes, Ill	National Carbide	12,500	116.20	134.40
May 1954	June 1954	Brooklyn, N.Y.	do	100,000	137.40	134.40
June 1954	do	Norfolk, Va	do	27,200	106.88	134.40

[1] Destination of shipment is approximately within 50 miles of listed city.
[2] Price often includes cost of drums.
[3] F.o.b. plant prices.

TABLE B-2(b).—*Calcium Carbide, Quarter, 100-Pound Drums, Delivered Various Destinations on West Coast*

Contract date	Delivery date	Destination area [1]	Company	Quantity (pounds)	Actual transaction price (dollars per ton, no time discount) [2]	BLS price as of contract date
April 1951	April 1951	Los Angeles, Calif	Linde Air Products	100,000	$127.30	$128.00
August 1951	September 1951	do	Stuart Oxygen	150,000	121.00	128.00
October 1951	November 1951	Puget Sound, Wash	Linde Air	140,000	[3] 106.00	128.00
Do	do	Oakland, Calif	National Carbide	134,800	141.12	128.00
November 1951	December 1951	Puget Sound, Wash	Linde Air	300,000	[3] 106.00	128.00
February 1952	February 1952	Los Angeles, Calif	Pacific Carbide	200,000	125.28	128.00
January 1953	February 1953	Oakland, Calif	Shawinigan Products	170,000	97.00	134.40
September 1953	September 1953	do	Pacific Carbide	153,000	129.60	134.40
Do	do	do	Shawinigan Products	100,000	122.00	134.40
June 1954	July 1954	do	National Carbide	96,700	143.40	134.40
September 1954	October 1954	do	Pacific Carbide	117,500	143.40	134.40

[1] Destination of shipment is approximately within 50 miles of listed city.
[2] Price often includes cost of drums.
[3] F.o.b. plant prices.

06–11–23 WPI Spec. 1949–56: Calcium carbide, standard generator size, carlots, delivered.

TABLE B-3.—*Calcium Hypochlorite, Technical, Type I, 100-Pound Drums, Delivered East of the Rockies*

Contract date	Delivery date	Company	Quantity (pounds)	Actual transaction price (dollars per 100 pounds, including drum cost)	BLS prices as of contract and delivery date	
					Contract	Delivery
February 1949	June 1949	Pennsylvania Salt Manufacturing.	73,300	$20.25	$24.00	$24.00
June 1949	November 1949	Cole Labs	20,000	20.29	24.00	24.00
Do	February 1950	Pennsylvania Salt Manufacturing.	40,000	20.69	24.00	24.00
August 1949	September 1949	Pittsburgh Plate Glass	30,000	20.55	24.00	24.00
November 1949	February 1950	Pennsylvania Salt Manfacturing.	240,000	[1] 18.50	24.00	24.00
April 1951	June 1951	Mathieson Chemical Corp.	50,000	21.75	25.25	25.25
July 1951	October 1951	do	20,000	21.75	25.25	25.25
October 1951	December 1951	Columbia Southern	50,000	21.75	25.25	25.25
April 1952	May 1952	Pennsylvania Salt Manufacturing.	50,000	[1] 19.10	25.25	25.25
May 1952	June 1952	Columbia Southern	25,000	21.75	25.25	25.25
June 1953	August 1953	Pennsylvania Salt Manufacturing.	40,000	[1] 18.08	25.25	25.25
September 1953	November 1953	Columbia Southern	60,000	21.72	28.65	28.65
January 1954	January 1954	Pennsylvania Salt Manufacturing.	45,000	24.30	28.65	28.65
July 1954	August 1954	Braun-Kneeth-Heiman	60,000	[2] 24.75	28.65	28.65
February 1955	May 1955	Pennsylvania Salt Manufacturing.	26,000	21.40	28.65	28.65
March 1956	May 1956	do	7,900	21.40	28.65	28.65

[1] F.o.b. plant.
[2] Delivered west of Rockies—San Francisco—and not including cost of drums.

06-11-27 WPI Spec. 1949-56: Calcium hypochlorite, 100-pound drums, delivered east of Rockies.

TABLE B-4.—*Sulfuric Acid, Technical, Specific Gravity 1.8287, 30-50-Ton Tank Cars, Delivered Various Destinations*

Contract date	Delivery date	Destination area	Company	Quantity (pounds)	Actual transaction price (dollars per ton, no time discount)	BLS price as of contract date
November 1946	November 1946	Brooklyn, N.Y.	General Chemical	100,000	[1] $13.00	$16.50
November 1948	December 1948	do	Allied Chemical	100,000	17.12	17.00
February 1949	June 1949	Portsmouth, N.H.	General Chemical	100,000	23.50	17.00
August 1949	October 1949	Brooklyn, N.Y.	do	100,000	22.00	17.00
January 1950	January 1950	Portsmouth, N.H.	Monsanto Chemical.	115,000	22.50	17.00
March 1950	April 1950	do	do	115,000	22.50	17.00
June 1951	June 1951	do	do	115,000	25.70	20.00
June 1947	10 days	Oakland, Calif.	General Chemical	120,000	[1] 15.40	16.50
November 1948	December 1948	do	Stauffer Chemical	160,000	22.35	17.00
May 1949	June 1949	do	do	100,000	18.60	17.00
June 1950	July 1950	do	do	100,000	18.72	17.75
April 1951	April 1951	do	Allied Chemical	104,000	21.24	20.00
July 1951		do	Stauffer Chemical	212,000	21.24	20.00
July 1953	July 1953	do	do	100,000	26.00	22.35
February 1954	February 1954	do	do	100,000	26.60	22.35

[1] F.o.b. plant price.

06-11-09 WPI Spec 1947-56: Sulfuric acid, 66° Be, tanks, f.o.b. works.

TABLE B-5

A. ACETONE, DELIVERED OAK RIDGE, TENN.

Contract date	Terms	Company	Location	Quantity	Sellers' offered price (dollars per gallon)	BLS price at contract date
Aug. 12, 1958	Net 30 days	Allied Chemical Corp.	New York City	Tank-car lots.	$0.477	----------
Do	do	Chemical Compounding Corp.	Perth Amboy, N.J.	do	.559	----------
Do	do	C. P. Chemical Solvents.	New York City	do	.561	----------
Do	do	Eastman Chemical Products.	Kingsport, Tenn.	do	.495	----------
Do	Net 10 days	Enjoy Co.	New York City	do	.56	----------
Do	Net 30 days	Octogon Process	Staten Island, N.Y.	do	.559	----------
Do	5 percent, 10 days.	Phipps Products Corp.	Boston, Mass.	do	.50369	----------
Do	Net 30 days	Shell Chemical Corp.	New York City	do	.561	----------
Do	do	Union Carbide Chemical Co.	do	do	.478	[1] $0.56015
					$\bar{X}$=.528	----------

[1] Translated from dollars per pound to dollars per gallon at 6.59 pounds per gallon.

06-12-01 WPI Spec 1958: Acetone, Chem. pure, tankcars, producer to first buyer, delivered. Friday price.

B. HYDROCHLORIC ACID, DELIVERED OAK RIDGE, TENN.

Contract date	Terms	Company	Location	Quantity	Sellers' offered price (dollars per ton)	BLS price at contract date
July 31, 1958	Net 30 days	Columbia Southern Chemical.	Charlotte, N.C.	Tank-car lots.	$30.10	----------
Do	do	Dow Chemical Co.	Midland, Mich.	do	26.34	----------
Do	do	E. I. du Pont de Nemours.	Wilmington, Del.	do	26.53	----------
Do	do	Monsanto Chemical	St. Louis, Mo.	do	26.49	----------
Do	do	Tennessee Products & Chemical Corp.	Nashville, Tenn.	do	18.00	$30.00
					$\bar{X}$=25.49	----------

Data from Vernon A. Mund, "Identical Bid Prices," *Journal of Political Economy*, April 1960, p. 156.

06-11-03 WPI Spec. 1958: HCL, 20° Be, Carboys, tankcars, producer to first buyer, f.o.b. works, freight equalized, Friday price.

TABLE B-6.—*Xylene, Grade A and B, Technical, Tankcar Lots, F.O.B. Various Points*

Bid opening date	F.o.b. point	Company	Actual transaction		BLS prices	
			Quantity (gal.)	Price (dollars per gal., no time discount)	Opening	3 months later
Dec. 27, 1954	Plant, Sewell Point	Esso Standard Oil	40,000	$0.335	$0.340	$0.340
June 25, 1956	Portsmouth, Va.	Shell Oil	13,140	.323	.340	.340
Aug. 1, 1956	Norfolk, Va.	do	10,000	.3365	.340	.340
Aug. 4, 1956	do	Esso Standard Oil	60,000	.335	.340	.340
Nov. 19, 1956	Mare Island, Calif.	Amco Chemical Corp.	23,512	.3379	.340	.340
Nov. 23, 1956	Portsmouth, Va.	Shell Oil	19,132	.3365	.340	.340
Feb. 15, 1957	do	Esso Standard Oil	24,820	.335	.340	.340

06-12-95 WPI Spec. 1947-60: Xylene (Xylol) petroleum, industrial, tankcars, producer to first buyer, f.o.b. works, Bayonne,[a] N.J.; Friday price.

[a] *Oil & Gas Journal*, Annual Refinery Issue, lists only Esso Standard Oil at Bayonne, N.J.

TABLE B-7.—*Acetylene, Gas, 225-Cubic-Foot Cylinder, Delivered Various Destinations*

Contract date	Contract period	Number of contracts	Quantity (ft.³)		High	Actual transaction price (dollars per 100 ft.³)			BLS index for contract period		
			Low	X̄		Low	X̄	High	Low	X̄	High
November 1959	November 1959 to November 1960	13	165,000	2,223,500	9,259,800	$1.87	$2.32	$2.86	124.8	124.8	124.8
April 1959	May 1959	2	2,763,000	3,006,500	3,250,000	2.04	2.11	2.178	124.8	124.8	124.8
November 1958	November 1958 to November 1959	15	100,000	1,599,730	8,000,000	1.66	2.58	5.975	124.8	124.8	124.8
November 1957	November 1957 to November 1958	14	129,150	2,022,230	8,000,000	1.71	2.18	2.62	124.8	124.8	124.8
November 1956	November 1956 to November 1957	8	100,125	1,075,200	4,410,200	1.98 [1] 1.89	2.33 [1] 2.12	3.00 [1] 2.42	118.7	120.22	124.8
December 1955	December 1955 to November 1956	13	125,325	2,248,100	8,256,000	[1] 1.50	[1] 2.02	[1] 2.45	113.0	116.8	118.7
November 1954	November 1954 to November 1955	15	120,150	2,138,800	8,346,800	[1] 1.54	[1] 1.93	[1] 2.25	113.0	113.0	113.0
November 1953	November 1953 to November 1954	17	14,625	2,125,620	12,872,700	[1] 1.59	[1] 2.08	[1] 2.69	113.0	113.0	113.0

[1] F.o.b. plant price.

06-12-03 WPI Spec. 1947-56: Acetylene, dissolved, in cylinders, f.o.b. plant or delivered in specified amounts; 1957-60: F.o.b. plant.

TABLE B-8.—*Carbon Dioxide, Gas, Grade B, Type II, Class I, 50-Pound Cylinders Delivered Various Destinations*

Contract date	Contract period	Quantity (lbs.)			Number of contracts	Actual transaction price (dollars per lb., no time discount)			BLS prices for contract period		
		Low	X̄	High		Low	X̄	High	Low	X̄	High
November 1959	November 1959 to November 1960	100,000	195,590	402,750	6	$0.028	$0.0453	$0.069			
November 1958	November 1958 to November 1959	74,600	275,950	460,000	7	.030	.0463	.069			
November 1957	November 1957 to November 1958	71,250	335,860	682,000	5	.032	.0438	.06	[1] $0.080	[1] $0.080	[1] $0.080
November 1956	November 1956 to November 1957	111,600	403,866	693,000	3	.0425 [2] .0387	.0489 [2] .0397	.054 [2] .0425	.080	.080	.080
February 1956	February 1956	388,250	388,250	388,250	1	.036 [2] .036	.036 [2] .036	.036 [2] .036	.080	.080	.080
November 1955	November 1955 to November 1956	53,000	257,500	530,000	4	.0383 [2] .049	.045 [2] .049	.0526 [2] .049	.080	.080	.080
November 1954	November 1954 to November 1955	60,000		523,000	2	[2] .045	[2] .0455	[2] .04594	.080	.080	.080

[1] Only applicable up to August 1958; different commodity thereafter.
[2] F.o.b. plant price.

06-11-33 WPI Spec. 1953-58: Carbon dioxide, industrial, cylinder, producer to first buyer, f.o.b. works; Friday price.

TABLE B-9A.—*Oxygen, General Use, 200-Foot³ Cylinder, Delivered Various Destinations*

Contract date	Contract period	Number of contracts	Quantity (ft.³)			Actual transaction price (dollars per 100 ft.³ no time discount)			BLS price index for contract period		
			Low	$\overline{X}$	High	Low	$\overline{X}$	High	Low	$\overline{X}$	High
November 1959	November 1959 to November 1960	11	335,620	1,444,300	3,320,000	$0.48	$0.597	$0.854	114.3	114.3	114.3
November 1958	November 1958 to November 1959	13	340,000	1,719,400	9,030,400	.52	.651	1.175	114.3	114.3	114.3
November 1957	November 1957 to November 1958	12	347,400	1,386,600	5,237,100	.49	.697	1.075	114.3	114.3	114.3
November 1956	November 1956 to November 1957	6	361,600	1,022,430	2,150,000	.60	.657	.73	110.6	111.216	114.3
						[1].52	[1].578	[1].61			
January 1956	January 1956 to November 1956	14	350,000	1,353,060	3,440,800	.50	.689	.99	105.3	109.28	110.6
						[1].42	[1].526	[1].67			
November 1954	November 1954 to November 1955	11	400,000	1,825,230	3,441,600	[1].436	[1].558	[1].67	105.3	105.3	105.3

[1] F.o.b. plant price.

06-11-49 WPI Spec. 1956-60: Oxygen, liquefaction, 99½ percent pure, manufacturer to reseller, f.o.b. plant.

TABLE B-9B.—*Oxygen, Users' Cylinders, 200–224 Ft.*[3] *per Cylinder, F.O.B. Plant*

Contract period	Number of bidders	Quantity (cylinders)	Sellers offered prices (dollars per 100 ft.[3] no time discounts)			BLS price index during contract period		
			Low	$\overline{X}$	High	Low	$\overline{X}$	High
July 1954, to July 1955	4	3,000	$0.60	$0.65	$0.73	106.3	105.3	105.3
July 1958, to July 1959	2	4,200	.55	.73	[1] .91/2.40	114.3	114.3	114.3
July 1959, to July 1960	5	4,500	.41	.676	[1] 1.07/2.40	114.3	114.3	114.3
July 1960, to July 1961	5	4,250	.41	.686	[1] 1.07/2.40	114.3	--------	--------

[1] Believed to be nonprimary market price quotes, hence not used in calculation of the mean ($\overline{X}$).

06-11-49 WPI Spec. 1953–60: Oxygen, liquefaction, 99½ percent pure, manufacturer to seller, f.o.b. plant.

TABLE B-10.—*Soap, Laundry, White, 1-Pound Bar Delivered Various Destinations*

Contract date	Delivery date	Company	Quantity [1] (pounds)	Actual transaction price (dollars per pound, no time discount)	BLS prices for contract and delivery date	
					Contract	Delivery
July 1950	November 1954	Procter & Gamble	130,000	$0.0606	$0.162	$0.162
November 1954	January 1955	Colgate Palmolive	44,600	.0605	.162	.163
May 1955	July 1955	Oakland Supply	57,000	.0533	.164	.164
July 1955	September 1955	Colgate Palmolive	23,340	.0512	.164	.164
April 1956	July 1956	Newport Soap	100,000	.0562	.170	.174
October 1956	December 1956	do	124,740	.0518	.174	.174
December 1956	January 1957	Procter & Gamble	7,320	.0722	.174	.174
January 1957	March 1957	West Coast Soap	52,800	.0601	.174	.177
April 1957	July 1957	National Milling & Chemical	16,380	.071	.177	.177
June 1957	August 1957	Concord Chemical	31,920	.070	.177	.177
October 1957	December 1957	Newport Products	122,280	.058	.182	.182
Do	January 1958	Valley Products	34,080	.062	.182	.182
November 1957	do	Murro Chemical	10,020	.071	.182	.182
April 1958	July 1958	Pioneer Soap	28,020	.0868	.182	.182
May 1958	August 1958	Kamen Soap	83,820	.067	.182	.182
June 1958	September 1958	Murro Chemical	36,300	.064	.182	.182
October 1958	January 1959	Pioneer Soap	32,160	.0783	.182	.190
November 1958	February 1959	Murro Chemical	46,200	.0745	.182	.190
February 1959	April 1959	Pioneer Soap	19,500	.067	.190	.190
June 1959	June 1959	Murro Chemical	28,500	.056	.190	.190
September 1959	December 1959	Colgate Palmolive	238,470	.0410	.169	.169
December 1959	March 1960	Murro Soap	84,720	.063	.169	.164

[1] Standard carlot is 40,000 pounds.

06-71-21 WPI Spec. 1947-60: Soap, laundry, bars, white, household use, manufacturer to jobber, or other carlot, buyer carlots, delivered.

TABLE B-11.—*Soap, Laundry, Powdered, 100-Pound Drums, Delivered Various Destinations*

Contract date	Delivery date	Company	Quantity (pounds)	Actual transaction price (dollars per pound)	BLS price at contract date
March 1949	July 1949	Gillam Soap	20,000	$0.099	$0.127
Do	do	U.S. Soap	280,000	.09147	.127
May 1949	do	Kamen Soap	100,000	.0737	.105
August 1949	September 1949	do	50,000	.0689	.116
Do	do	do	100,000	.0824	.116
November 1949	March 1950	do	500,000	.0712	.119
August 1950	August 1950	Pioneer	10,200	.145	.136
Do	September 1950	Patek	1,000	.1325	.136
September 1950	do	do	2,400	.1425	.159
January 1951	March 1951	Gillam Soap	50,000	.1577	.197
February 1951	do	Los Angeles Soap	3,000	.210	.207
Do	do	Pacific Soap	10,000	.185	.207
April 1951	May 1951	Fitzpatrick	50,000	.1609	.187
Do	June 1951	Beach Soap	50,000	.1692	.187
July 1951	August 1951	Procter & Gamble	3,000	.0924	.150
July 1952	August 1952	Newport Soap	25,000	[1].0775	.121
Do	do	Iowa Soap	40,000	[1].066	.121
February 1953	June 1953	Lever Bros	200,000	[1].060	.091
June 1953		Kamen	108,000	[1].066	.083
Do	October 1953	Swift	36,000	[1].0662	.083
Do	September 1953	Newport	72,000	[1].0702	.083
August 1953	August 1953	Colgate-Palmolive	3,040	.073	.083
October 1954	December 1954	Iowa Soap	20,000	.097	.109
Do	do	Pioneer	315,500	.1042	.109
Do	do	Murro	264,500	.0938	.109
February 1955	April 1955	J. T. Stayley	75,000	.0988	.132
Do	do	Gillam	50,000	.1138	.132
Do	do	Newport	85,000	.1104	.132
November 1955	January 1956	West Coast Soap	63,000	.1062	.129
Do	December 1955	Murro Chem	226,000	.1034	.129
December 1955	February 1956	Pacific Chem	5,000	.121	.129

[1] Price includes cost of drums.

06-71-41 WPI Spec. 1947-56: Soap, powdered or granulated, for laundry use, bulk, delivered in specified area.

TABLE B-12.—*Paint, Interior, Flat, First Grade, White, in One Gallon Cans, Delivered Various Destinations*

Contract date	Delivery date	Company	Quantity (gallons)	Actual transaction price (dollars per gallon)	BLS price at contract date
March 1951	March 1951	Old Colony Paint	100	$1.89	$2.74
December 1951	December 1951	Bradley Paint	1,000	1.50	2.762
February 1952	March 1952	Central Paint & Varnish	3,700	1.47	2.771
August 1952	September 1952	Carolina Paint	500	1.48	2.782
Do	do	Central Paint & Varnish	600	1.58	2.782
December 1952	June 1952	Jaegle Paint & Varnish	2,000	1.47	2.782
March 1953	May 1953	William A. Smith	1,100	1.46	2.782
June 1954	July 1954	Ampruf Paint	2,100	1.499	2.868
Do	do	Pur-all Products	600	1.58	2.868
May 1955	August 1955	William A. Smith	1,800	1.33	2.945
Do	July 1955	Ampruf Paint	4,300	1.468	2.945
February 1956	April 1956	Hub Paint & Varnish	1,300	1.42	3.116
May 1956	July 1956	Olympic Paint	800	1.58	3.116
August 1956	October 1956	S. K. Labs	2,600	1.49	3.116
November 1956	December 1956	Ampruf	4,000	1.45	3.242
April 1957	September 1957	William A. Smith	3,068	1.53	3.264
Do	do	Ampruf	500	1.49	3.264
May 1957	do	do	5,500	1.39	3.280
July 1957	January 1958	Atlas Paint	6,000	1.40	3.383
Do	February 1958	Hub Paint	3,700	1.46	3.383
Do	January 1958	Ampruf	900	1.39	3.383
October 1957	February 1958	do	4,000	1.35	3.383
Do	do	William A. Smith	400	1.85	3.383
April 1958	September 1958	Hub Paint	1,900	1.48	3.383
Do	August 1958	Ampruf Paint	2,828	1.59	3.383
October 1958	March 1959	Allied Paint	430	1.56	3.396
February 1959	June 1959	Ampruf	700	1.69	3.405
Do	do	Hub Paint	3,868	1.44	3.405

06-21-31 WPI Spec. 1947-60: Paint, inside, white, flat, 1st grade, gallon cans; f.o.b. destination delivered specified area, or freight allowed or prepaid on specified amounts.

TABLE B-13.—*Enamel, Class A (First Grade), Exterior and Interior White, in (1) Gallon Cans, Four to the Case, Delivered Various Destinations*

Bid opening date	Delivery date	Destination	Number of bidders	Quantity (gallons)	Sellers' offered price (dollars per gallon, no time discounts taken)			BLS price from opening to delivery		
					Low	$\bar{X}$	High	Opening	$\bar{X}$	Delivery
Dec. 19, 1956	60 days	Read Valley, N.J.	11	37,532	$1.94	[1] $2.31 2.74	[1] $3.17 7.05	[2] $4.986 4.980	$4.986	$4.986
Jan. 7, 1957	120 days	Read Valley, N.J.	6	3,696	1.94	2.07	[3] 2.23 2.30	4.986 [2] 4.980	4.983	4.980
Mar. 19, 1957	Within 150 days	Massachusetts, Rhode Island, Virginia, South Carolina, Illinois.	8	9,092	2.15	2.36	2.90	4.980	5.023	5.128
June 17, 1957	Within 150 days	Virginia, South Carolina, Texas.	6	4,800	1.79	2.22	3.00	5.029	5.108	5.128

[1] $\bar{X}$ and high disregarding the $7.05 quote which is believed to be a nonprimary market quote.
[2] Series has been spliced; no change in index.
[3] F.o.b. price quote.

06-21-21 WPI Spec. 1954-57: Enamel, white or colors, first grade, gallon cans, manufacturer to retailer. F.o.b. factory, freight allowed on specified amounts. 1958: In case lots of 4 gallons to the case.

TABLE B-14.—*Gasoline, Minimum 86 Octane, Research Method, Gulf Coast, F.O.B. Refinery*

Bid opening date	Number of bidders	Quantity (gallons)	Sellers' offered price (dollars per gallon; no time discount)			BLS price for gulf coast 87 octane gasoline	BLS price adjusted to approximate gulf coast 86 octane gasoline (−$0.002)
			Low	X̄	High	Opening month	Opening month
Apr. 20, 1954	9	113,400,000	$0.0974	$0.1027	$0.1150	$0.103	$0.101
June 16, 1954	8	1,890,000	.0950	.0993	.1024	.103	.101
Nov. 6, 1954	10	6,510,000 [1] 21,000,000	.09333	.0997	.1033	.105	.103
May 4, 1955	10	18,060,000	.0948	.1009	.1075	.105	.103
Aug. 3, 1955	6	[1] 4,872,000	.0992	.1038	.1100	.105	.103
Oct. 25, 1955	3	10,080,000	.0844	.0855	.0875	.105	.103
Apr. 25, 1956	3	2,100,000 [1] 10,080,000	.099	.1047	.11	.105	.103
Oct. 9, 1956	10	3,360,000 [1] 840,000	.0985	.1013	.10495	.105	.103
Oct. 30, 1956	9	1,480,000 [1] 10,080,000	.09585	.0983	.10495	.105	.103
Dec. 12, 1957	1	630,000	.09615	.09615	.09615	.104	.102
Apr. 30, 1958	8	38,430,000 [1] 10,080,000	.0949	.1000	.10625	.096	.094

[1] Special cold weather gasoline, same octane.

05-51-02 WPI Spec. 1954-60: Gasoline, gulf coast, regular grade, 87 octane research, minimum of 20,000 barrels (840,000 gallons), refiner to other refiner, export agent, or tanker terminal operator, cargo lots, f.o.b. ship at gulf, Monday price.

TABLE B-15.—*Pennsylvania Anthracite, Buckwheat No. 1, F.O.B. Car at Mine*

Bid opening date	Period of contract	Months of price offer	Number of bidders	Quantity (net tons)	Sellers' offered price (dollars per net ton, all discounts taken)			BLS prices during contract period		
					Low	$\bar{X}$	High	Low	$\bar{X}$	High
Apr. 16, 1951	July 1951 to June 1952	July	9	8,000	$7.70	$7.83	$7.90	----	$7.942	----
Do	do	August to June	9	8,000	7.73	7.84	8.00	$7.963	7.963	$7.963
Apr. 14, 1952	July 1952 to June 1953	July to September	11	8,400	7.49	7.77	7.90	7.963	8.134	8.419
Do	do	October to June	11	8,400	7.49	7.80	8.00	8.825	9.705	10.119
Aug. 8, 1952	August to September 1952	August to September	1	4,000	7.90	7.90	7.90	8.019	8.219	8.419
Apr. 23, 1953	July 1953 to June 1954	July to September	10	9,000	8.41	9.63	10.15	10.169	10.215	10.263
Do	do	October to June	10	9,000	8.41	9.65	10.40	9.30	9.965	10.205
May 18, 1954	July 1954 to June 1955	July to June	11	9,000	6.84	7.70	8.90	8.864	9.431	9.664
May 10, 1955	July 1955 to June 1956	do	12	10,500	5.05	5.75	7.00	8.589	8.687	9.533
May 15, 1956	July 1956 to June 1957	do	6	10,000	5.95	7.44	8.57	8.799	9.75	10.696
May 10, 1957	July 1957 to June 1958	August to September	5	8,000	9.65	10.06	10.29	10.031	10.196	10.360
Do	do	October	5	8,000	9.90	10.29	----	10.808	----	----
Do	do	November to June	5	8,000	9.90	10.43	10.73	10.003	10.696	11.179
June 20, 1958	July 1958 to June 1959	August to September	8	6,500	8.47	8.92	9.55	10.22	10.273	10.325
Do	do	October to March	8	6,500	8.47	9.11	9.63	10.703	10.938	11.354
Do	do	April	8	6,500	8.47	9.05	9.63	----	10.241	----
Apr. 16, 1959	July 1959 to June 1960	August to June	11	6,000	7.84	8.63	9.65	10.185	10.589	10.801

05-11-03 WPI Spec. 1951-60: Pennsylvania anthracite, buckwheat No. 1, f.o.b. car at mine.

TABLE B-16.—*Pennsylvania Anthracite, Chestnut, F.O.B. Car at Mine*

Bid opening date	Period of contract	Months of price offer	Number of bidders	Quantity (net tons)	Sellers' offered price (dollars per net ton, all discounts taken)			BLS price during contract period		
					Low	$\bar{X}$	High	Low	$\bar{X}$	High
Apr. 16, 1951	July 1951 to June 1952	July	11	7,000	$12.60	$13.31	$14.15		$14.156	
Do	do	August	11	7,000	12.95	13.35	14.25		14.319	
Do	do	September	11	7,000	12.95	13.49	14.45		14.513	
Do	do	October to June	11	7,000	12.95	13.55	14.45	$13.394	14.173	$14.513
Apr. 14, 1952	July 1952 to June 1953	July to Aug. 18	16	7,200	11.32	12.43	13.85	13.869	13.99	14.119
Do		Aug. 18 to September	16	7,200	11.32	12.45	14.15	14.119	14.169	14.219
Do	do	October to June	16	7,200	11.32	12.59	14.45	14.619	15.288	16.013
Aug. 8, 1952	August 1952 to September 1952.	August to September	11	4,000	10.63	11.40	13.05	14.119	14.169	14.219
Apr. 23, 1953	July 1953 to June 1954	July to September	15	8,400	11.34	12.73	14.80	15.319	15.542	15.756
Do	do	October to December	15	8,400	11.34	12.76	14.80	15.508	15.525	15.533
Do	do	January to March	15	8,400	11.34	12.80	14.80	15.533	15.533	15.533
Do	do	April to June	15	8,400	11.34	12.73	14.80	12.850	13.273	13.588
May 18, 1954	July 1954 to June 1955	July to June	11	300	9.20	10.64	14.34	11.829	13.349	13.836
May 10, 1955	July 1955 to June 1956	do	12	3,500	9.12	10.33	12.49	12.257	13.160	14.124
May 15, 1956	July 1956 to June 1957	do	7	1,500	10.73	11.57	12.74	12.88	14.198	15.575
June 20, 1958	July 1958 to June 1959	August to September	13	3,000	9.70	10.80	12.49	13.685	13.818	13.951
Do	do	October to March	13	3,000	9.70	11.00	12.49	14.343	14.552	14.966
Do	do	April	13	3,000	9.70	10.88	12.49		13.391	
Apr. 16, 1959	July 1959 to June 1960	July to June	13	2,000	8.82	10.25	12.34	13.188	14.131	14.651

05-11-01 WPI Spec. 1951-60: Pennsylvania anthracite, chestnut, f.o.b. car at mine.

TABLE B-17.—*Pennsylvania Anthracite, Pea, F.O.B. Car at Mine*

Bid opening date	Period of contract	Months of price offer	Number of bidders	Quantity (net tons)	Sellers' offered price (dollars per net ton, all discounts taken)			BLS price during contract period		
					Low	$\overline{X}$	High	Low	$\overline{X}$	High
Apr. 23, 1953	July 1953 to June 1954	July to June	12	400	$9.50	$10.02	$10.69	$9.90	$11.514	$12.169
May 18, 1954	July 1954 to June 1955	do	9	150	8.24	8.85	10.66	9.87	10.44	10.757
May 10, 1955	July 1955 to June 1956	July to December	10	50	6.95	7.75	8.47	10.086	10.287	10.523

05-11-02 WPI Spec. 1953-60: Pennsylvania anthracite, pea, f.o.b. car at mine.

TABLE B-18.—*Bituminous Coal, Egg 5 to 7 Inches x 2 to 3 Inches, F.O.B. Car at Mine*

Bid opening date	Period of contract	Number of bidders	Quantity (net ton)	Sellers' offered price (dollars per net ton, no time discount)			BLS price during contract period		
				Low	$\overline{X}$	High	Low	$\overline{X}$	High
Apr. 9, 1951	July 1951 to June 1952	11	3,600	$5.30	$5.61	$6.00			
Mar. 27, 1952	July 1952 to June 1953	7	1,000	4.75	5.30	5.75			
Nov. 13, 1952	November 1952 to June 1953	13	3,200	5.23	5.57	6.00			
Mar. 31, 1953	July 1953 to June 1954	7	4,000	4.65	5.09	5.50	[1] $6.398	[1] $6.419	[1] $6.440
Apr. 30, 1954	July 1954 to June 1955	12	3,600	4.09	4.82	6.15	6.37	6.752	6.961
Mar. 29, 1955	July 1955 to June 1956	5	3,600	4.60	4.87	5.50	6.588	6.954	7.233
Apr. 4, 1956	July 1956 to June 1957	6	3,600	6.00	6.17	6.50	6.795	7.320	7.641
Apr. 16, 1957	July 1957 to June 1958	4	3,600	4.65	5.95	6.50	[2] 7.095	[2] 7.519	[2] 7.72
Nov. 17, 1958	November 1958 to June 1959	7	1,500	4.65	5.16	6.85	7.313	7.699	8.013
Mar. 27, 1959	July 1959 to June 1960	9	2,500	4.70	5.13	6.00	7.300	7.730	7.953

[1] First introduced in April 1954.
[2] Only for period of July 1957 to May 1958.

05-12-04 WPI Spec. 1954-60: Bituminous coal, large domestic sizes, producer to retail dealer, f.o.b. car at mine.

TABLE B-19.—*Coke Foundry, Byproduct, F.O.B. Foundry*

Bid opening date	Period of contract	Location	Number of bidders	Quantity (net ton)	Sellers' offered price (dollars per net ton, no time discount)			BLS price during contract period		
					Low	$\overline{X}$	High	Low	$\overline{X}$	High
June 8, 1954	July 1954 to June 1955	Ironton, Ohio	1	400		$21.24			(1)	
May 8, 1956	July 1956 to June 1957	do	1	400		24.74			(1)	
July 30, 1957	August 1957 to June 1958	do	1	400		25.74		$29.00	$29.00	$29.00
Oct. 3, 1958	October 1958 to June 1959	do	1	300		27.74		29.00	29.83	30.50
July 30, 1957	August 1957 to June 1958	Birmingham, Ala.	1	400		[2] 26.50		28.85	28.85	28.85
Oct. 3, 1958	October 1958 to June 1959	do	1	300		[2] 26.50		28.85	29.68	30.35
July 15, 1959	August 1959 to June 1960	do	1	500		[2] 28.00		30.35	30.35	30.35
July 30, 1957	August 1957 to June 1958	Swedeland, Pa.	1	400		29.50		29.50	29.50	29.50
July 15, 1959	August 1959 to June 1960	do	1	500		31.00		31.00	31.00	31.00

[1] Individual coke price series first given in 1957.
[2] Prices are actually Tarrant, Ala., 3 miles from Birmingham, Ala.

05-20 WPI Spec. 1957-1960: Coke, foundry, Byproduct, f.o.b. Swedeland, Pa. (Birmingham, Ironton), ovens, Wednesday price.

TABLE B-20.—*Aluminum Alloy Sheet, No. 3003 (35), H-14, 0.064 Inches x 36 Inches x 96 Inches, Delivered Various Destinations*

Contract date	Delivery date	Company	Quantity (pounds)	Actual transaction price, (dollars per pound, no time discount)	BLS price at contract price
January 1955	April 1955	Metimpex	30,000	$0.308	$0.367
September 1955	December 1955	Alcoa	3,000	.449	.393
December 1955	March 1956	Metimpex	5,000	.355	.393
May 1956	July 1956	T. I. Alum., Ltd	5,600	.38	.408
November 1956	February 1957	Atl. Steel and Iron	16,000	.359	.427
December 1956	March 1957	Alcoa	3,600	.427	.427
January 1957	January 1957	do	11,000	.427	.427
May 1957	October 1957	Metimpex	7,000	.3704	.427
May 1958	October 1958	do	5,200	.3436	.429
August 1958	January 1959	do	10,500	.3564	.443
November 1958	April 1959	do	32,000	.3175	.443
June 1959	December 1959	Atl. Alum. and Met.	15,000	.3296	.443

10-25-01 WPI Spec 1949-60: Aluminum sheet, 3003 (or 35), H-14 mill finish, hard alloy; 0.064 inches x 48 inches x 144 feet, 30,000-pound-base quantity, manufacturer to user, f.o.b. shipping point, freight allowed.

TABLE B-21.—*Aluminum Ingot, Primary, Grade 2, Commercial, F.O.B. Plant*

Bid opening date	Delivery date	Number of bidders	Quantity (pounds)	Sellers' offered price (per pound, no time discount)			BLS price at opening and delivery date	
				Low	$\overline{X}$	High	Opening	Delivery
Dec. 31, 1953	75 days	3	30,000	$0.1875	$0.1963	$0.2013	$0.215	$0.215
Jan. 28, 1955	30 days	1	22,401	.225	.225	.225	.227	.232
May 25, 1955	30 days	4	17,320	.2045	.2321	.2735	.232	.232
March 15, 1956	90 days	1	30,000	.2284	.2284	.2284	.244	.259
May 28, 1956	100 days	2	50,000	.2434	.2458	.2481	.259	.271

WPI Spec. 1947-60: Aluminum ingot, 30 pounds, 99 percent plus, base price, 10,000 pounds and over, f.o.b. shipping point, freight allowed.

TABLE B-22.—*Brass Bar, Free Turning, Commercial, Half Hard Round, ½-Inch dia. 0.723 Pound per Foot, Delivered Various Destinations*

Contract date	Delivery date	Company	Quantity (pounds)	Actual transaction price (dollars per lb., no time discount)	BLS price as of contract and delivery date	
					Contract	Delivery
February 1952	June 1952	American Brass Co.	1,000	$0.3258	(1)	(1)
April 1952	July 1952	Mueller Brass Co.	14,500	.328	(1)	(1)
June 1952	October 1952	do	6,200	.328	(1)	(1)
January 1953	April 1953	Revere Copper	2,500	.3330	(1)	(1)
March 1953	April 1953	Titan Metal Manufacturing.	2,000	.3345	(1)	(1)
January 1954	April 1954	do	1,800	.3442	$0.349	$0.349
March 1954	July 1954	do	2,000	.3375	.349	.349
August 1954	October 1954	do	7,000	.3265	.349	.351
November 1954	March 1955	do	2,000	.3275	.351	.358
January 1955	January 1955	Revere Copper	2,000	.336	.339	.339
August 1955	September 1955	Mueller Brass	5,000	.3705	.395	.427
April 1956	June 1956	Revere Copper	200	.4425	.464	.455
February 1957	July 1957	Scoville Manufacturing.	1,400	.3712	.388	.328
May 1957	June 1957	Chase Brass	2,280	.3464	.349	.348
June 1958	September 1958	Bridgeport Brass	4,000	.2833	.293	.290
August 1958	November 1958	Chase Brass	4,000	.2408	.290	.300
September 1959	March 1960	Mueller Brass	3,700	.3145	.330	.317

[1] Commodity first introduced in 1954.

10-25-13 WPI Spec. 1954-60: Yellow brass rod, free cutting, round, ⅜ inch to ⅝ inch, random lengths, 5,000 to 10,000 pounds, manufacturer to distributors warehouse; f.o.b. mill, freight allowed or prepaid.

TABLE B-23(a).—*Steel, Sheet, Medium, Black, 0.125 Inch (10 Gage) x 48 Inches x 120 Inches, 204 Pounds per Sheet, F.O.B. Mill*

Contract date	Delivery date	Company	Quantity (pounds)	Actual transaction price, (dollars per 100 pounds)			BLS price at contract date
				Unadjusted	Adjustment 1 [1]	Adjustment 2 [2]	
February 1949	August 1949	Armco	145,000	$4.20	$3.15		[3] $3.60
April 1949	October 1949	Bethlehem	140,000	4.30	3.25		[3] 3.60
December 1949	January 1950	Alan Wood	20,000	4.20	3.15		[3] 3.60
Do	February 1950	Bethlehem	180,000	4.10	3.05		[3] 3.60
November 1950	February 1951	Armco	20,400	4.75	3.70		[3] 3.70
December 1950	February 1950	Bethlehem	40,800	4.82	3.77		[3] 3.95
January 1951	March 1951	United States Steel	81,410	4.72	3.67		[3] 3.95
Do	January 1952	Bethlehem	112,200	5.02	3.97		[3] 3.95
Do	December 1951	United States Steel	56,100	4.825	3.775		[3] 3.95
April 1951	September 1951	do	530,000	4.70	3.65		[3] 3.95
March 1952	September 1952	do	180,000	4.72	3.67		[3] 3.95
May 1952	October 1952	do	230,000	4.90	3.85		[3] 3.95
November 1952	June 1953	Armco	—	4.88	3.83		[3] 4.125
December 1952	do	Bethlehem	25,000	5.03	3.98		[3] 4.125
September 1953	February 1954	United States Steel	60,000	5.75	4.70		4.765
Do	March 1954	Bethlehem	160,000	5.575	4.525		4.765
Do	February 1954	United States Steel	20,196	[4] 5.625	[4] 4.578	$3.848	4.765
July 1954	October 1954	Bethlehem	40,000	[4] 5.80	[4] 4.75	3.97	4.88
August 1954	do	Jones & Laughlin	20,000	[4] 5.00	[4] 3.95	3.17	4.88
August 1956	October 1956	Republic Steel	380,640	[4] 6.95	[4] 5.90	5.02	5.695
October 1956	March 1957	do	158,208	[4] 6.95	[4] 5.90	5.02	5.695
December 1956	June 1957	Jones & Laughlin	206,880	[4] 6.7	[4] 5.65	4.77	5.695
February 1958	April 1958	Bethlehem	114,400	[4] 7.32	[4] 6.27	5.39	6.192

[1] $1.05 adjustment for quality and marking costs as suggested by the Navy, based on sellers' price.
[2] Price excluding average transportation charge.
[3] Price quoted for 11 gage; however, 10 gage had the same list price.
[4] Price includes an average delivered transportation cost added by the Government.

10-14-46 WPI Spec. 1948-53: Sheet, hot rolled, carbon steel, 11 gage, 36 inches to 48 inches wide, 10 feet long, base quantity, f.o.b. producing points, Pittsburgh area.
1953-60: 10 gage x 48 inches x 120 inches, sheared edge, base chemistry, commercial quality, base quantity, mill to user, f.o.b. mill.

TABLE B-23(b).—*Steel Sheet, Hot Rolled, Grade M, 0.125 Inch (10 Gage) x 48 Inches x 120 Inches, F.O.B. Mill*

Bid opening date	Delivery date	Number of bidders	Quantity, pounds	Sellers' offered price (dollars per 100 pounds, all discounts taken)			BLS price, opening to delivery date		
				Low	$\bar{X}$	High	Opening	$\bar{X}$	Delivery
July 12, 1954	October 1954	3	40,000	$4.53	$4.66	[1] $4.73–$7.52	$4.88	$4.88	$4.88
Sept. 10, 1954	January 1955	3	300,324	4.19	4.70	[2] 5.25	4.87	4.878	4.88
Apr. 4, 1955	April 1955	3	14,288	4.14	4.68	[3] 5.40–[4] 5.89	4.87	4.87	4.87
Apr. 12, 1955	July 1955	3	40,000	4.30	4.53	[4] 4.93–5.40	4.87	4.939	5.145

[1] Doubtful whether Atlantic Steel & Trading is considered in the primary market.
[2] Kaiser bid on only 19,723 pounds of steel for west coast delivery.
[3] Kaiser bid.
[4] Doubtful whether A. M. Castle & Co. is considered in the primary market.

10-14-46 WPI Spec. 1953-60: Sheets, hot rolled, carbon steel, 10 gage x 48 inches wide x 120 inches long, sheared edge, cut length base chemistry, commercial quality, base packaging, base quantity, mill to user, f.o.b. mill.

TABLE B-24.—*Steel Plate, Black, Grade M, 0.250 Inch x 72 Inches x 240 Inches*

[F.o.b. mill]

Bid opening date	Delivery date	Number of bidders	Quantity (pounds)	Sellers' offered price (dollars per 100 pounds, discounts taken)			BLS price opening to delivery date		
				Low	$\overline{X}$	High	Opening	$\overline{X}$	Delivery
May 23, 1955	July 1955	[1] 3, 2	22,032	$4.35	$4.47 [1] 4.75	$4.60 [1] 5.30	$4.675	$4.765	$4.950
May 9, 1955	August 1955	2	36,720	4.35	4.46	4.56	4.675	4.813	4.950
June 22, 1955	July 1955	2	51,408	4.45	4.48	4.50	4.675	4.813	4.95
June 20, 1957	November 1957	2	70,922	5.32	5.43	5.54	5.90	6.108	6.15

[1] Includes Goodstein Iron & Steel quotation supplying Bethlehem Steel from Sparrows Point, Md.

10-14-26 WPI-Spec. 1953-59: Plates, carbon steel, 0.250 inch x 72 inches x 240 inches, ASTM specification A7, base quantity, mill to user, f.o.b. mill.

TABLE B-25.—*Plywood, Douglas Fir, Exterior Type, Grade A-C, ⅜ Inch x 48 Inches x 96 inches, 3 Ply, Untreated*

[F.o.b. mill]

Contract date	Delivery date	Company	Quantity (feet)	Actual transaction price			BLS price at contract date
				Dollars per board	Dollars per 1,000 feet [1]	Adjusted [2]	
January 1952	February 1952	North Robbins Plywood.	58,880	$3.60	$112.50		$114.41
August 1952	September 1952	Weyerhaeuser	47,328	3.62	113.13		120.094
November 1952	December 1952	do	26,752	3.30	103.13		109.637
January 1953	February 1953	do	22,400	3.66	114.38		116,252
November 1953	December 1953	Shaefers Woerner	35,200	3.42	106.88		108.443
Do	do	Weyerhaeuser	115,200	3.33	104.06		108.443
February 1954	March 1954	do	87,680	3.48	108.75		114.390
Do	do	Georgia-Pacific	27,136	3.57	111.56		114.390
May 1954	June 1954	Weyerhaeuser	13,120	3.26	101.88		109.063
December 1954	December 1954	North Robbins	16,000	[3] 3.82	[3] 119.38		114.390
January 1955	March 1955	Aetna Plywood	24,000	[3] 3.84	[3] 120.00	$108.69	114.390
August 1955	September 1955	Arcata Plywood	44,800	[3] 3.86	[3] 120.63	109.31	115.671
November 1955	December 1955	do	5,600	[3] 3.90	[3] 121.88	109.94	115.671
February 1956	April 1956	Northwest Door	26,688	[3] 4.13	[3] 129.06	111.19	123.217
May 1956	July 1956	do	64,000	[3] 3.58	[3] 111.88	116.91	112.179
August 1956	October 1956	do	19,200	[3] 3.19	[3] 99.69	99.73	101.721
Do	do	Weyerhaeuser	16,000	[3] 3.14	[3] 98.13	87.54	101.721
November 1956	January 1957	Harbor Plywood	49,600	[3] 2.948	[3] 92.13	85.98	92.215
Do	do	Georgia-Pacific	3,200	[3] 2.948	[3] 92.13	79.98	92.215
Do	do	Northwest Door	12,800	[3] 2.86	[3] 89.38	79.98	92.215
February 1957	April 1957	Roddiscraft	3,200	[3] 3.15	[3] 98.44	77.23	101.721
May 1957	July 1957	Northwest Door	7,680	[3] 3.08	[3] 96.25	86.29	101.721
Do	do	Columbia Plywood	9,600	[1] 3.14	[1] 98.13	84.10	101.721

[1] Delivered price.
[2] Price excluding the average delivered transportation cost in applicable cases.
[3] Price includes an average delivered transportation cost calculated by the Government.
08-31-02 WPI Spec. 1947-58: Plywood, Douglas-fir, exterior, A-C grade, ⅜ inch x 36 inches x 96 inches sheets, 3-ply carlots, f.o.b. mill.

TABLE B-26.—*Plywood, Douglas Fir, Grade A-D, Interior, Untreated, ¼ Inch x 48 Inches x 96 Inches, 3 Ply*

[F.o.b. mill]

Contract date	Delivery date	Company	Quantity (feet)	Actual transaction price: Dollars per board	Actual transaction price: Dollars per 1,000 feet [1]	Actual transaction price: Adjusted [2]	BLS price at contract date
December 1951	February 1952	Ply-Bilt	55,232	$2.08	$65.00		$71.30
May 1952	May 1952	Columbia Plywood	26,464	2.48	77.50		83.494
August 1952	September 1952	Dant & Russell	42,912	2.48	77.50		83.494
Do	do	Weyerhaeuser	18,784	2.53	79.06		83.494
November 1952	December 1952	Coquille Plywood	39,040	2.32	72.50		76.053
December 1952	January 1953	Weyerhaeuser	67,200	2.50	78.13		76.053
April 1953	June 1953	Davidson Plywood	18,400	2.82	88.13		85.560
Do	May 1953	Weyerhaeuser	31,840	[1] 2.81	[1] 87.81		85.560
May 1953	June 1953	California Builder	200,000	[1] 2.80	[1] 87.50		85.560
November 1953	December 1953	Weyerhaeuser	28,800	2.34	73.13		74.733
February 1954	March 1954	Dant & Russell	48,000	2.50	78.13		80.807
Do	do	Anacortes	25,600	2.50	78.13		80.807
May 1954	June 1954	Weyerhaeuser	52,800	2.32	72.50		74.733
Do	do	do	6,400	2.30	71.88		74.733
July 1954	August 1954	do	32,000	[3] 2.65	[3] 82.81	$75.31	79.863
November 1954	December 1954	North Robbins	32,000	[3] 2.69	[3] 84.06	76.56	80.807
Do	do	California Plywood	64,000	[3] 2.64	[3] 82.50	75.00	80.807
January 1955	March 1955	Arcata Plywood	32,000	[3] 2.69	[3] 84.06	76.56	80.807
April 1955	May 1955	California Plywood	80,000	[3] 2.70	[3] 84.38	76.88	80.807
June 1955	August 1955	Northwest Door	6,400	[3] 2.67	[3] 83.44	75.94	80.807
July 1955	do	Arcata	33,600	[3] 2.70	[3] 84.38	76.88	80.807
August 1955	September 1955	North Robbins	14,400	[3] 2.72	[3] 85.00	77.50	80.807
Do	do	Arcata	19,200	[3] 2.72	[3] 85.00	77.50	80.807

[1] Delivered price.
[2] Price excluding the average delivered transportation cost in applicable cases.
[3] Price includes an average delivered transportation cost added by the Government.
08-31-01 WPI Spec. 1951-58: Plywood, Douglas fir, interior, grade A-D, ¼- x 48- x 96-inch sheets, 3-ply, carlots or mixed carlots, f.o.b. mill.

TABLE B-27.—*Tape, Gummed Paper, 100 Percent Unbleached Sulfate, Kraft, Class 2, 3 Inches Wide, 600 Feet per Roll, 10 Rolls per Bundle, Delivered Various Destinations*

[Minimum tensile breaking strength, 45 pounds]

Contract date	Delivery date	Company	Quantity (rolls)	Actual transaction price (dollars per 10 rolls)	BLS price at contract date
September 1951	December 1951	Adhesive Prod	3,000	$6.90	$7.20
Do	do	Bulkley Dunton	5,000	6.79	7.20
January 1952	March 1952	Hudson Pulp	3,500	5.22	7.20
March 1952	July 1952	Gummed Prod	3,000	5.18	7.20
December 1952	May 1953	do	2,200	6.55	6.90
February 1953	July 1953	do	7,000	5.663	7.125
July 1953	August 1953	Mid-States Gummed.	800	7.20	6.90
September 1953	October 1953	Stocker Mfg	10,900	5.40	6.90
March 1954	May 1954	Gummed Prod	6,000	5.212	6.30
July 1955	September 1955	Crowell	3,600	5.844	6.60
November 1955	do	Adhesive Prod	1,090	6.90	6.60
Do	do	Arlington Sales	3,000	6.45	6.60
December 1955	do	Stocker Mfg	1,820	5.98	6.60
February 1956	April 1956	General Gummed	6,120	5.578	6.60
May 1956	August 1956	Hyman & Sons	6,340	5.60	6.60
Do	do	General Gummed	2,670	5.70	6.60
August 1956	September 1956	do	180	5.99	6.60
December 1956	February 1957	do	2,630	5.80	6.60
May 1957	June 1957	Piedmont	3,750	6.10	6.10
Do	July 1957	General Gummed	13,190	5.649	6.10
October 1957	December 1957	Piedmont	7,880	5.74	6.10
Do	do	Adhesive	1,070	6.00	6.10
January 1958	March 1958	Atlantic Gummed	4,000	4.045	6.288
May 1958	July 1958	Central Paper	1,480	6.02	6.288
August 1958	October 1958	General Gummed	500	5.70	6.10
November 1958	December 1958	do	9,500	5.51	6.10
January 1959	March 1959	do	7,610	5.708	5.95

09-54-01 WPI Spec. 1947-60: Gummed sealing tape, Std. No. 2, 60-pound basis, 600 feet, 3 inches width, bursting strength 92-100 percent, sulphate paper, animal glue, bundle of 10 3-inch rolls, 500 bundle lots (5,000 rolls), f.o.b. mill, carload freight allowed.

TABLE B-28.—*Tubes, Automobile, 6.70 x 15, First Line, Delivered in Continental United States*

Bid opening date	Period of contract	Number of bidders	Sellers' offered price (dollars per tube, no time discount)			BLS index during contract period		
			Low	$\bar{X}$	High	Low	$\bar{X}$	High
Apr. 26, 1956	July 11-Dec. 31, 1955	19	$1.79	$1.80	$1.97	107.7	114.2	118.1
June 1, 1956	June 12, 1956	12	1.79	1.79	1.79	118.1	120.3	121.2
Nov. 5, 1956	Jan. 12, 1957	24	1.79	1.796	1.89	119.0	120.4	122.2
Sept. 30, 1957	Jan. 12, 1958	20	1.79	1.793	1.85	122.0	122.0	122.0
Oct. 22, 1958	Jan. 12, 1959	17	1.79	1.79	1.79	120.7	120.7	120.7
Apr. 15, 1959	Apr. 12, 1959	14	1.79	1.79	1.79	120.7	120.7	120.7
Oct. 12, 1959	Jan. 12, 1960		1.79	1.79	1.79	120.7		

07-22-01 WPI Spec. 1954-60: Tube, automobile, passenger and front tractor, 6.70 x 15, 1st line, manufacturer to wholesaler or dealer; f.o.b. factory, freight allowed on specified weight.

TABLE B–29.—*Batteries, Storage, Lead Acid, Passenger and Commercial Vehicles, 1H, High, 6 Volt, Delivered Maryland, West Virginia, Virginia, District of Columbia*

Bid opening date	Contract date	Quantity	Number of bidders	Sellers' offered price (dollars per battery; no time discount)			BLS index for period of contract		
				Low	$\overline{X}$	High	Low	$\overline{X}$	High
Feb. 2, 1949	April 1949 to March 1950	(3)	6	$12.51	$13.88	$16.32 [1] 33.08	$92.03	$101.7	$114.9
Mar. 13, 1950	April 1950 to March 1951	(3)	14	[2] 7.84	[2] 10.01	[2] 14.95	92.3	99.78	107.0
Jan. 31, 1951	April 1951 to March 1952	(3)	6	9.52	12.76	15.56	107.0	111.08	113.7
(3)	April 1952 to March 1953	(3)	3	12.36	10.42	15.15	107.8	108.60	112.6
Jan. 27, 1953	April 1953 to March 1954	(3)	5	10.36	10.95	12.08	106.9	107.96	108.2
Feb. 1, 1954	April 1954 to March 1955	(3)	5	9.34	9.75	10.41	101.5	103.42	106.2
Feb. 4, 1959	May 1959 to April 1960	(3)	6	7.60	8.78	10.50	121.1	126.88	129.4

[1] Nonprimary market quotation.
[2] F.o.b. shipping point price.
[3] Open contract, lot sizes from March 1949.

11-78-01 WPI Spec. 1947-60: Storage battery, automotive type, 6 volts, 3 cells, 15 plates per cell, 95-105 amperes at 20 meter rate, wood separators, manufacturer to distributor, jobber or dealer; f.o.b. factory, or f.o.b. factory, freight prepaid.

TABLE B–30.—*Linoleum, Green, ⅛ Inch x 72½ Inches Wide, Delivered Various Destinations*

Contract date	Delivery date	Company	Quantity (yards [2])	Actual transaction price (dollars per yard [2])	BLS Price Index at contract date
August 1950	October 1952	Bonafide Mills	1,300	$1.62	$110.6
September 1952	November 1952	Congoleum-Nairn	2,600	1.71	110.6
September 1952	November 1952	Armstrong Cork	3,500	1.59	110.6
November 1952	April 1953	do	80,750	1.492	110.6
May 1953	October 1953	Bonafide Mills	9,500	1.59	111.9
November 1954	January 1955	Congoleum-Nairn	1,700	1.67	119.3
January 1955	April 1955	Bonafide Mills	16,200	1.78	120.4
Do	April 1955	Congoleum-Nairn	600	1.69	120.4
June 1955	January 1956	Bonafide Mills	9,000	1.55	120.4
Do	October 1955	do	5,000	1.51	120.4
January 1956	April 1956	Armstrong Cork	42,700	1.52	124.6
October 1956	June 1957	Bonafide Mills	11,200	1.60	127.2
December 1956	March 1959	do	5,259	1.49	128.4
Do	March 1957	Armstrong Cork	3,500	1.61	128.4
Do	March 1957	Congoleum-Nairn	24,700	1.57	128.4
January 1957	April 1957	Bonafide Mills	8,146	1.56	130.8
October 1957	January 1958	do	3,005	1.76	125.6
June 1958	January 1959	Congoleum-Nairn	4,400	1.60	128.6
October 1958	January 1959	do	800	1.73	128.6
November 1958	May 1959	Bonafide Mills	26,000	1.72	128.6
November 1959	April 1960	Congoleum-Nairn	6,000	1.73	130.5

12-32-01 WPI Spec. 1947-60: Linoleum, inlaid, standard gage, manufacturer to wholesaler or distributor, f.o.b. factory.

TABLE B-31.—*Glass, Plate, Polished, Glazing Quality, ¼-In., 25–50-Ft.[2] Size, Delivered to D.C. and Contiguous Areas*

Bid opening date	Contract period	Number of bidders	Quantity	Sellers' offered price (dollars per foot[2], no time discount)			BLS Index during contract period		
				Low	X̄	High	Low	X̄	High
July 11, 1949	August 1949 to February 1950	5, [1] 7	(2)	$0.53, [1] .54	$56.6, [1] .57	$0.65, [1] .65	104.5	104.5	104.5
Jan. 12, 1950	February to August 1950	6, [1] 7	(2)	.53, [1] .52	.58, [1] .58	.65, [1] .70	104.5	111.52	112.7
(3)	August 1950 to February 1951	7, [1] 6	(2)	.54, [1] .52	.62, [1] .61	.77, [1] .80	112.7	118.63	121.0
(3)	February to August 1951	5, [1] 4	(2)	.62, [1] .60	.68, [1] .64	.75, [1] .66	121.0	121.0	121.0
June 26, 1951	August 1951 to February 1952	6, [1] 7	(2)	.60, [1] .59	.66, [1] .62	.74, [1] .66	121.0	121.0	121.0
(3)	August 1953 to February 1954	6	(2)	.61	.71	.815	132.0	132.0	132.0
(3)	February to August 1954	5	(2)	.61	.70	.80	132.0	132.0	132.0
(3)	February to August 1955	3	(2)	.68	.72	.75	132.0	133.57	137.5
(3)	August 1955 to February 1956	3	(2)	.75	.76	.78	137.5	137.5	137.5
Jan. 11, 1956	February to August 1956	4	(2)	.85	1.07	1.24	137.5	139.84	145.7
(3)	August 1956 to February 1957	4	(2)	.80	.8425	.88	145.7	145.7	145.7
(3)	February to August 1957	4	(2)	.76	.81	.84	145.7	145.7	145.7
June 8, 1957	August 1957 to February 1958	5	(2)	.71	.75	.79	145.7	145.7	145.7
(3)	February to August 1958	5	(2)	.70	.74	.79	145.0	145.6	145.7
(3)	August 1958 to February 1959	4	(2)	.72	.77	.85	144.3	144.4	145.0

[1] F.o.b. plant quote.
[2] Open contract, $50 to $5,000 size per order.
[3] Opening date approximately 1 month before contract period.

13-11-01 WPI Spec. 1949-60: Plate Glass, polished, ¼-inch glazing quality, bracket 25 to 50 ft.[2], manufacturer to jobber or wholesale distributor, carlots f.o.b. factory, freight equalized.

TABLE B-32.—*Golf Balls, Cadwell-Geer (or Equal), Top Grade, Processed Balata Cover, by the Dozen, Delivered East of the Mississippi (with Exception of Arkansas and Louisiana)*

Bid opening date	Contract period	Number of bidders	Quantity (dozen)	Sellers' offered price (per doz., no time discount)			BLS index during contract period		
				Low	$\bar{X}$	High	Low	$\bar{X}$	High
(1)	Aug. 1, 1949 to Jan. 31, 1950	7	(2)	$4.74	$5.70	$6.84	100.1	102.2	104.4
(1)	March 1950 to August 1950	7	(2)	4.41	5.81	7.02	104.4	104.66	106.0
(1)	September 1950 to February 1951	6	(2)	4.10	5.27	6.84	109.7	109.7	109.7
Feb. 19, 1951	March 1951 to August 1951	5	(2)	4.07	5.43	7.27	109.7	109.7	109.7
July 3, 1951	September 1951 to February 1952	4	(2)	4.45	5.23	6.00	109.7	110.6	110.4
(1)	March 1953 to August 1953	6	(2)	4.04	5.46	6.96	110.4	112.85	113.9
(1)	September 1953 to February 1954	7	(2)	3.81	5.25	7.08	113.9	113.9	113.9
(1)	March 1954 to August 1954	6	(2)	4.69	6.07	7.55	113.9	118.23	119.1
(1)	September 1954 to February 1955	6	(2)	5.23	6.42	7.43	119.1	119.1	119.1
Jan. 4, 1955	March 1955 to August 1955	8	(2)	5.00	6.08	6.96	119.1	119.1	119.1
(1)	September 1955 to February 1956	9	(2)	5.00	5.65	6.96	119.1	124.56	127.3
(1)	March 1956 to August 1956	9	(2)	5.00	5.90	7.26	127.3	127.90	130.9
July 21, 1957	September 1957 to February 1958	7	(2)	4.26	[3] 4.95 5.64	[3] 7.26 9.75	130.9	130.9	130.9
Jan. 23, 1958	March 1958 to August 1958	4	(2)	4.17	4.21	4.27	130.9	130.9	130.9
(1)	September 1958 to February 1959	6	(2)	4.08	4.39	5.77	130.9	130.9	130.9
(1)	March 1959 to August 1959	6	(2)	3.98	4.32	5.77	130.9	131.95	137.2
June 10, 1959	September 1959 to February 1960	8	(2)	3.83	4.61	7.26	137.2	137.2	137.2

[1] Date not given—estimated 1 to 3 months prior to contract period.
[2] Open contract—size of $50–$4,000 per order.
[3] Calculated omitting most obvious nonprimary market quote

15-12-21 WPI Spec. 1949-60: Golf ball, manufacturer to distributor, retailer or dealer f.o.b. factory or shipping point.

APPENDIX C

TABLE C-1.—*Comparison of Yearly Average Prices on F.O.B. Plant Basis, 1951–59*

Commodity	1951	1952	1953	1954	1955	1956	1957	1958	1959
Aluminum sulfate (dollars per 100 lbs.) commercial 17% AL_2O_3:									
A	$1.55	$1.562	$1.669	$1.767	$1.775	$1.762	$1.799	$1.875	$1.868
B	1.70	1.60	1.64	(1)	1.653	1.796	(1)	(1)	(1)
C	1.65	1.65	1.767	1.850	1.850	1.850	1.925	2.00	2.00
Calcium carbide (dollars per ton):									
A	84.537	84.302	82.749	89.179	93.853	96.972	99.894	99.991	103.08
B	[2] 126.082	[2] 112.542	[2] 109.20	[2] 120.16	(1)	(1)	(1)	(1)	(1)
C	[3] 126.717	[3] 132.267	[3] 134.40	[3] 134.40	[3] 134.40	[3] 134.40	[3] 139.267	[3] 149.00	[3] 149.00
Calcium chloride (dollars per ton) 77–80%, solid to flake:									
A	23.093	23.356	23.821	24.667	25.304	26.524	27.756	28.858	27.653
B	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
C	25.00	25.00	25.667	27.00	27.667	29.000	30.667	31.00	31.00
Acetylene (dollars per 100 ft.):									
A	1.26	1.30	1.28	1.26	1.20	1.21	1.21	1.249	1.183
B	(1)	(1)	(1)	2.08	1.93	[2] 2.02	2.12	[2] 2.18	[2] 2.58
C	[3] 110.5	[3] 112.5	[3] 113.0	[3] 113.0	[3] 113.0	[3] 117.3	[3] 120.7	[3] 124.8	[3] 124.8
Carbon dioxide (dollars per lb.), industrial:									
A	.0323	.0334	.0354	.0365	.0340	.0318	.0301	.0297	.0307
B	(1)	(1)	(1)	(1)	(1)	.0450	.0489	.0438	.0463
C	.06	.0717	.08	.08	.08	.08	.08	[4] .08	----------
Oxygen (dollars per 100 ft.), liquefication:									
A	.2702	.2704	.2452	.2572	.2361	.2481	.2657	.2337	.2081
B	(1)	(1)	(1)	(1)	.558	.526	.578	(1)	(1)
C	[3] 103.9	[3] 105.9	[3] 105.5	[3] 105.3	[3] 105.3	[3] 109.3	[3] 111.9	[3] 114.3	[3] 114.3

[1] Not available.
[2] Delivered price.
[3] Price index number.
[4] Terminates Aug. 31, 1958.

KEY: A. Bureau of Census, *Facts for Industry*, yearly average price as calculated from value and quantity data.
B. Yearly average offered contract prices as collected from Federal purchasing organizations.
C. Yearly average wholesale prices or indices as collected by the BLS.

STAFF PAPER 10

APPRAISAL OF ALTERNATIVE CONCEPTS AND MEASURES OF AGRICULTURAL PARITY PRICES AND INCOMES

Geoffrey Shepherd, Iowa State University

The agricultural parity concept developed step by step during the late 1920's and early 1930's.[1] ". . . the concept as we now know it did not spring full blown from the brain of some economic Jupiter, but rather grew out of the continuous groping for a concrete measure of justice for the farmer, and was steadily modified by conditions prevailing in the economic life of farmers and the Nation. In other words, parity did not develop as the practical application of an economic theory immaculately conceived, free from all taint of original sin in the form of class interest. On the contrary, parity, like Topsy, just growed; and whatever economic justification can be found for it in its present form may be considered largely a rationalization." [2]

Objective of the Parity Legislation

The first specific parity formula was incorporated in the Agricultural Adjustment Act of 1933. The objective stated in the act was to "reestablish prices to farmers at a level that will give agricultural commodities a purchasing power, with respect to articles that farmers buy, equivalent to the purchasing power of agricultural commodities in the base period. The base period in the case of all agricultural commodities except tobacco shall be the prewar period, August 1909–July 1914. In the case of tobacco, the base period shall be the postwar period, August 1919–July 1929." [3]

Parity prices, then, were to be prices which would give *farm products* the same purchasing power *per unit* (bushel, bale, etc.) for goods and services used in both production and family living as prevailed in the base period.

The legislation was passed, of course, not for the benefit of the farm products concerned as such, but for the benefit of the farmers who produced these products. The objective was to restore the price conditions that existed during the base period, on the assumption that this would restore the economic situation of the producers of the products.

The word parity itself was not used in the AA Act of 1933. It first appeared in agricultural legislation in the AA Act of 1938. The purpose of that act, as stated in the opening paragraph, was to accom-

[1] The development and present status of the present parity price formula is well outlined in *Possible Methods of Improving the Parity Formula*, Senate, 85th Cong., 1st sess., S. Doc. 18, pp. 8–13, 1957. See also *An Alternative Parity Formula for Agriculture*, Research Bulletin 476, Iowa State University, Ames, Iowa, February 1960.

[2] E. W. Grove, *The Concept of Income Parity for Agriculture*, Studies in Income and Wealth, Vol. 6, New York, National Bureau of Economic Research, 1943.

[3] Agricultural Adjustment Act, Public Law 10, *U.S. Statutes at Large*, 73d Cong., 1st sess., XLVIII, May 12, 1933, p. 32.

plish a number of things "assisting farmers to obtain, insofar as practicable, parity prices for such commodities and parity of income . . . ."

Pursuant to the objective stated in the AA Act of 1933, the parity formula was developed to reflect changes in the prices of the "articles that farmers buy." Parity prices then could be computed for agricultural commodities that farmers sell which would give those commodities the same purchasing power that they had in the base period.

Content of the Parity Formula

The Department of Agriculture had been compiling and publishing the price data called for in the AA Act of 1933 for some years previous to 1933. The index of prices *received* by farmers for the products they sell was compiled on a monthly basis beginning with 1909. It was first published in 1921.

The basic data for the index of prices paid for the "articles that farmers buy" were more difficult to obtain. This index was compiled on an annual basis beginning with 1909, on a quarterly basis beginning with 1924, and on a monthly basis beginning with 1937. This index of prices paid by farmers was first published in 1928.[4] At that time, the pre-World War I base, 1910–14, seemed a reasonable base to use for both series—the prices received by farmers, and the prices paid by farmers. That base was written into the AA Act of 1933.

The parity formula laid down in the AA Act of 1933 was amended and reenacted several times after 1933.[5] The prices of certain services were added to the prices paid by farmers, and "comparable prices" were provided for some products which had not come into general use until after 1929. In addition, the Agricultural Act of 1948 introduced a table of loan rates that varied inversely with the supply of the crop.

PRICE BASES

The Agricultural Act of 1948 also included provisions which "modernized" the parity formula; it brought the base period for computing the relative parity prices of individual farm products (the parity prices relative to each other) up to a more recent date—the most recent 10-year moving average. The 1910–14 base period was retained, however, for parity prices as a whole. This modernized formula was to become effective in 1950. The Agricultural Act of 1949 modified the formula by the inclusion of farm wage rates in the parity index and the inclusion of direct subsidy payments on dairy products, cattle, and lambs in prices received before it became effective.

To avoid extremely sharp declines in the parity prices of any commodity, transitional parity prices were provided by the 1948 act. They were to be used for those commodities for which the new parity prices are less than 95 percent of the old parity prices in 1950, 90 percent in 1951, and so on. In other words, the parity price as cal-

[4] In the Agricultural Acts of 1948 and 1949, the index of prices paid by farmers was legally defined as the parity index.

[5] The details concerning these amendments, and the steps involved in the computation of parity prices for different products, are given in B. R. Stauber, et al., "The Revised Price Indexes." *Agricultural Economics Research*, II; 2, April 1950, pp. 33–62. Some interesting background on the evolution of the term "parity" is given in R. L. Tontz, "Evolution of the Term Parity in Agricultural Usage," *Southwestern Social Science Quarterly*, March 1955, pp. 345–355.

culated under the old method was to be reduced 5 percent each year until the transitional parity was less than the parity prices as defined by the new act. From then on, the new parity was to be used. These transitional prices were incorporated into the 1949 act. In actual practice, for several years, "dual parity" was used with the six basic crops. The parity prices computed by the modernized formula went into effect only if they were higher than prices computed under the old formula.

For the purpose of illustrating the computation of parity prices the calculation of the effective parity price for corn based on data for January 1960 is given below. The parity price under the new formula of the amended act is computed as follows:

"The 120-month, January 1950–December 1959, average of prices received by farmers for corn, adjusted to include an allowance for unredeemed loans, etc., was $1.39 per bushel. The 120-month average of the Index of Prices Received by Farmers, adjusted to include an allowance for unredeemed loans, etc., was 255. Dividing $1.39 by 255 gives $0.545 per bushel, the adjusted base price. Multiplying this adjusted base price by 299, the Parity Index based on data for January 1960, gives the indicated price of $1.63 per bushel as computed using the new formula."

Since the effective parity for corn, a basic commodity, was the transitional parity based on data for December 1959, it was also necessary to compute the transitional parity based on data for January 1960. As noted above the transitional parity for basic commodities during 1960 is 80 percent of the parity price computed by the old formula. The parity price according to the old formula is calculated by multiplying the average price received by farmers for corn for the 60-months, August 1909–July 1914, which was $0.642 per bushel, by the January 15, 1960, unrevised Index of Prices Paid, including Interest and Taxes, which is 315 percent. This gives an indicated parity price of $2.02 per bushel under the old formula. Multiplying by 80 percent gives $1.62 the transitional parity price. Since this is lower than the indicated parity price under the new formula of $1.63 per bushel, the parity price under the new formula is now the effective parity price for corn.

Effective parity prices for most commodities have shifted to the new formula, but for some commodities the transitional parity is still the effective parity price.[6]

WEIGHT BASES

In 1950, the weight base used in computing the index of prices paid was moved up from 1924–29 to 1937–41, and the weights were revised in line with the quantities used in the later period. In January 1959, the weight-base period was moved up again, to 1955, with weights revised in line with the 1955 Farm Expenditure Survey and the 1955 Food Consumption Survey.[7] The weight base for the index of prices

[6] *Agricultural Prices*, Department of Agriculture, Agr. Mktg. Serv., Jan. 29, 1960, p. 44.
[7] B. R. Stauber, R. F. Hale, and B. S. Peterson. "The January 1959 Revision of the Price Indexes," *Agricultural Economics Research*, Vol. XI, Nos. 2 and 3.

received was moved up to 1953–57 (the 5-year period was used so as to average out most of the year-to-year variations in quantities sold which result chiefly from irregular variations in weather).

The indexes of prices received and prices paid from 1910 to 1959 are given in Table 1. The ratio between the two indexes (the parity ratio) is also given. The data since World War II are shown graphically in Figure 1.

FIGURE 1

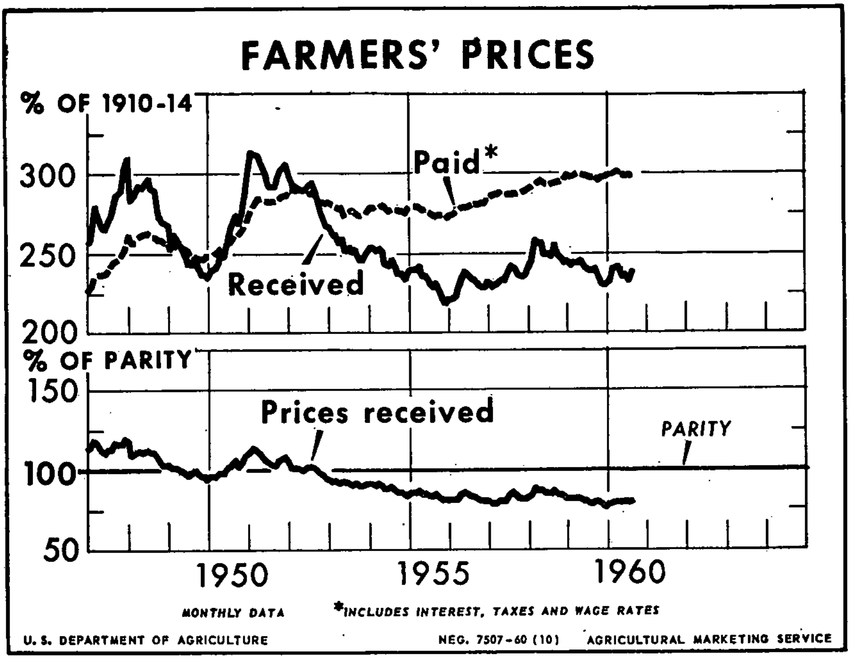

TABLE 1.—*Indexes of Prices Received by Farmers for Commodities, and Prices Paid for Commodities, Interest, Taxes, and Wage Rates, and Parity Ratios, United States, 1910–59*

(index base, 1910–14=100)

Year	Index of prices received	Index of prices paid [1]	Parity Ratio	Year	Index of prices received	Index of prices paid [1]	Parity ratio
1910	104	97	107	1949	250	251	100
1920	211	214	99	1950	258	256	101
1930	125	151	83	1951	302	282	107
1940	100	124	81	1952	288	287	100
1941	124	133	93	1953	255	277	92
1942	159	152	105	1954	246	277	89
1943	193	171	113	1955	232	276	84
1944	197	182	108	1956	230	278	83
1945	207	190	109	1957	235	286	82
1946	236	208	113	1958	250	293	85
1947	276	240	115	1959	240	298	81
1948	287	260	110				

[1] Including interest, taxes, and farm wage rates.

Percentages of Parity Prices Used as Bases for CCC Loan Rates

In October 1933, the Commodity Credit Corporation was organized for the purpose of stabilizing the supplies and prices of the basic farm products. It operated as a storage agency, making nonrecourse commodity loans to farmers and taking over the commodities for which the loans were not redeemed.

For the first few years, the CCC set the loan rates at appropriate levels for stabilization purposes. But in 1938, the Agricultural Adjustment Act of 1938 took the setting of the loan rates out of the CCC's hands and wrote into law the range of percentages of parity prices within which the loan rates were to be set. The range extended from 52 to 75 percent of parity. In the case of corn, the loan rate varied within the range, inversely with the size of the crop.

In May 1941, Congress went further. It directed the CCC to set the loan rates for the "basic" commodities—cotton, corn, wheat, tobacco, and rice—at 85 percent of parity. This raised loan rates about 50 percent higher than the 1940 rates on cotton and wheat and 13 percent higher on corn. The rates for most products were raised to 90 percent of parity in 1944, where they remained until they began to be reduced in 1955. The data for corn are given for illustration in Figure 2 and Table 2.

Figure 2

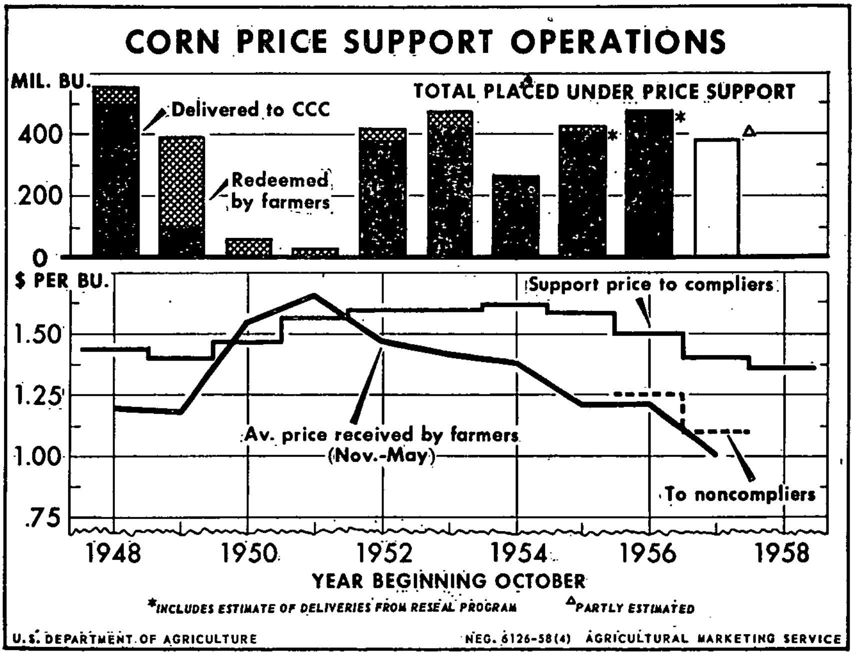

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TABLE 2.—*Corn: U.S. Loan Rates, U.S. Average Farm Prices, and Differentials Between Them, Support Prices and Quantity Placed Under Support, 1933–56*

Year beginning October	Announced national average loan rate[1] (dollars per bushel)	Average price November–May[2] (percentage of parity)	Average price minus announced loan rate (dollars per bushel)		Placed under price support				Under loan or owned by CCC at end of crop year (million bushels)
					Loans[3] (million bushels)	Purchase agreements (million bushels)	Total (million bushels)	Percentage of production	
1933	$0.45	60	$0.45	$0.00	268	----------	268	11.2	82
1934	.55	68	.83	.28	20	----------	20	1.4	----------
1935	.45	55	.55	.10	31	----------	31	1.3	----------
1936	.55	66	1.06	.51	(4)	----------	(4)	----------	----------
1937	.50	58	.51	.01	61	----------	61	2.3	45
1938	.57	70	.44	−.13	230	----------	230	9.0	258
1939	.57	69	.55	−.02	302	----------	302	11.7	471
1940	.61	75	.58	−.03	103	----------	103	4.2	403
1941	.75	85	.74	−.01	111	----------	111	4.2	197
1942	.83	85	.90	.07	56	----------	56	1.8	8
1943	.90	85	1.12	.22	8	----------	8	.3	6
1944	.98	90	1.07	.09	21	----------	21	.7	9
1945	1.01	90	1.15	.14	3	----------	3	.1	----------
1946	1.15	90	1.38	.23	26	----------	26	.8	9
1947	1.37	90	2.20	.83	1	----------	1	----------	----------
1948	1.44	90	1.20	−.24	377	[5] 174	551	15.3	493
1949	1.40	90	1.18	−.22	332	55	387	11.9	650
1950	1.47	90	1.55	.08	52	2	54	1.8	488
1951	1.57	90	1.66	.09	25	1	26	.9	306
1952	1.60	90	1.47	−.13	309	107	417	12.7	580
1953	1.60	90	1.42	−.18	369	102	471	14.7	736
1954	1.62	90	1.38	−.24	200	59	259	8.5	870
1955	1.58	87	1.21	−.37	356	65	421	13.0	1,060
1956[6]	1.50	84	1.21	−.29	401	76	477	13.8	1,295
1957[6]	1.40	77	1.02	−.38	320	49	369	10.8	1,355
1958[6]	1.36	77	1.05	−.31	343	38	381	10.0	1,400
1959	1.12	66	1.00	−.12	[8] 439	[8] 38	[8] 512	11.7	----------
1960[7]	1.06	65	----------		----------	----------	----------	----------	----------

[1] Applies to commercial area only in years when acreage allotments are in effect.
[2] Average price received by farmers in period when most of the corn is placed under price support. In recent years, loans have been available from time of harvest through May.
[3] Excludes purchase agreement corn placed under loan in the following year during the period 1948 to date.
[4] Included 14 million bushels of 1937 corn placed under loan for first time in 1938 under short-term loan program.
[5] Purchase agreements not available prior to 1947.
[6] Loans were made to noncooperators at $1.25 per bushel in 1956, $1.10 in 1957, and $1.06 in 1958.
[7] Minimum support; may be increased at beginning of marketing year if higher support is required.
[8] Preliminary. Compiled from reports of Commodity Stabilization Service. Data published currently in: Department of Agriculture, Agricultural Marketing Service, *The Feed Situation*.

Source: Department of Agriculture, *Agricultural Outlook Charts*, 1956, Nov. 1955, Table 35, p. 68; Department of Agriculture, *Grain and Feed Statistics*, through 1954. Department of Agriculture Statistics Bulletin 159, March 1955, Table 48, p. 46; Department of Agriculture Agricultural Marketing Service, *The Feed Situation*. May 1959, p. 23.

EFFECTS OF USING PERCENTAGES OF PARITY PRICES

The effects of this use of percentages of parity prices as the bases for loan rates were spectacular. They distorted the allocative function of prices in the direction of the supported commodities. Agricultural production in the United States was already increasing faster than the demand was increasing, under the impact of rapid technological development. The setting of price supports at percentages of parity, above long-run free-market equilibrium levels, further stimulated overproduction of the supported commodities above market needs, and at the same time reduced the consumption of those products.

As a result, huge stocks of corn, cotton, and wheat, particularly, accumulated in CCC hands. Desperate attempts to reduce production by acreage controls and stimulate consumption by domestic and export consumption subsidies have been only partially successful. The sizes of the stocks in recent years—several times larger than needed for stabilization purposes—are shown in Figure 3.

FIGURE 3

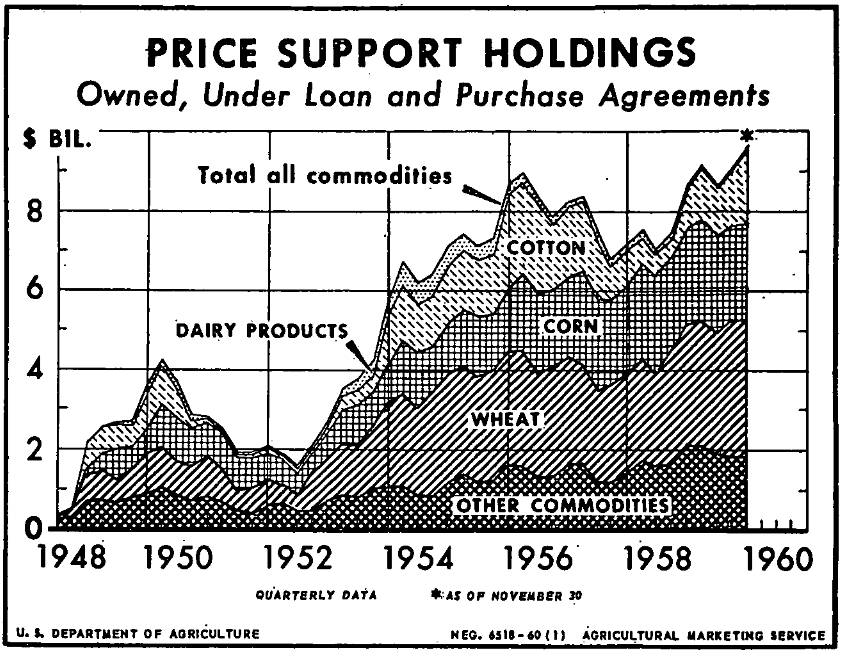
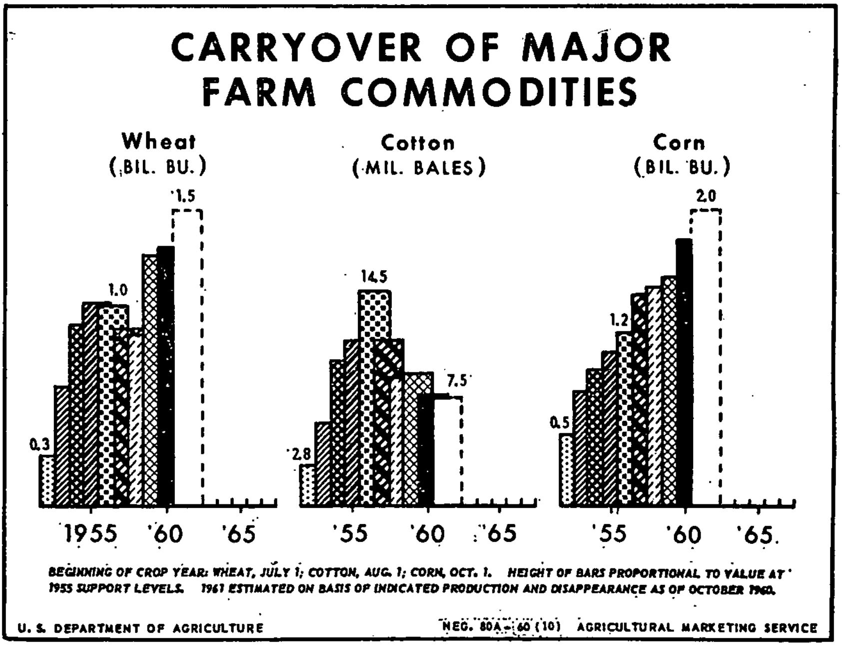


FIGURE 3—Concluded



On January 31, 1960, the "investment of the CCC in price-support programs amounted to $9,239,499,000—made up of loans outstanding of $1,944,551,000 and the cost value of inventories, $7,294,948,000." The "realized cost" of "programs primarily for stabilization of farm prices and income" in fiscal 1958 was $2,665,700,000.[7a] Only a part of these expenditures went directly to farmers. The rest went to other groups, such as storage agencies for storage fees, and indirectly to construction companies for the building of additional storage space. These other agencies received a substantial part of the income transferred from taxpayers. In fiscal 1958, for example, the "realized cost" of the corn program was $271 million. Of this amount, $110 million—more than a third—went to the grain trade and transportation agencies to cover storage and handling charges. None of this went to farmers.[8] The program thus was a "grain trade program" as well as a farm program.

Appraisal of the Parity Price Indexes

The present parity price indexes and ratios may now be appraised with reference to the job they were originally set up to do—to measure the prices received by farmers, the prices paid by farmers, and the ratio between the two, for agriculture as a whole and for individual farm products. The parity price indexes and ratios may also be appraised with reference to the uses to which they are now being put. These are vastly different from the uses for which the indexes were originally designed. The two appraisals are given separately in order below.

APPRAISAL OF THE PARITY INDEXES WITH REFERENCE TO THE USES FOR WHICH THEY WERE ORIGINALLY DESIGNED

Type of Formula Used.—The parity price indexes are computed by the use of an aggregative Laspeyres type formula, with base-year weights.[9]

This formula meets neither the factor-reversal test nor the time-reversal test. But the use of a formula such as Fisher's Ideal (the geometric average of a Laspeyres formula with base-year weights and a Paasche formula with given-year weights) is impractical. The cost of getting given-year weights for the index of prices paid in time to use for current calculations would be prohibitive. Getting given-month weights would be clearly impracticable.

The Laspeyres type formula is subject to the problem of the increasing obsolescence of the base-period weights with the passage of time. The USDA has dealt with this problem by using the same weight base period for a number of years, then using a more recent period and splicing the two indexes at an appropriate point. This has the disadvantage of causing a sudden change in the index of 3.4 percent, for

[7a] The "realized cost" is large in recent years partly because it includes the cost of acquiring the large inventory built up in those years. If crops were very small in 1960 and later years, and prices rose enough to pull substantial quantities out of storage for sale on the market, the revenue from those sales would offset a large part of the total costs in those years and "realized cost" would be relatively small.

[8] Correspondence from CCC.

[9] B. Ralph Stauber, Nathan M. Koffsky, and C. Kyle Randall, The Revised Price Indexes, *Agricultural Economics Research,* USDA, Bureau of Agricultural Economics, April 1950, p. 53.

example, when the last revision was made in January 1959. In principle, this could be avoided or at least reduced to insignificance (actually, spread out in little steps over a period of years) by the use of a recent moving average weight base period. But the cost of obtaining the weights for the index of prices paid would be high and other disadvantages of a more technical nature would be incurred. On the whole, the USDA practice seems justified, and their request for permission and funds to put the gathering of the weight data on a regular and more frequent schedule than in the past seems to be reasonable.

Adequacy of Coverage.—Another feature of a price index is the adequacy of its coverage of the prices it purports to measure.

The index of prices received by farmers began in 1910 as a weighted average of price relatives for 10 crops; the base period was the average of December 1 prices for 1866–1908. Several years later, livestock prices were added. In 1924, the index included the prices for 30 commodities, and the base period was moved up to August 1909–July 1914. In 1924, prices for 20 more products were added. Some changes in the coverage were made in 1950. Under the latest revision in 1959, the prices for 55 farm products are included, which are weighted by the quantities marketed in 1953–57, and represent 93 percent of total farm marketings in 1953–57. The largest single item omitted is farm forest products.[10]

This coverage of 93 percent is close enough to 100 percent to be regarded as satisfactory. It probably represents an optimum allocation of limited appropriations to alternative uses.

The index of prices paid by farmers began in 1910 with 142 commodities, expanded to 181 in 1927, to 335 in 1935, and to about 390 in 1959. The production component of the index contains about 230 items; the living, about 200 items (two-thirds as many as the BLS consumer price index) and both production and living, 46 items. These items are weighted by expenditures in 1955. They cover about 84 percent of farmer expenditures in 1955.

The most important fields not covered in the family living part of the parity index are medical, dental, and hospital expenses, which in 1955 amounted to $1,444 million or 7.2 percent of all farm family living expenditures. Others were personal insurance and recreation which accounted for 2.6 and 2.1 percent, respectively, of all living expenditures. In production, important omissions are machine hire and custom work, marketing expenses for crops and livestock, cash rent, irrigation, and business insurance, which in 1955 accounted collectively for nearly 9 percent of all production expenditures.[11]

This coverage appears less adequate than the coverage of the index of prices received. Larger appropriations would permit the USDA to increase the coverage.

Separate Parity Indexes for Individual Farm Products.—The present legislation provides for the use of the same index for all farm products (except for the use of the "Unrevised Index" for the few commodities still on the transitional basis). The present parity index is a single index for the whole United States. It is based upon the prices of about 389 goods and three services (interest, taxes, and

[10] B. R. Stauber, *Critical Problems in Index Number Construction*, Agricultural Marketing Service, USDA. Presented to a joint meeting of the American Statistical Association and the American Farm Economic Association, December 1959, pp. 13–14, 21.
[11] Stauber, *op. cit.*, p. 21.

wages). The index shows the prices of goods and services for the average farmer in the United States.

But most actual farmers differ widely from average farmers. Some of them are cotton farmers, using cotton machinery, fertilizer, and labor; some are Corn Belt farmers, using corn planters, pickers, etc; some are wheat farmers, using "one-way's" and combines; some are truck farmers, ranchers, fruit growers, etc., each with his own list of goods and services purchased, differing in kind and quantity from that of the others. The parity index—an average index for the whole United States—does not accurately fit any of them.

The prices paid for different items in the parity index have risen at markedly different rates since 1940. Hired labor wages have risen to an index of well over 400 (1935–39=100). Machinery prices have more than doubled. But fertilizer prices have risen only 50 percent. The combination of resources used in the production of different farm products has changed in different ways in different areas. The use of machinery on Southern Piedmont cotton farms exactly doubled from 1935 to 1953, but on Central Northeast dairy farms it rose only 36 percent. The use of labor declined at different rates among the different farm areas. Yet the same weights for all types of farms are used in the parity index. The prices of the different factors of production change at different rates, so the use of the same quantity weights for all farm areas, when in fact the quantity weights change at different rates, means that the single parity index for the United States as a whole is not an accurate index of the prices paid in each of the different farming areas. Parity prices for individual farm products would more accurately reflect the parity purchasing power of those products if the parity index were computed separately for each product.

Separate indexes of prices paid for commodities used in production for 27 types of farms in several major farming areas in the United States, have been computed by the USDA. They are shown in Table 3, along with the index for the United States as a whole. Each one of these indexes for important types of farms represents the situation on commercial family-operated farms of a particular type in a particular location. For this reason, the indexes are not necessarily representative of all farms involved in the production of a particular commodity over the Nation as a whole. They approximate, however, the differences in price trends for production items that might be expected between farms producing different commodities and also the differences between areas producing the same commodity.

Table 3 indicates that all the special prices-pair indexes for the different types of farms shown from 1947–49 to 1955, ranged from a 4-percent decline for sheep ranches in the Southwest to an increase of 26 percent for wheat-pea farms in Washington-Idaho. This is a total range of 30 percentage points. The rise in the United States index during the same period was 14 percent.

There is almost as much variation in some instances in the cost-rates indexes in the production of the same commodity in different areas as there is between different commodities. For example, increases in the specialized price indexes for cattle ranches range from 9 percent in the Southwest to 25 percent in the northern Great Plains and Intermountain areas. Similarly, the increases since 1947–49 for

TABLE 3.—*Indexes of Prices Paid for Commodities Used in Production, United States, and Types of Farming Areas*

[1947-49=100]

	1937-41	1947-49	1952	1953	1954	1955	1956
United States [1]	50	100	117	112	112	112	114
Dairy farms:							
Central Northeast [2]	50	100	115	110	109	107	108
Eastern Wisconsin [2]	51	100	116	114	114	112	115
Western Wisconsin [2]	51	100	115	114	114	114	116
Hog-dairy farms, Corn Belt [2]	54	100	116	114	113	113	114
Hog-beef raising farms, Corn Belt [2]	53	100	117	116	114	113	114
Hog-beef fattening farms, Corn Belt	45	100	112	102	105	103	100
Cash grain farms, Corn Belt [2]	55	100	119	120	121	123	124
Tobacco-livestock farms, Kentucky Bluegrass [2]	45	100	118	118	121	118	120
Tobacco-cotton farms, Coastal Plains, North Carolina [2]	(3)	100	114	116	118	119	123
Tobacco farms (small), Coastal Plains, North Carolina [2]	(3)	100	113	115	117	117	117
Tobacco-cotton farms (large), Coastal Plains, North Carolina [2]	(3)	100	109	110	117	118	123
Cotton farms:							
Southern Piedmont [2]	48	100	115	112	108	118	112
Black Prairie, Texas [2]	46	100	115	111	111	110	106
Nonirrigated, High Plains, Texas [2]	47	100	112	119	104	109	112
Irrigated, High Plains, Texas [2]	(3)	100	108	104	99	101	101
Small, Delta [2]	(3)	100	113	110	109	108	107
Large-scale, Delta [2]	(3)	100	116	107	110	108	107
Wheat-small grain-livestock farms, Northern Great Plains [2]	49	100	115	115	116	116	111
Wheat-corn-livestock farms, Northern Great Plains [2]	59	100	117	114	117	117	116
Wheat-roughage-livestock farms, Northern Great Plains [2]	51	100	117	115	113	115	112
Winter wheat farms, Southern Plains [2]	52	100	118	119	117	120	121
Wheat-pea farms, Washington and Idaho [2]	51	100	121	122	120	118	126
Sheep ranches:							
Northern Great Plains livestock area [2]	47	100	133	119	117	116	115
Southwest [2]	(3)	100	123	103	97	103	96
Cattle ranches:							
Northern Great Plains livestock area [2]	50	100	126	121	119	121	125
Intermountain region [2]	53	100	121	120	115	121	123
Southwest [2]	(3)	100	128	108	110	104	109

[1] Prices paid for production items, interest, taxes, and wages as published in monthly Agricultural Prices.
[2] Prices paid, including taxes (but not interest), and wages to hired labor as published in *Farm Costs and Returns*, Agriculture Information Bulletin No. 158, ARS, USDA.
[3] Not available.

SOURCE: *Policy for Commercial Agriculture*, Joint Committee Print, 1957, p. 516.

cotton farms range from only 1 percent for irrigated operations in the high plains of Texas to some 12 percent in the southern Piedmont.

The USDA study implies that this variety of experience even within a given commodity area constitutes an argument against the use of separate parity indexes. The report says:[12] "A specialized cost rate or prices-paid index reflecting the average wheat farmer under this variety of situations might be considered no more satisfactory to producers in particular areas or particular kinds of operations than the generalized parity index."

To us, this variety of experience seems rather to be a point in favor of using separate parity indexes for separate areas producing the product under different conditions.

A Separate Parity Index for Cotton.—We may form some quantitative estimate of the effects of using separate commodity parity indexes

[12] Doc. 18, op. cit., p. 24.

by considering the case of cotton. Estimates for cotton are quoted from a USDA report on cotton.[13]

An index representing the composite average price of items used in producing the United States cotton crop was developed for each year 1945 through 1955 and for 1939. Items included were labor, land planting seed, insecticides, fertilizer, irrigation water, power and machinery, and ginning. Items not included were management and general overhead.

The index was computed in the following manner. A weighted aggregate of actual prices of the production items was obtained for each year, using as weights the average quantity of each item used in 1947–49. In the development of the weights, the total quantity of each item actually employed in production was used whether or not it was usually purchased. The 1947–49 period was chosen largely because better data were available for those years than for any others. However, this period is considered representative of the postwar period before reinstitution of acreage allotments and marketing quotas.

The price index for production items was calculated by dividing the weighted aggregates for each year by that for a base year and multiplying the result by 100. To derive a parity price based only on items used in cotton production, the price index for each year was multiplied by the parity price for the same base year, as then calculated.

In addition to being an index for cotton rather than an average index for all farms, this concept differs from the present parity formula in two important respects. Items used in family living are given weights and are included in present parity calculations but not in cotton's own parity calculations.[14] The present parity formula includes and gives weight only to items which are purchased, and weights are assigned on the basis of relative importance in total purchased items. In cotton's own parity full weight is given to each item even though only a part of the item is usually purchased.

Table 4 gives results of the calculation of cotton's own parity in index form for selected years and for 2 base years. Two important comparisons can be made from these data. For the period 1945–55, with 1945 taken as a base, the index of cotton's own parity changed in about the same proportion as did the old parity index. If such comparisons are made from the prewar base of 1939, however, it will be noted that the index of cotton's own parity increased about threefold while the old parity index rose only to about 2¼ times its 1939 level. This difference is due largely to the fact that labor and land account for a substantial part of the total weight in cotton's own parity. Farm wage rates and farmland values have increased at a substantially greater rate

[13] *Report on Various Methods of Supporting the Price of Cotton*, 85th Cong., 1st sess., S. Doc. 12, 1957, pp. 13–16.

[14] It might be better to include or exclude items used in family living so as to make the two directly comparable.

since 1939 than have prices of items such as fertilizer and farm machinery.

TABLE 4.—*Indexes of Parity Prices of Cotton*

Year	1945=100		1939=100	
	Old parity	Cotton's own parity	Old parity	Cotton's own parity
1939	70	51	100	100
1945	100	100	143	196
1950	149	132	214	258
1955	159	157	238	307

Representativeness of the Price Base Period.—Another important question concerning the parity price indexes is the representativeness of the base periods.

A recent USDA report on the parity formula stated the requirement for a base period clearly. It said, "The base period should be fairly representative of the kind of agriculture that is likely to prevail for some years ahead. Otherwise, the parity measurement would have little meaning in appraising the agricultural situation as it develops in the future." [15] How do the parity price indexes measure up to this standard?

In the computation of "modernized" parity prices, the adjusted base price for each farm product is computed by dividing the average of the United States average price for that product, over the most recent 10 years, by the average index of prices received by farmers for the same 10 years. This permits the parity prices for individual farm products to reflect recent market forces, but keeps the parity prices for farm products as a group on the original 1910–14 base.

This brings the *relative* parity prices in line with *relative* market prices over the most recent 10-year averages. But it only "modernizes" the relations among the prices. It leaves the parity prices all high or low relative to the most recent 10-year average relationship, if the 1910–14 base is high or low relative to that most recent 10-year average relationship. It leaves parity prices as a group, and the overall parity ratio, as anciently based as before.

In a world full of pronounced and rapid changes, it is anachronistic to measure relative prices with reference to a 1910–14 base, 46 years and two world wars in the past. Increasingly with the passage of time since 1910–14, therefore, suggestions have been made that the 1910–14 base should be replaced by a more recent base.

Alternative Base Periods.—A 1958 USDA report [16] considered several different more recent periods, and computed their effects on the average level of prices. Their figures are shown in Table 5. We have added two more recent bases, 1950–59 and 1955–59, to bring their table up to date. The report recommended that the base period be changed from 1910–14 to 1947–56. No legislation to that effect, however, has been passed.

[15] *Possible Methods of Improving the Parity Formula*, Report of the Secretary of Agriculture pursuant to Section 602 of the Agricultural Act of 1956, 85th Cong., 1st sess., S. Doc. 18, Feb. 1, 1957, p. 18.
[16] *Ibid.*

TABLE 5.—*Indexes of Prices Received and Paid by Farmers and the Parity Ratio, Selected Periods, 1910–59*

Period	Index of prices received (1910–14=100)	Index of prices paid (parity index, 1910–14=100)	Parity ratio (1910–14=100)	Percentage change in the average level of parity prices
1910–14	100	100	100	0
1925–29	147	161	91	−9
1935–39	107	125	86	−14
1947–51	275	258	108	+8
1947–56	264	270	98	−2
1950–59	254	281	90	−10
1955–59	237	280	83	−17

If 1947–56 was a good base for the USDA to recommend in 1957, would 1950–59 be a better base to recommend in 1960?

The answer depends upon what the parity index is used for. If the purpose is still to compare the purchasing power of farm products as a group now with their purchasing power in 1910–14, but without the stigma attached to the use of this ancient base, then the use of the 1947–56 base would come within 2 points of doing the job.

If, however, the purpose is to follow the principle laid down in the USDA report, that the base period should be fairly representative of the kind of agriculture that is likely to prevail for some years ahead, then the 1950–59 base would come closer to doing this job than the 1947–56 base. The use of the 5-year base, 1955–59, would come still closer. Agriculture for some years ahead is likely to be more similar to agriculture over the past 5 or 10 years than to agriculture in 1910–14 or 1949–56.

It is not within the power of the USDA to change the base period on its own initiative. The base period is laid down as 1910–14 in the legislation, amended by later legislation to permit the use of the most recent 10-year average of market prices for individual farm products, but still retaining 1910–14 as the base for farm products as a group. New legislation would be required to permit the use of a more recent base than 1910–14.

APPRAISAL OF THE PARITY INDEXES WITH REFERENCE TO THE CHIEF USES TO WHICH THEY ARE NOW BEING PUT

The present parity price indexes were designed originally simply to measure the prices received by farmers, the prices paid by farmers, and the ratio between the two price indexes. But with the passage of time, the indexes began to be used also for two other different purposes.

1. The parity ratio—the ratio between the prices received and the prices paid by farmers—is widely used now to measure the economic status of agriculture.[17] This ratio is published on the front page of the monthly USDA publication, *Agricultural Prices*, and is frequently quoted as it comes out by newspapers and farm magazines. When the parity ratio is 78, for example, as it was in February 1960, that

[17] For example: "The drop in prices . . . caused the parity ratio—index of relative farm prosperity—to fall one point . . ." (*Des Moines Register*, July 28, 1956).

". . . the parity ratio—measure of the farmers' well-being in relation to the whole economy . . ." (News item by Charles Bailey of the *Des Moines Register's* Washington Bureau, *Des Moines Register*, Nov. 30, 1957, p. 11).

"Regardless of the pros or cons of the parity formula in regard to getting price supports, it still is the nation's chief yardstick for measuring the relative position of the farmer and the long-term price trends." (John Harms, "Outlook for Ag. Leaders," *County Agent and Vo-Ag Teacher*, February 1959).

ratio is regarded as indicating that the prices received by farmers are too low; some regard a parity ratio of 78 as indicating that the prices of farm products are 22 percent too low. Some farm programs are being proposed with the objective of raising the prices of farm products to 100 percent of parity, presumably in the belief that this would restore agriculture to its fair economic status.

In addition, the ratio between the actual market price for an individual farm product and the parity price of that product is widely used as a measure of the economic status of the producers of that product. This ratio for corn, for example, was 61 in February 1960. These ratios are also published monthly in *Agricultural Prices*. Such a ratio, of course, does not measure the economic status of the producers of the product but merely expresses a purchasing power ratio for the particular commodity.

2. Since the passage of the Agricultural Adjustment Act of 1938, the parity prices for some individual farm products (actually, certain percentages of parity prices) have been used as bases for the price-support operations of the CCC for those products. The operations involve billions of dollars, as shown earlier in this report.

Are the indexes well suited to these two purposes?

It is obvious that the parity price indexes are not well suited to these two purposes. Economic status depends upon *income* relationships, not merely upon price relationships. The measurement of income requires that quantities purchased and sold be taken into account as well as prices. Price supports also need to be set with reference to quantities as well as to prices.

One simple illustration of this inaccuracy is the situation in 1958. The parity ratio then was only 85, but net income per person on farms was at an alltime high. Even net income per person on farms from farm sources only was exceeded by only two other years, and then only slightly.[18]

Another illustration is the divergence between movements of the parity ratio from 1951 to 1959 and the income per person on farms over the same period. The parity ratio declined 27 points, from 107 in 1951 to 80 in 1959. But income per person on farms declined only 2 percent, from $983 to $960. Even income from farming alone declined only about 14 percent. This point is important, since technological developments in agriculture production have markedly changed the output per unit of input over the past 15 or 20 years. Accordingly, suggestions have been made that these changes in quantities should be included in the present parity price formula.

Here again the USDA is not free to include, on its own intitiative, quantities as well as prices in order to measure the purchasing power of the farmer. New legislation would be required for that purpose, also. The USDA, however, has made some estimates of the effects of taking quantities into account, for farm products as a group.[19]

[18] See Table 7 later in this report.
[19] The next four paragraphs are quoted from S. Doc. 18, p. 26 (see footnote 15).

These estimates are presented and discussed below.

Illustration of an Efficiency Modifier and Its Effect on Parity Prices.—

"The development of a price-support system which permits the adjustment of price supports in line with changes in efficiency involves the calculation of an index of efficiency for a period of years. This index is referred to in this report as the "efficiency modifier."

A preliminary index treating agriculture as a whole has been developed to reflect the trend in the use of productive inputs per unit of farm output since 1940. This index and the separate indexes of the total volume of selected farm inputs and of farm output from which it was derived are shown in Table 6 and Figure 4.

TABLE 6.—*Indexes of Selected Farm Inputs, Total Farm Output, and the Ratio of Selected Inputs Per Unit of Output*

[1940=100]

Year	Index of selected farm inputs [1]	Index of total farm output [2]	Index of selected farm inputs per unit of total farm output [3]
1940	100	100	100
1941	99	104	95
1942	103	116	89
1943	104	113	92
1944	104	117	89
1945	100	116	86
1946	99	118	84
1947	99	114	87
1948	100	125	80
1949	101	122	83
1950	99	120	82
1951	103	124	83
1952	103	129	80
1953	103	130	79
1954	103	130	79
1955	104	135	77

[1] Preliminary. Based on estimated inputs of total farm labor, land, buildings, machinery, fertilizer and lime, combined on basis of average 1947–49 cost rates.
[2] Published regularly on a 1947–49 basis.
[3] Preliminary index of selected inputs divided by index of total farm output.

Source: S. Doc. 18, p. 27.

NOTE.—The information in this table has been discontinued and replaced by the slightly different series given in Table 6a, based on estimated farm production output in terms of constant dollars.

According to these preliminary calculations, which can only be considered indicative of the general trend, farmers, as a group, used some 23 percent fewer inputs per unit of farm production in 1955 than in 1940. The chart also indicates that the improvement in efficiency reflected by the reduction in inputs per unit of output was substantially greater in the 5-year war period, 1940 to 1945, than in the ensuing 10 years.

For reasons of lack of data, the index presently cannot be carried back to the 1910–14 base period. Thus, it is impossible to appraise the effects of an adjustment for improved efficiency on parity prices since that period. However, even

FIGURE 4

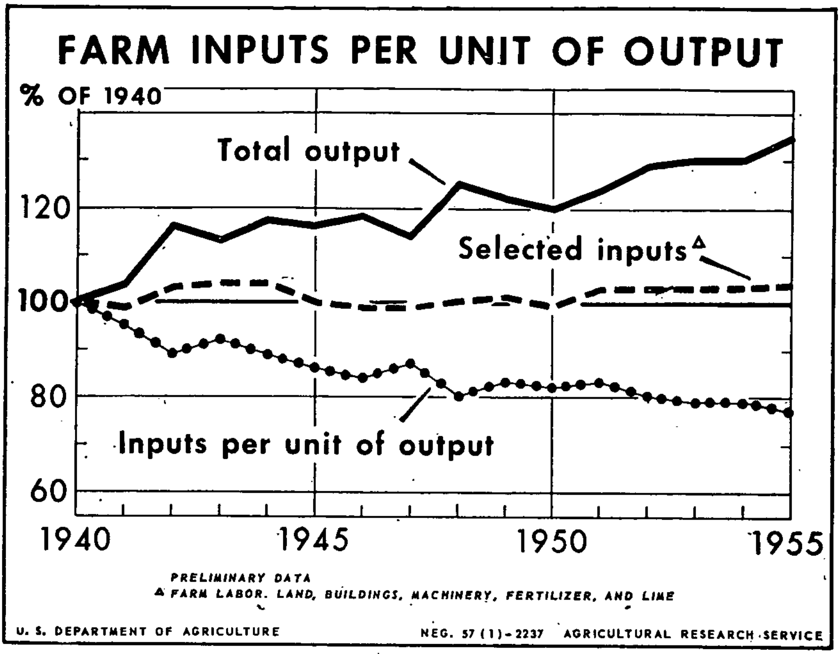


TABLE 6a.—*Index Numbers of Inputs, Output, and Productivity, United States Agriculture, 1940–58*

[1947–49=100]

Year	Production inputs [1]	Farm output	Productivity [2]
1940	97	82	85
1941	97	85	88
1942	101	96	95
1943	101	94	93
1944	101	97	96
1945	99	95	96
1946	99	98	99
1947	99	95	96
1948	100	104	104
1949	101	101	100
1950	101	101	100
1951	104	104	100
1952	104	108	104
1953	103	109	106
1954	102	109	107
1955	102	113	111
1956	102	114	112
1957	100	114	114
1958	101	124	123

[1] Combined volume of farm labor; land and service buildings; machinery and equipment; fertilizer and lime; purchases of feed, seed, and livestock; and miscellaneous production items, in terms of constant dollars.

[2] Output per unit of production inputs.

SOURCE.—B. R. Stauber, USDA.

> if only the efficiency increases that have taken place in agriculture since 1940 were given full weight in the parity formula, the level of parity prices for all farm products would have been reduced 23 percent in 1955. If the adjustment for efficiency were to reflect only the improvement since 1945, the parity prices would be reduced some 10 percent. In other words, if the base period for parity prices is moved to more recent years, the effect of the efficiency modifier on parity prices would be sharply diminished. Thus, assuming the recent 10-year period as a base, the downward adjustment to the parity level from the efficiency factor would be about 5 percent.

The USDA report then goes on to raise the question whether an efficiency modifier should be used in the parity formula in any case. Its use would imply that the gains from increased production efficiency should be passed on to the consumers in the form of lower prices. The report states that this is not the general practice in the nonfarm economy, and concludes that it should not be adopted in agriculture.

The USDA report also developed an efficiency modifier for a specific farm product, cotton.

Efficiency Modifier for Cotton.—

> In order to calculate the efficiency modifier, it was necessary to obtain estimates of the quantities of the major items used in producing the United States cotton crop [inputs] during each year of the 1945–55 period and for 1939. The items included are the same as those listed on page 13 [of the report]. The estimates of inputs relate to those actually used in cotton production each year and do not make allowance for resources that might have been unemployed in a given year because of fluctuations in the size of the cotton crop.
>
> Production input data were obtained from several sources. The acreage of cotton planted and harvested, the total quantities of labor, fertilizer, and planting seed used in producing cotton and the cost of ginning were available largely from published information. Estimates of power, machinery, irrigation, and other items were developed from various local area studies and from miscellaneous sources.
>
> An index of the quantity of physical inputs required to produce a bale of cotton for the years 1945–55 and for 1939 was computed as follows: A weighted measure of the total quantity of inputs used in production was obtained for each year by applying appropriate average 1947–49 prices as weights to the quantity of each input item used in each year and summing their products. These weighted aggregates were converted to index numbers by dividing the total for each year by the total for a base year and multiplying by 100. An index of the number of bales of cotton produced was also calculated. The index of quantity of inputs was divided by the index of bales produced to derive an index of quantity of inputs per bale of cotton, called the efficiency modifier.

FIGURE 5

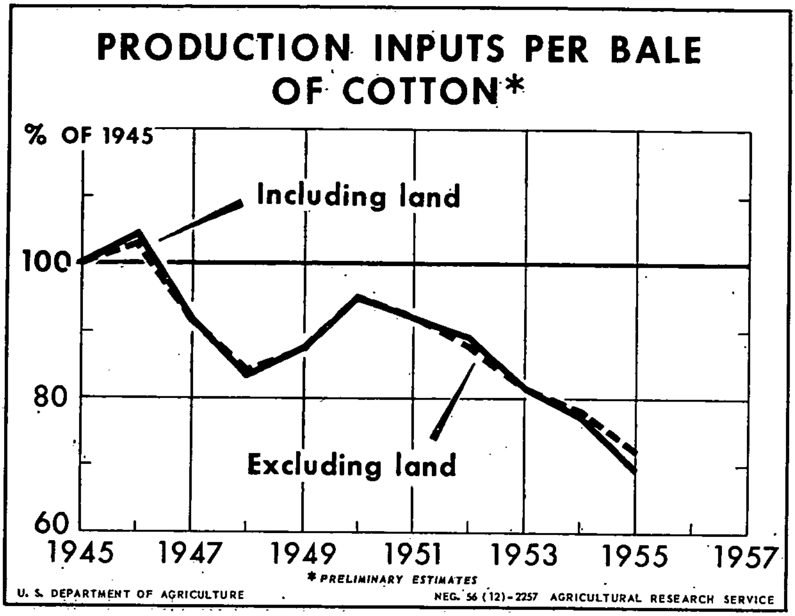
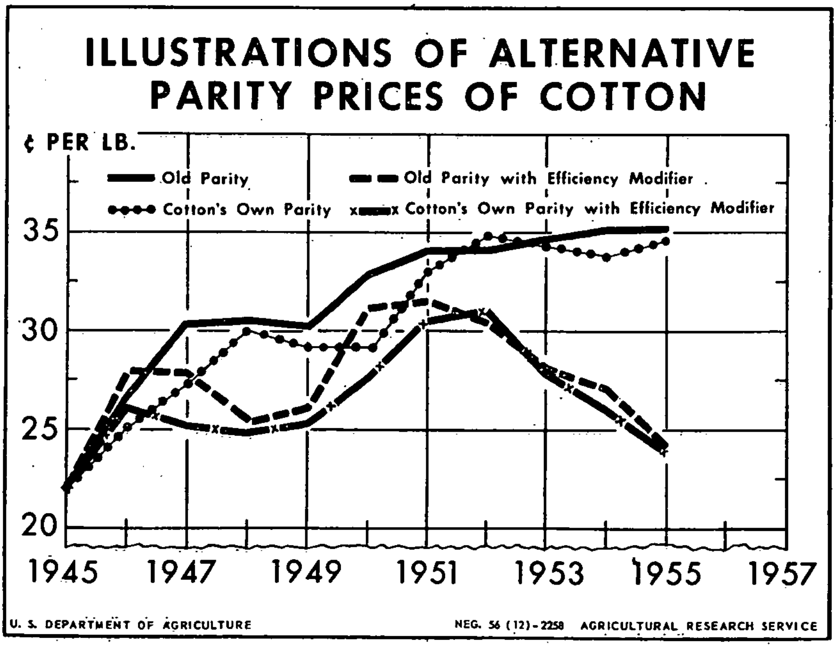


FIGURE 6



> The results of these calculations using the year 1945 as a base are given in Figure 5. In general, there has been a sharp decrease in inputs per bale and they were 30 percent less in 1955 than in 1945. The inclusion or exclusion of land as an input had relatively little effect on the index during the 1945–55 period.
>
> A trend line fitted to the data shown in Figure 5 indicates that the quantity of inputs per bale of cotton has decreased at an average rate of about 3 percent per year from 1945 to 1955. Figure 6 shows the parity price for cotton that would result from use of cotton's own parity and the efficiency modifier during the 1945–55 period. As indicated above, the use of cotton's own parity (1945 equals 100) would have resulted in substantially the same parity prices for cotton in most years as those resulting from the use of old parity. In this instance the old parity price for 1945 and cotton's own parity for 1945 were assumed to be the same. The application of the efficiency modifier (1945 equals 100) to the old parity price of cotton and to cotton's own parity would have reduced the parity price of each substantially during most of the years considered. For example, if in 1955 the efficiency modifier were multiplied by the old parity price and by cotton's own parity, respectively, resulting prices would be about 24.2 and 23.9 cents a pound. Without use of the efficiency modifier, cotton's own parity would have been about 34.6 cents in 1955. Old parity in 1955 was 35.1 cents per pound.[20]

The use of the efficiency modifier would have had a much larger effect than the use of a separate parity index for cotton; the efficiency modifier would have lowered the parity price of cotton in 1955 by 31 percent.

Parity Ratio Type Indexes for Different Income Classes of Farms.—Just as a single parity index is calculated for all farm products, so it is made to cover all farms, ranging from very small to very large. Again the question arises: how important are the different farm expenses, in this case for different size farms? To answer the question, it would be necessary to compute separate parity-ratio type indexes for different sizes of farms, with size measured by income class. The indexes weighted by appropriate quantities for low-income farms may differ appreciably from those for medium- or high-income farms, and from all of them as a group.

Data for prices received are not available by economic (income) class of farm. Accordingly, only the regular United States index of prices received could be used for all income classes. Data for prices paid are available by economic class, but only based on the 1955 expenditure survey extended back to 1952.

> Similarly, data on prices paid are not available by economic class of farm, and it was likewise impossible to approximate a prices-paid index for low-income farmers prior to 1952, when the current weighting data were first used. Expenditure data by economic class of farm were not available for earlier weight-base periods. In consequence, indexes

[20] S. Doc. 18, pp. 15–16.

of cost rates for goods and services for the several economic classes (including interest, taxes, and wage rates) were computed with 1955 equalling 100 and all linked to the current index in September 1952. These approximations were made using existing group indexes with weights appropriate to each economic class.

These "approximations" probably measure with acceptable accuracy the course of prices paid for commodities and services for the several economic classes of farms since September 1952. It is doubtful that they can be considered as having more than casual value as measures of comparisons of the present with 1910–14 by economic class of farm, since linking in September 1952 *assumes* that the indexes for all economic classes were identical for that date—a most unlikely assumption.[21]

Within these limitations, the USDA computed parity ratios for large (classes I–II), medium (classes III–V), and small (classes VI–VIII) farms from 1952 to 1959.

A summary of the weights used in the computation of the indexes by economic class of farms is given in Table 7. The price indexes themselves are shown in Table 8. The maximum difference between them at any one time was 3 points. They ended only one point apart in 1959.

TABLE 7.—*Farm Expenditures: Percentage Distribution by Economic Class of Farm, United States, 1955, by Commodity and Service Groupings*

[Percent]

Item	Economic class of farm			
	All	I-II	III-V	VI-VIII
Living	39.5	22.5	41.6	68.4
Food	13.4	6.69	14.2	24.7
Clothing	6.34	3.63	7.07	10.3
Auto and supplies	5.63	3.11	5.40	10.9
Household operations	5.77	3.49	6.37	9.00
Household furnishings	3.99	2.46	4.21	6.70
Building materials	4.37	3.12	4.35	6.80
Production	50.9	62.6	50.7	28.4
Feed	12.8	17.0	11.6	7.06
Livestock	4.60	7.51	3.31	1.62
Motor supplies	8.39	8.43	9.93	5.10
Motor vehicles	4.38	4.47	5.08	2.75
Farm machinery	5.21	5.95	5.85	2.45
Building and fencing	5.20	6.30	5.01	3.41
Fertilizer and lime	4.11	4.88	4.10	2.60
Equipment and supplies	3.66	5.17	3.06	1.99
Seeds	2.55	2.89	2.76	1.42
Total commodities	90.4	85.1	92.3	96.8
Taxes	2.04	2.45	2.21	.86
Interest	.96	1.05	1.06	.56
Cash wage rates	6.60	11.4	4.43	1.78
Total commodities, taxes, interest, cash wage rates	100.0	100.0	100.0	100.0

SOURCE.—Materials supplied upon request to the Price Review Committee by AMS, USDA.

21 These paragraphs and tables were supplied by the Agricultural Marketing Service, USDA.

TABLE 8.—*Parity Ratios for All Farm Product Price and Ratio Approximations by Type of Farm Groupings, United States, September 1952 and June 1953–59*

Month and year	Economic class of farm			
	All	I-II	III-V	VI-VIII
September 1952	101	101	101	101
June 1953	92	93	91	90
June 1954	88	89	87	86
June 1955	85	86	84	84
June 1956	86	87	85	84
June 1957	81	83	81	80
June 1958	85	86	84	84
June 1959	81	82	81	81

SOURCE: Same as Table 7.

The differences between the parity ratios by economic class of farms in this brief period, then, were small. But the results raise another type of question concerning the parity index for all farms as a group. The low income farms (classes VI–VIII) account for only about 3.5 percent of the value of total farm products sold, according to the *1954 Census of Agriculture*. These farms, however, account for 35 percent of the expenditures by farm operators for living, but for only 10.8 percent of expenditures for production, other than interest, taxes, and wage rates.[22]

This raises the question, then, whether these class VI–VIII farms, which contribute so little to farm production but so much to the weight of family living items in the computation of the parity index, should continue to be included in the computations. Most of them are not farms at all in the ordinary use of the term, but only country residences, part-time farms, etc.

The new definition of a farm used in the 1960 Census, raising the minimum size from 3 acres to 10 acres (unless it has sales of $250 or more per year), will cut out a number of these "farms." This may reduce the size of the problem, but the problem as such will still remain. There are good grounds for maintaining that the coverage of the indexes should be restricted to commercial farms (classes I through VI) defined as those with annual sales of $250 or more, with operator not working off the farm as much as 100 days, and farm sales greater than income of family members from off-farm sources, with weights appropriate to those farms.

Farm Parity Indexes Reflecting Farm Income from Nonfarm Sources.—A full measure of the economic status of farmers would presumably cover as wide a range of farmers' income as of their expenditures. Since the indexes of prices paid by farmers cover their entire living costs, it can be argued that the corresponding index of prices received by farmers should reflect the large amounts of income received from off-farm work.

That is, the present index of prices paid by farmers covers living as well as production expenses, so it obviously pertains to the farm household as a consumer as well as producer. Accordingly, the index of prices received should be equally comprehensive, and include farm income from off-farm sources as well as from farm sources.

[22] *Department of Agriculture Appropriations for 1960.* Hearings before the Subcommittee of the Committee on Appropriations, H.R., 86th Cong., 1st Sess., p. 215.

This argument is not quite airtight. The division of the two kinds of costs (of farm production and of running the household) is not the same as the division of income (from the farm and from off the farm). But there are in any case good grounds for wanting two price indexes—the present one representing the price component of farm income from the sale of crops and products and a second one representing the price component of farm income from nonfarm sources. The two then could be combined to show the farm income from nonfarm sources as well as from farm sources. Neither one would be right or wrong; both would have their uses, much the same as it would be useful to compile an index of professors' income from books, consultation, etc., as well as from salaries alone.

A parity price formula could be constructed to reflect farm income from off-farm sources as well as from farm sources by assuming that the off-farm income is all wage income (although in fact there are numerous other minor sources) and adding a term in the formula to the present prices-received term, made up of the off-farm wage ratio multiplied by the percentage of net farm income that comes from off-farm sources.

The USDA publishes two series of farm incomes in dollar terms—farm income from farm sources and farm income from nonfarm sources. Off-farm wages could be used as the prices, and the relative size of the off-farm income could be used as the weights, to compute indexes of "prices" received by farmers for their services sold off-farms. The combined formula would include the present price term, plus another one to represent off-farm prices, as follows:

$$\text{Index of prices received} = P_{FI}\left(\frac{\Sigma P_1 Q_0 / \Sigma P_0 Q_0}{\text{1935–39 Avg. of numerator}}\right) + P_{0FI}\left(\frac{W_1}{W_0}\right)$$

Where

P_{FI} in the first term is the 1935–39 average percentage of farm income that comes from farm sources,

P_{0FI} in the second term is the 1935–39 average percentage of farm income that is received from off-farm sources,

$^{w}1$ is the off-farm wage rate of the current year,

^{w}o is the average off-farm wage rate for 1935–39.

The off-farm term would have fixed weights, like the present (on-farm) price index term does. It, therefore, would reflect only changes in wage rates, not changes in the quantity of off-farm services. But at least in this respect it would be similar to the present price index term.

The weight base period for the present index of prices received is 1953–57. The *price* base period for the present index of prices received, as a group, is still 1910–14. This base period cannot be used for the off-farm income term, since the relevant division of farm and off-farm income data runs back only to 1934. Accordingly, if the two terms are to be comparable, a more recent base period (since 1934) has to be used. The period chosen is 1935–39 and the adjustment is made by dividing both terms by their 1935–39 average.

The annual indexes computed by the use of this formula are given in Table 9. The shortcomings of these indexes are obvious. The assumption that all farm income from off-farm source is received in the form of wages is clearly an oversimplification. The off-farm income may consist chiefly of factory wage income, but while the exact percentages are unknown, a substantial part of the off-farm income consists of items other than factory wages—interfarm work, interest, insurance payments of one sort or another, miscellaneous receipts as from hauling, custom work, and perhaps other items. There is no satisfactory way of introducing the prices of such items into a price index. It is difficult to put a price to be entered on an interest return, or on an insurance indemnity payment, and to include a wage element for off-farm work which may vary from merely the exchange of a little labor with a neighbor down the road to virtually full-time employment in a factory for some of the small "farmers" living in metropolitan or industrial suburbs.

TABLE 9.—*Index of Prices Received by Farmers for Income from Both Farm Sources and Off-Farm Sources, United States, 1934–59*

Year	Million dollars (1)	Million dollars (2)	Million dollars (3)	Percent (4)	Percent (5)	Index (6)	Dollars (7)	Index (8)	Index (9)	Index (10)
1934	2,941	1,900	4,841	60.75	39.25	90	0.53	56.96	28.51	85.47
1935	5,303	2,000	7,303	72.61	27.39	109	.55	68.99	29.59	98.58
1936	4,332	2,300	6,632	65.32	34.68	114	.56	72.15	30.12	102.27
1937	6.048	2,500	8,548	70.75	29.25	122	.62	77.21	33.36	110.57
1938	4,405	2,300	6,705	65.70	34.30	97	.63	61.39	33.89	95.28
1939	4,489	2,500	6,989	64.23	35.77	95	.63	60.13	33.89	94.02
1940	4,570	2,700	7,270	62.86	37.14	100	.66	63.29	35.51	98.80
1941	6,573	3,100	9,673	67.95	32.05	124	.73	78.48	39.27	117.75
1942	9,924	3,800	13,724	72.31	27.69	159	.85	100.63	45.73	146.36
1943	11,822	4,200	16,022	73.79	26.21	193	.96	122.15	51.65	173.80
1944	11,807	4,400	16,207	72.85	27.15	197	1.02	124.68	54.88	179.56
1945	12,411	4,200	16,611	74.72	25.28	207	1.02	131.01	54.88	185.89
1946	15,252	4,300	19,552	78.01	21.99	236	1.09	149.36	58.64	208.00
1947	15,544	4,900	20,444	76.03	23.97	276	1.24	174.68	66.71	241.39
1948	17,789	5,100	22,889	77.72	22.28	287	1.35	181.64	72.63	254.27
1949	12,926	5,200	18,126	71.31	28.69	250	1.40	158.23	75.32	233.55
1950	14,000	5,300	19,300	72.54	27.46	258	1.47	163.29	79.07	242.38
1951	16,334	5,600	21,934	74.47	25.53	302	1.59	191.14	85.54	276.68
1952	15,337	6,100	21,437	71.54	28.46	288	1.67	182.28	89.85	272.13
1953	13,278	6,000	19,278	68.88	31.12	255	1.77	161.39	95.23	256.62
1954	12,691	5,800	18,491	68.63	31.37	246	1.81	155.69	97.38	253.07
1955	11,767	6,300	18,067	65.13	34.87	232	1.88	146.83	101.14	247.97
1956	11,617	6,700	18,317	63.42	36.58	230	1.98	145.57	106.52	252.09
1957	11,780	6,600	18,380	64.09	35.91	235	2.07	148.73	111.37	260.10
1958	14,017	6,400	20,417	68.65	31.35	250	2.13	158.23	114.59	272.82
1959	11,826	6,800	18,626	63.49	36.51	240	2.22	151.90	119.44	271.34

Column Legend

(1) Net income of farm operators from farm sources, including government payments.
(2) Net income of farm operators from off-farm sources.
(3) Total net income of farm operators (col. 1+col. 2).
(4) Percent of farm operator income coming from farm sources (col. 1 divided by col. 3).
(5) Percent of farm operator income coming from off-farm sources (col. 2 divided by col. 3).
(6) Current index of prices received by farmers.
(7) Current hourly wages for all manufacturing production workers or nonsupervisory employees.
(8) First term of new index or prices received (income from farm sources).
(9) Second term of new index of prices received (income from off-farm sources).
(10) Proposed new index of prices received by farmers for income from both farm and off-farm sources.

CONCEPTS OF PARITY INCOME

The preceding discussion has moved step by step from price indexes, which reflect income very imperfectly, to various modifications which bring the price indexes closer and closer to measures of income. The present section takes the last step and deals with concepts of parity income.

HISTORICAL DEVELOPMENT OF CONCEPT

It was recognized as parity price indexes were developed that prices were only one of the things that determined income. It was recognized also that what farmers were really interested in was income, not prices. So, along with the development of parity prices went several legislative attempts to define parity income.

During the 1930's the concept of parity income developed as an extension of the parity price concept. It first appeared in legislation in 1936. A declared purpose of the Soil Conservation and Domestic Allotment Act of 1936 was the "reestablishment, at as rapid a rate as the Secretary of Agriculture determines to be practicable and in the general public interest, of the ratio between the purchasing power of the net income per person on farms and the income per person not on farms that prevailed during the 5-year period August 1909–July 1914, inclusive, as determined from statistics available in the United States Department of Agriculture and the maintenance of such ratio."

There was a good deal of criticism of this definition of parity income. In the Agricultural Adjustment Act of 1938, therefore, the definition was changed to read as follows: "Parity, as applied to income, shall be that per capita net income of individuals on farms from farming operations that bears to the per capita net income of individuals not on farms, the same relation as prevailed during the period from August 1909–July 1914."

The 1938 definition of parity income differed from the 1936 definition in four respects. (1) The term "net" was used; it was applied to per capita income of persons not on farms as well as to that of persons on farms. (2) The "purchasing power" provision in the 1936 definition was omitted in the 1938 definition. (3) The income of persons on farms included income from farming operations only. (4) The limitation "as determined from statistics available in the USDA" was omitted.

The 1938 definition of net income avoided the difficulty of measuring intangibles—the nonmonetary items of income on the farm and off the farm, such as the independence of the farm operator compared with the dependence of the urban worker on his job, the open air nature of farm work, the generally poorer schools in the country, etc. It did not call for direct comparisons of current net incomes on farms with current net incomes off farms. Thus if current income data showed net farm income to be only half as much as nonfarm income (or twice as much) that would still represent income parity if half (or twice) were the relation that existed in the base period.

The Agricultural Act of 1948 changed the definition of parity farm income again. Title II, Sec. 201 (2), defined parity farm income as follows: "(2) 'Parity,' as applied to income shall be that gross income from agriculture which will provide the farm operator and his family with a standard of living equivalent to those afforded persons dependent upon other gainful occupation." This new definition was incorporated in the Agricultural Act of 1949 and became effective on January 1, 1950.

This definition got away from the problems involved in any formula which includes a base period. It got away, for example, from the problem of what base period to use (one period might have a much higher or lower parity income than another). It also got away from the problem of continuous obsolescence of any base period. But it got into a different problem—the problem of comparing levels of living in different occupations. The new formula involved more than a simple comparison of farm and nonfarm dollar incomes. It required in addition the determination of differences in their purchasing power, as represented by their different levels of living. So far, this new definition, while "effective January 1, 1950," has not been computed and put into actual use.

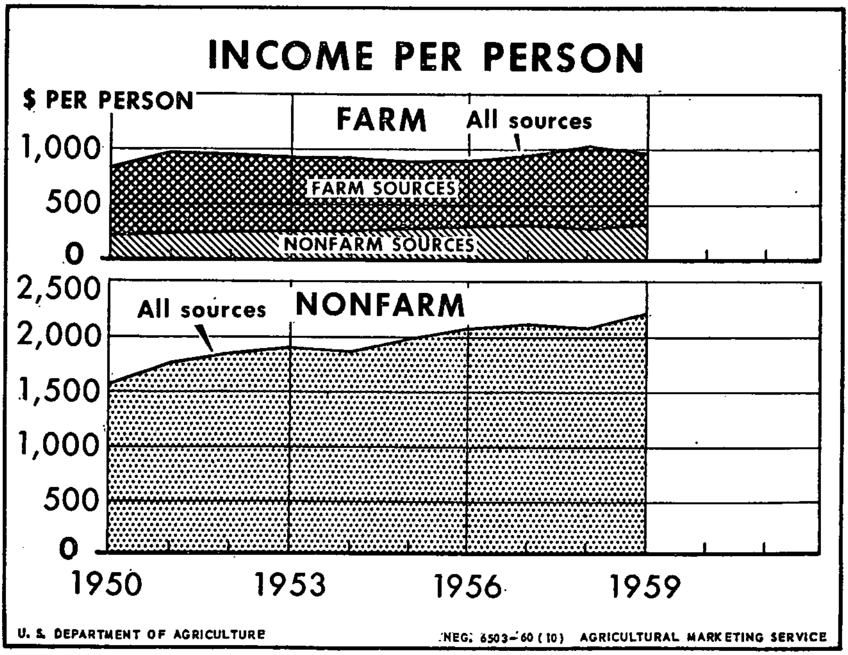
The Agricultural Act of 1948 also defined parity gross income for individual commodities as follows: "'Parity' as applied to income from any agricultural commodity for any year, shall be that gross income which bears the same relationship to parity income from agriculture for such year as the average gross income from such commodity for the preceding ten calendar years bears to the average gross income from agriculture for such ten calendar years." This was the first time that a method of apportioning income parity among the individual commodities was prescribed by law. Inasmuch as the overall level of parity gross income could not be determined, this additional step has not had much significance.

Alternative Measures of Farm Income

What income data are available which might make it possible to measure the economic status of farmers more accurately than the existing parity prices indexes, and permit parity *income* to be computed?

Measures of gross income (prices received times quantities sold) and of cost (prices paid times quantities purchased) are available, and they can be used to measure net income per farmer. The USDA compiles several measures of this character.

Figure 7



FARM INCOME PER CAPITA

The one that is most widely publicized is farm income per capita. It is shown in Table 10 and Figure 7. These data are the basis for the frequently repeated statement that farm income is only about half as high as nonfarm income.

TABLE 10.—*Average Per Capita Net Income, by Residence and by Source of Income, 1910–58*

Year	Average net income per capita of—									
	Farm population						Nonfarm population			Total population from all sources
	From agriculture			From nonfarm sources	From all sources		From agriculture	From nonfarm sources	From all sources	
	Excluding Government payments	Government payments	Total		Amount	Percent of nonfarm average				
1910	$147	0	$147	--------	--------	--------	$12	--------	--------	$360
1920	282	0	282	--------	--------	--------	22	--------	--------	711
1930	166	0	166	--------	--------	--------	14	--------	--------	613
1931	129	0	129	--------	--------	--------	10	--------	--------	484
1932	80	0	80	--------	--------	--------	8	--------	--------	345
1933	90	$3	93	--------	--------	--------	9	--------	--------	323
1934	94	12	106	$59	$165	35.3	9	$459	$468	391
1935	167	15	182	62	244	47.2	10	507	517	448
1936	148	8	156	72	228	38.5	10	582	592	502
1937	207	9	216	80	296	46.1	10	632	642	558
1938	153	12	165	74	239	40.6	9	580	589	506
1939	147	21	168	81	249	39.8	10	616	626	537
1940	153	21	174	88	262	38.2	10	675	685	588
1941	230	16	246	103	349	42.4	13	810	823	715
1942	360	19	379	130	509	49.2	16	1,018	1,034	920
1943	476	21	497	157	654	52.7	17	1,223	1,240	1,126
1944	497	27	524	172	696	52.4	17	1,311	1,328	1,211
1945	528	26	554	166	720	54.9	17	1,295	1,312	1,205
1946	618	26	644	162	806	62.2	21	1,274	1,295	1,204
1947	634	10	644	181	825	59.2	22	1,372	1,394	1,287
1948	756	9	765	197	962	62.7	22	1,512	1,534	1,433
1949	561	6	567	200	767	50.8	20	1,491	1,511	1,381
1950	616	10	626	212	838	52.9	20	1,565	1,585	1,461
1951	741	10	751	232	983	55.8	20	1,743	1,763	1,641
1952	701	10	711	251	962	52.0	20	1,829	1,849	1,712
1953	658	8	666	265	931	48.9	19	1,883	1,902	1,764
1954	644	10	654	262	916	49.5	18	1,834	1,852	1,724
1955	593	9	602	281	883	44.6	17	1,962	1,979	1,830
1956	576	21	597	300	897	43.2	17	2,057	2,074	1,917
1957	586	41	627	306	933	44.1	16	2,100	2,116	1,967
1958	702	46	748	295	1,043	50.3	18	2,055	2,073	1,946

The averages in this table are derived by dividing appropriate totals appearing in Tables 3 and 5 by the population estimates in Table 6. Gaps arise from the same difficulty mentioned in footnote 4 of Table 3 (of the source publication).

SOURCE.—*The Farm Income Situation*, AMS, USDA, Feb. 1960, p. 32. This is a revised version of page 39, FIS-174, July 1959.

These figures, however, understate the average farm income per person in the usual sense of the word farm, because "farm" in this case is "farm" as defined by the Census. This definition includes "farms" all the way down to 3 acres in size if the value of agricultural products exclusive of home gardens is $150 or more; it includes places of less than 3 acres if the value of *sales* of agricultural products is $150 or more.

Most of the "farmers" on these small "farms" are not farmers at all in the ordinary sense of the term. Their chief source of income is a nonfarm job, not farming. About 1.7 million of these small farms are classed as noncommercial farms—part-time, residential, or subsistence farms. These are really acreages where city people live, rather than farms. They constitute more than a third of the total of 4.8 million farms of all kinds in the United States.[23] This large number of "not really farms" inflates the number of farms and farmers that is divided into the total United States net farm income, and therefore reduces the "average farm income" substantially below the average income for *commercial family* farms, with the part-time, residential, and subsistence farms taken out.[24]

In 1956, these part-time and residential farms, nearly one-third of all farms, made only 2 percent of all sales of farm products. "Clearly, the welfare of the families on low-production farms is more closely linked with the expanding nonfarm sector of our economy than with agriculture as such."[25]

In addition, the estimates of net farm income value the farm products produced on the farm and consumed by the farm household at farm prices. There is some disagreement whether these products should be valued at farm prices or at retail prices. People in town have to buy their food at retail prices, so on the face of it, farm and nonfarm incomes would seem to be more nearly comparable if the food produced on the operator's own farm were valued at retail prices too. Against this it may well be argued that a gallon of peas in the pod just picked from the farm garden by the farm wife, for example, is not at all comparable with the package of frozen peas ready to put in the pot purchased by the city housewife. For another example, however, eggs from the henhouse are just as ready to cook as eggs in the retail store, and usually fresher.

On the average, farmers get less than half the consumer's retail food dollar. The USDA estimates that valuing the food that is included in farm income at retail prices would add a little more than $100 to per capita farm income.[26]

The allowance for the value of housing provided by the farm, including taxes, insurance, interest, maintenance, and depreciation, in recent years has been about $300 per farm. Average nonfarm rental runs about $600. Many farm homes, of course, do not have indoor toilets or baths and other facilities that are usually found in urban homes; but most of them provide more room, quiet, and seclusion than the average urban home. Perhaps the USDA allowance is too conservative.

A part of the difference between the average farm and nonfarm income results from the fact that a large part of the farm population is concentrated in the South where incomes and prices are generally

[23] To include them in the farm average is about like computing the average salary of professors by including numerous graduate students receiving part-time stipends, if these stipends were very small and the graduate students lived chiefly on other sources of income.

[24] E. W. Gross and N. M. Koffsky made this point clear in their article, "Measuring the Incomes of Farm People," *Journal of Farm Economics,* XXXI: 4, Part 2, Nov. 1949, p. 1, 110. So do K. L. Bachman and R. W. Jones, *Sizes of farms in the United States,* USDA Tech. Bul. 1019, July 1950, p. 7, where they say that this "often gives rise to serious misconceptions," and show that excluding these noncommercial farms raises the average operator's net income 27 percent.

But Koffsky and Grove, in their later article, "The Current Income Position of Commercial Farmers," Joint Committee Print, Policy for Commercial Agriculture, Nov. 22, 1957, pp. 79–90, overlook the matter, and conclude on the basis of United States average data that "the level of income per person on farms has averaged roughly one-half of the non-farm level." By this they unwittingly give support to the "serious misconception."

[25] *Economic Report of the President,* January 1959, p. 99.

[26] S. Doc. 18.

lower than in the North where industrial workers are concentrated. Income comparisons on a state or regional basis reveal about a 25 percent smaller difference between farm and nonfarm incomes than the straight United States averages quoted above.

The USDA estimates that adjustment to take these food and housing and location matters into account would increase per capita farm income about 30 percent.[27]

INCOME PER FARM WORKER

Another answer concerning relative farm and nonfarm income is based on a comparison of income per farm worker [28] with the average annual wage per employed factory worker. These per worker income figures for 1958 were: farm $2,129; factor, $4,342. Conclusion: Income per farm worker is only about half as high as income per factory worker. Income per farm *operator* was $2,990 in 1958. This is only about 69 percent as high as income per factory worker..

This situation appears to confirm the conclusion that is usually drawn from the per capita income figures given in the preceding section—that farm income is only about half as great as nonfarm income. But it is also misleading. The farm workers include the family workers, and the farm income includes a good deal of disguised partial unemployment, whereas the factory workers include only *employed* factory workers. The average farm worker's income data therefore understate the actual average income much as the per capita income data do, partly for the same reason and partly for different ones.

Alternative Measures of Parity Farm Income

The USDA, well aware of the characteristics of the United States average farm income data given above, has discussed their use in parity income computations in the following terms: [29]

> The idea of parity income centers on the relation between incomes of farm people and incomes of nonfarm people. Generally, there are two basic approaches to the problem of determining parity income. One involves the maintenance of a historical income ratio which would provide for farmers' incomes and opportunities for a rising standard of living to grow at the same rate as others. The alternative approach would establish the standard of equal incomes or equal living standards as between farmers and others. Both approaches have appeared in the farm legislation relating to income parity. These alternatives lead to a wide range in results. Historical incomes ratios as between farm and nonfarm persons on which the two earlier parity income definitions were based indicate that incomes in agriculture in recent years were about at or above parity as compared with 1910–14. On the other hand, direct income comparisons tend to show that farm income falls far short of the nonfarm

[27] S. Doc. 18, p. 39.

[28] *The Farm Income Situation*, p. 40. This is total United States realized net farm income from farming, including government payments, divided by the total average number of persons engaged in agriculture during the year, including farm operators and other family workers (except those doing housework only) as well as hired workers.

[27] S. Doc. 18, p. 39.

level, although there are considerable questions as to the meaning of measures of this kind.

PARITY INCOME BASED ON HISTORICAL INCOME RATIOS

Table 10 (p. 485)—
shows the available data on income per person living on farms from all sources, nonfarm as well as farm, and income per person not living on farms, from 1910 to 1958, as published regularly by the Department. It should be noted that estimates of nonfarm income received by farm people, such as wages or salaries from nonfarm occupations, are not available prior to 1934. However, for purposes of indicating, in Table 11, at least roughly, how income ratios in recent years compared with the 1910–14 period, we have made an assumption that nonfarm income received by farm people in the 1910–14 period totaled $1.5 billion annually. This assumption is based on the probability that poorer transportation in those days restricted nonfarm job opportunities to farm people as compared with recent years.

TABLE 11.—*Illustrative Per Capita Income Parity Ratios of Farm Population to Nonfarm Population, as Defined in Agricultural Legislation of 1936, 1938, and 1934–56*

Year	Ratio of per capita income of farm population to per capita income of nonfarm population		Year	Ratio of per capita income of farm population to per capita income of nonfarm population	
	Income to farm people from farming only (1938 legislation)	Income to farm people from all sources (1936 legislation)		Income to farm people from farming only (1938 legislation)	Income to farm people from all sources (1936 legislation)
1934	74	85	1946	159	149
1935	115	115	1947	150	144
1936	85	94	1948	162	153
1937	109	112	1949	122	124
1938	91	99	1950	128	128
1939	88	97	1951	139	136
1940	83	93	1952	125	127
1941	98	104	1953	116	121
1942	119	120	1954	116	121
1943	131	129	1955	102	111
1944	129	128	1956 [1]	98	108
1945	138	134			

[1] Tentative estimates; revised Mar. 5, 1957.

NOTE.—Assumes nonfarm income of farm population averaged $1,500,000,000 in the base years 1910–14. No reliable estimate of such income is available for that period.

For more recent data, see Table 11a.

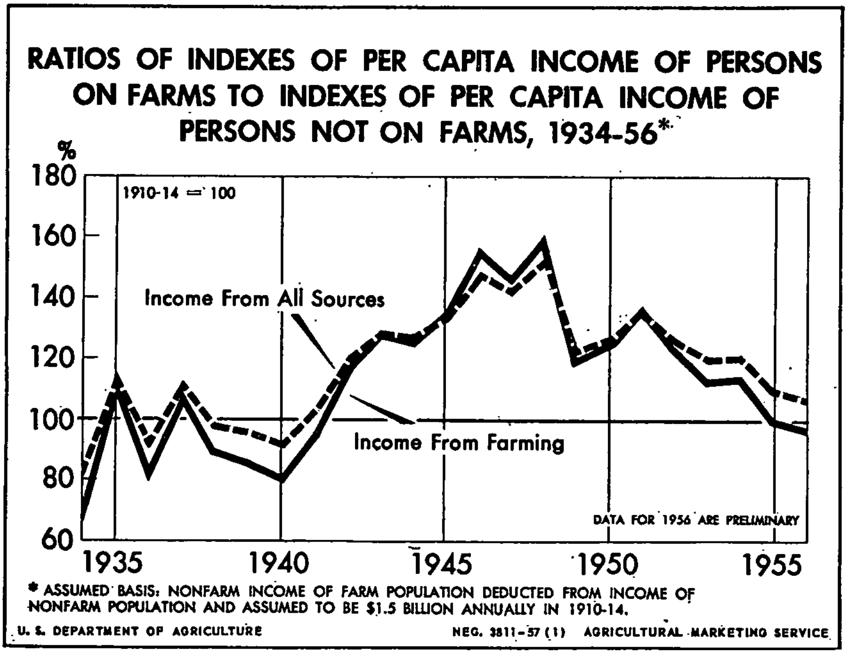
TABLE 11a.—*Illustrative Per Capita Income Parity Ratios of Farm Population, as Defined in Agricultural Legislation of 1936, 1938, and 1934–59*

Year	Ratio of per capita income of farm population to per capita income of nonfarm population	
	Income to farm people from farming only (1938 legislation)	Income to farm people from all sources (1936 legislation)
1953	114	119
1954	115	120
1955	99	109
1956	94	105
1957	97	108
1958	117	123
1959	95	106

NOTE.—Table 11 has been revised from 1953 forward, and this table from B. R. Stauber, USDA, presents the later data.

The chart (Figure 8) compares income ratios based on the 1910–14 base period, illustrating the definitions involved in the acts of 1936 and 1938 as follows:

FIGURE 8



(1) Ratios of per capita net income of the farm population from farming to per capita net income of the nonfarm population (1938 legislation). The data for 1956 indicate that the income ratio of farm people to nonfarm people was about the same as in the 1910–14 period, ranging from slightly above the pre-World War I base to slightly below, depending on whether or not income of the nonfarm population is adjusted to exclude nonfarm income received by farm people.

(2) Ratios of per capita net income of the farm population from all sources to per capita net income of the nonfarm population (1936 legislation). Assuming income from nonfarm sources averaged $1.5 billion annually in 1910–14, this series indicates that the 1956 income ratio was 8 percent higher than in the 1910–14 period. However, a considerable range is actually involved, depending on the assumption made with respect to nonfarm income of farm people in the base period. If the size of that income is assumed to total $2 billion for the 1910–14 average, which would imply approximately the same rate of farmers' participation in nonfarm activities as in recent years, the 1956 income ratio would be 2 percent lower than in the 1910–14 period. On the other hand, if farmers' participation in nonfarm activities was even less than first assumed, and nonfarm income was only $1 billion for the 1910–14 average, the 1956 income ratio would be 20 percent higher.

The index or ratio which compares income of farm people from all sources with income of nonfarm people appears to be more appropriate as a measure of farm well-being than the ratio including only the income of farm people from farming. Nonfarm income is becoming increasingly important as a source of income to farm people and as a means of maintaining or increasing living levels.

It should be noted also that comparison of these ratios need not be limited to the 1910–14 base period. If for example, the last 10 years (1947–56) were considered as the base period, the ratio involving income per person on farms from farming would be 22 percent under the base average ratio, and the ratio involving income per person on farms from all sources some 15 percent lower. The parity price ratio for 1956 was also 15 percent under the 1947–56 average.

Finally, in considering the appropriateness of historical income ratios, the comparison can involve other series such as earnings in agriculture as compared with earnings in selected other occupations, which are shown in Table 12 from 1929 to 1956. For example, the ratio of hourly earnings in agriculture, after allowance for capital investment, to hourly earnings in manufacturing could be used in place of an income ratio.

TABLE 12.—*Average Hourly Earnings in Agriculture and in Selected Industries, 1929–59*

[Dollars]

Year	Workers in agriculture		Production workers in industry [2]					
	Realized return per hour to all farm labor and management [1]	Composite hired farm wage rate per hour	Manufacturing	Bituminous coal mining	Building construction	Class I railroads	Telephone	Wholesale trade
1929	0.259	0.241	0.566	0.681	----------	----------	----------	----------
1930	.172	.226	.552	.684	----------	----------	----------	----------
1931	.093	.172	.515	.647	----------	----------	----------	----------
1932	.055	.129	.446	.520	----------	----------	----------	----------
1933	.106	.115	.442	.501	----------	----------	----------	----------
1934	.172	.129	.532	.673	0.795	----------	----------	----------
1935	.203	.142	.550	.745	.815	----------	----------	0.648
1936	.232	.152	.556	.794	.824	----------	----------	.667
1937	.221	.172	.624	.856	.903	----------	0.774	.698
1938	.187	.166	.627	.878	.908	----------	.816	.700
1939	.199	.166	.633	.886	.932	0.730	.822	.715
1940	.200	.169	.661	.883	.958	.733	.827	.739
1941	.315	.206	.729	.993	1.010	.743	.820	.793
1942	.450	.268	.853	1.059	1.148	.837	.843	.860
1943	.610	.353	.961	1.139	1.252	.852	.870	.933
1944	.618	.423	1.019	1.186	1.319	.948	.911	.985
1945	.684	.472	1.023	1.240	1.379	.955	.962	1.029
1946	.858	.515	1.086	1.401	1.478	1.087	1.124	1.150
1947	1.010	.547	1.237	1.636	1.681	1.186	1.197	1.268
1948	.945	.580	1.350	1.898	1.848	1.301	1.248	1.359
1949	.803	.559	1.401	1.941	1.935	1.427	1.345	1.414
1950	.826	.561	1.465	2.010	2.031	1.572	1.398	1.483
1951	.920	.625	1.59	2.21	2.19	1.73	1.49	1.58
1952	.879	.661	1.67	2.29	2.31	1.83	1.59	1.67
1953	.874	.672	1.77	2.48	2.48	1.88	1.68	1.77
1954	.805	.661	1.81	2.48	2.60	1.93	1.76	1.83
1955	.754	.675	1.88	2.56	2.66	1.96	1.82	1.90
1956	.839	.705	1.98	2.31	2.80	2.12	1.86	2.01
1957	.776	.728	2.07	3.02	2.96	2.26	1.95	2.10
1958	.970	.757	2.13	3.02	3.10	2.44	2.05	2.17
1959 [3]	.716	.798	2.22	3.25	3.22	2.54	2.18	2.24

[1] After allowance for capital investment. Derived in Table 10.
[2] *Economic Report of the President*, January 1957, p. 149.
[3] Preliminary.

Data since 1956, and revisions of some data before 1956, from Murray Thompson, USDA.

DIRECT COMPARISONS, FARM AND NONFARM

The alternatives relating to direct standard of living or income comparisons between farm and nonfarm people present unusual and difficult problems of measurement and of interpretation. For example, the Agricultural Act of 1948 defined parity income, effective January 1, 1950, as "'Parity,' as applied to income, shall be that gross income from agriculture which will provide the farm operator and his family with a standard of living equivalent to those afforded persons dependent upon other gainful occupation. 'Parity,' as applied to income from any agricultural commodity for any year, shall be that gross income which bears the same relationship to parity income from agriculture for such year as the average gross income from such commodity for the preceding 10 calendar years bears to the average gross income from agriculture for such 10 calendar years."

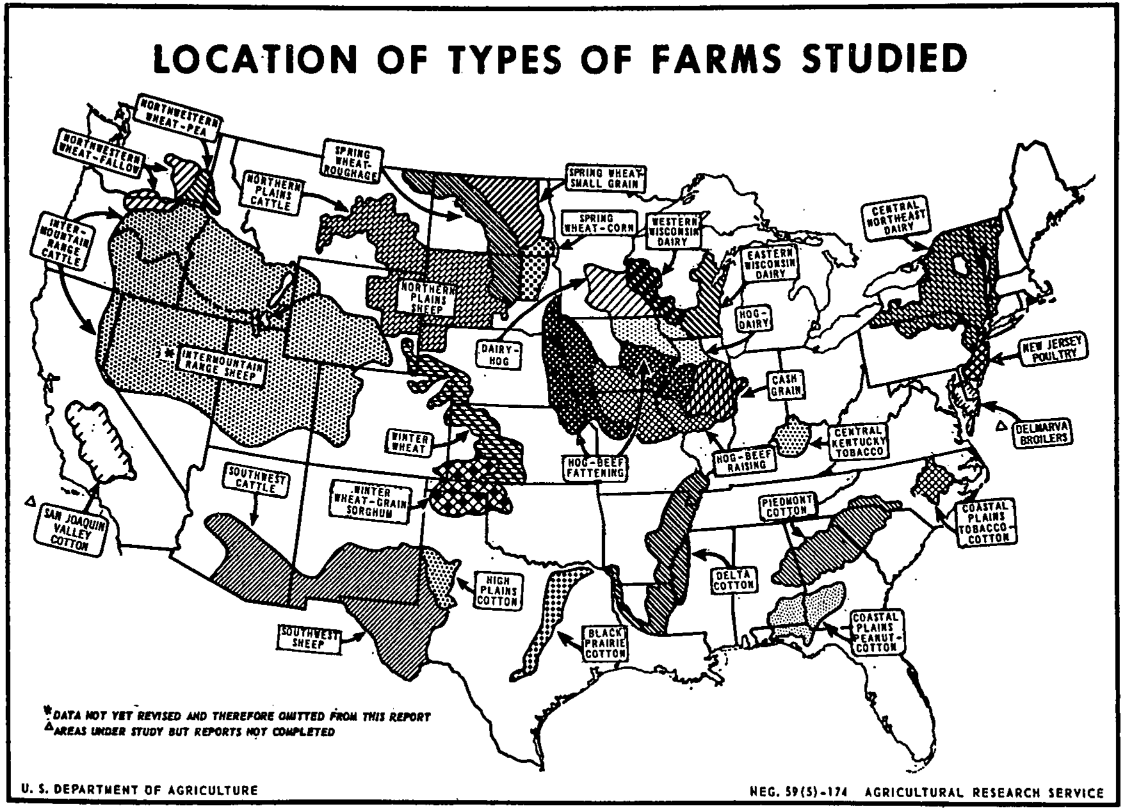
This Department has not been in a position to bring statistical meaning to this definition. The determination of equivalent standards of living involves much more than equivalent dollar incomes. A family's well-being depends not only on income but also on other factors such as the accumulation of assets and consumer goods over the years, the availability of adequate health and educational facilities, and such intangible factors as are involved in evaluating life in the country versus life in the city. It is noteworthy that indexes developed to measure changes in levels of living of farm operator families indicate that there has been persistent improvement each year in farm operator family level of living since 1951 despite declines in farm income during most of that period.

COMMERCIAL FAMILY FARM INCOME, BY AREAS

The preceding discussion has run in terms of national average incomes, with all the shortcomings of those incomes that have been pointed out. A more appropriate measure of farm income for our purposes is the average income for *commercial family farms*.

The USDA publishes another set of figures which show this income per commercial family farm, by types of farming in different areas. These figures are compiled differently from those given above. They do not show income per farm for the United States as a whole; they show income per commercial family farm for each of the 32 chief types of farming, separately for each of the relatively homogeneous areas shown in Figure 9.

FIGURE 9


LOCATION OF TYPES OF FARMS STUDIED
NORTHWESTERN WHEAT-PEA
NORTHWESTERN WHEAT-FALLOW
INTER-MOUNTAIN RANGE CATTLE
NORTHERN PLAINS CATTLE
SPRING WHEAT-ROUGHAGE
SPRING WHEAT-SMALL GRAIN
SPRING WHEAT-CORN
WESTERN WISCONSIN DAIRY
EASTERN WISCONSIN DAIRY
CENTRAL NORTHEAST DAIRY
NORTHERN PLAINS SHEEP
INTERMOUNTAIN RANGE SHEEP
DAIRY-HOG
HOG-DAIRY
CASH GRAIN
NEW JERSEY POULTRY
DELMARVA BROILERS
WINTER WHEAT
HOG-BEEF FATTENING
HOG-BEEF RAISING
CENTRAL KENTUCKY TOBACCO
SOUTHWEST CATTLE
WINTER WHEAT-GRAIN SORGHUM
PIEDMONT COTTON
COASTAL PLAINS TOBACCO-COTTON
SAN JOAQUIN VALLEY COTTON
HIGH PLAINS COTTON
DELTA COTTON
BLACK PRAIRIE COTTON
COASTAL PLAINS PEANUT-COTTON
SOUTHWEST SHEEP
*DATA NOT YET REVISED AND THEREFORE OMITTED FROM THIS REPORT
△AREAS UNDER STUDY BUT REPORTS NOT COMPLETED
U. S. DEPARTMENT OF AGRICULTURE
NEG. 59(5)-174 AGRICULTURAL RESEARCH SERVICE

The average net income per farm for the past few years is computed separately for each area, and published annually in tabular form.[30] The most recent data are given in Table 13. The unweighted average of these incomes was $7,238 in 1958.[31] This on the face of it looks like a pretty good income. It is about 75 percent higher than the average annual wage per employed factory worker in 1958.

TABLE 13.—*Net Farm Income, Specified Types of Commercial Farms, 1958, With Comparisons*

[Dollars]

Type and location of farm	Average			1955	1956	1957	1958[1]
	1937–41	1947–49	1948–57				
Dairy farms:							
Central Northeast	960	3,892	4,029	4,248	4,179	4,641	4,810
Eastern Wisconsin	1,480	4,365	3,837	2,816	3,456	3,656	3,360
Western Wisconsin	1,236	3,284	3,146	2,434	2,978	3,286	3,341
Dairy-hog farms: Southeastern Minnesota	1,217	3,868	3,871	3,427	3,926	3,919	4,302
Corn Belt farms:							
Hog-dairy	1,642	5,639	5,796	4,419	5,108	6,339	7,448
Hog-beef raising	928	3,370	3,727	3,016	3,169	4,135	5,488
Hog-beef fattening	2,521	10,665	8,658	4,433	6,899	7,445	9,619
Cash grain	2,627	8,930	8,495	6,737	9,382	7,239	7,811
Poultry farms: New Jersey (egg-producing)	----------	5,975	3,875	3,273	2,326	2,127	2,693
Cotton farms:							
Southern Piedmont	495	1,565	1,776	2,297	1,570	1,529	2,473
Texas:							
Black Prairie	1,019	3,090	2,491	2,572	903	1,790	2,885
High Plains (non-irrigated)	1,675	6,411	4,143	2,544	2,526	6,718	9,265
High Plains (irrigated)	----------	10,761	10,945	7,039	12,594	11,228	17,819
Mississippi Delta:							
Small	----------	1,923	1,802	2,033	1,714	1,271	1,344
Large-scale	----------	20,465	21,018	25,921	20,383	12,020	13,598
Peanut-cotton farms: Southern Coastal Plains	----------	2,313	2,519	3,133	2,759	2,265	3,410
Tobacco farms:							
Kentucky, tobacco-livestock	1,192	3,334	3,365	2,850	3,200	2,873	3,414
North Carolina:							
Tobacco-cotton	----------	3,208	3,338	3,550	3,674	2,290	3,394
Tobacco-cotton (large)	----------	3,923	4,158	4,463	4,944	2,779	4,430
Tobacco (small)	----------	2,354	2,618	2,885	2,970	2,021	2,667
Spring wheat farms:							
Northern Plains:							
Wheat-small grain-livestock	872	6,323	5,007	6,090	6,930	4,053	6,867
Wheat-corn-livestock	1,127	5,972	4,310	2,547	3,278	5,332	7,104
Wheat-roughage-livestock	533	5,370	4,012	4,259	2,899	4,475	5,032
Winter wheat farms:							
Southern Plains:							
Wheat	1,174	10,016	7,050	4,914	3,764	5,923	12,446
Wheat-grain sorghum	1,092	9,433	4,302	1,647	2,332	5,178	11,465
Pacific Northwest:							
Wheat-pea	2,764	11,864	12,404	9,989	13,363	15,040	9,645
Wheat-fallow	2,026	12,776	12,469	6,664	7,637	14,785	12,107
Cattle ranches:							
Northern Plains	954	6,439	4,954	2,863	2,108	4,164	6,409
Intermountain region	2,892	8,665	8,039	4,625	5,728	8,382	13,115
Southwest	----------	5,698	3,898	3,016	−1,245	4,873	9,242
Sheep ranches:							
Northern Plains	2,711	6,914	7,975	4,557	6,057	10,949	13,289
Southwest	----------	5,224	4,380	3,294	723	6,062	11,328

[1] Preliminary.

SOURCE.—*Farm Costs and Returns*, ARS, USDA, Agr. Info. Bul. No. 176, revised August 1959.

[30] *Farm Costs and Returns; Commercial Family-Operated Farms by Type and Location*, ARS.

These farm cost and income data are not obtained by a survey of actual farms. They are synthetic figures, calculated by applying estimated changes in prices, yields, inputs, etc., to model type farms. They are estimates of the average costs and returns, not of all commercial family farms in each area, but of the type of farming specified in each area.

[31] This unweighted average is not as accurate an average as if the data were weighted by the numbers of farms in the different types. These numbers are not available at present. I believe that this lack of accuracy is small compared with that of the other averages discussed in the preceding sections. In any case, national averages do not mean much because of the great diversity behind the averages, as shown later in this paper. I use them here only because they are used so much in national policy discussion. My chief point is made later with the diverse area data.

But before we conclude from this that average net farm income for commercial family farms really was substantially higher than nonfarm income, we need to recognize that these net farm income figures include what is called the "charge for capital." [32] Deducting this charge for capital from the net income leaves the return to the operator and his family for their labor and management only. This is done for the years 1954 to 1958 in Table 14.

TABLE 14.—*Return to Operator and Family Labor, 1954–58*

[Dollars]

	1954	1955	1956	1957	1958
Dairy farms:					
Central Northeast	2,551	2,984	2,758	2,887	2,844
Eastern Wisconsin	1,899	1,489	2,044	1,796	1,372
Western Wisconsin	1,493	1,553	2,033	2,040	1,997
Dairy-hog farms: Southeastern Minnesota	2,119	2,056	2,438	1,986	2,231
Corn Belt farms:					
Hog-dairy	4,729	2,689	3,345	3,991	5,061
Hog-beef raising	1,573	1,624	1,679	2,116	3,320
Hog-beef fattening	6,551	1,995	4,426	4,286	6,287
Cash grain	5,107	3,200	5,556	2,125	2,500
Poultry farms: New Jersey (egg-producing)	−3,529	606	−703	−565	−239
Cotton farms:					
Southern Piedmont	680	1,521	756	567	1,479
Texas:					
Black Prairie	756	1,501	−260	294	1,287
High Plains (nonirrigated)	2,912	929	880	4,222	6,542
High Plains (irrigated)	9,460	3,563	9,054	6,449	12,536
Mississippi Delta:					
Small	1,197	1,627	1,233	649	649
Large-scale	11,012	19,798	12,133	2,360	2,820
Peanut-cotton farms: Southern Coastal Plains	1,804	2,760	2,444	1,644	2,664
Tobacco farms:					
Kentucky tobacco-livestock	2,517	1,906	2,251	1,477	2,021
North Carolina:					
Tobacco-cotton	1,889	2,513	2,606	1,067	2,081
Tobacco-cotton (large)	1,419	2,580	3,034	618	2,145
Tobacco (small)	1,843	2,354	2,430	1,410	2,014
Spring wheat farms:					
Northern Plains:					
Wheat-small grain-livestock	421	4,428	5,076	1,633	4,384
Wheat-corn-livestock	1,738	867	1,593	2,953	4,629
Wheat-roughage-livestock	1,244	2,678	1,190	2,339	2,702
Winter wheat farms:					
Southern Plains:					
Wheat	4,426	1,898	702	2,025	8,015
Wheat-grain sorghum	261	−1,454	−715	1,415	7,373
Pacific Northwest:					
Wheat-pea	10,459	3,915	6,489	6,152	359
Wheat-fallow	(1)	(1)	(1)	8,215	5,250
Cattle ranches:					
Northern Plains	979	95	−841	633	2,777
Intermountain Region	1,995	2,004	2,033	5,101	9,211
Southwest	−5,113	−2,174	−6,471	−1,701	2,068
Sheep ranches:					
Northern Plains	1,107	1,259	2,609	6,626	8,560
Southwest	−6,337	−3,821	−6,366	−3,004	1,530

[1] Not available.

SOURCE.—Ag. Inf. Bul. 176, ARS, USDA.

[32] "This charge is the current value of land and buildings times the current interest rate on farm mortgages on this kind of property in the area plus estimated current value of working assets (machinery and equipment, livestock, and crops on hand January 1) times the interest rate on intermediate and short-term farm loans" (ARS, USDA, *Costs and Returns, Commercial Family-Operated Farms by Type and Size, 1930–1951,* Statistical Bulletin No. 197, November 1956, page 7).

"There are slight differences in our net farm income as presented in the various statistics on commercial farms and the net farm income released by AMS and given in figure 2, page 5, of AIB No. 176. Our farm series are based on owner-operated farms. Our net farm income therefore is the return to operator and family for their labor and management and for return on all capital or investment regardless of ownership. The net farm income used in figure 2 includes as expenditure interest on farm mortgage debt and net rent to nonfarm landlords" (letter from Wylie Goodsell, Assistant Chief of Costs, Income, and Efficiency Research Branch, USDA, December 17, 1959).

The charge for land and buildings in the charge for capital was computed differently before 1954, so the returns to operator and family labor before that date are not comparable with the returns for the years after 1954.

These labor and management returns are roughly comparable in concept with the United States average farm income data shown above, but they show the average net income for regular commercial family farms in the areas shown in Figure 9, separately by types of farming in the different areas, rather than for all "farms" as defined in the Census, for the United States as a whole.

The labor and management returns are also more clearly comparable with the earnings of employed factory workers than the net farm income figures given above; they both show the returns to labor, not including a charge for capital in either case.[33]

Significance of the Return to Operator and Family Labor Data.—The simple United States average of the net farm incomes for commercial family farms in 1958 was $7,238. The United States average "return to operator and family labor" after the charge for capital is deducted from the net farm income, shown in Table 14, was $3,702.

This $3,702 is about 24 percent higher than the United States average "farm" income from farming of $2,990 for 1958. Neither series is perfect for showing average farm income, but the data given in the table show more nearly what most people have in mind when they talk about farm policy.

Two things need to be pointed out here. First, practically all the discussion about farm income is based on the United States average "farm" data which include all census "farms" and yield the average farm income figure for 1958 of $2,990 just quoted. Not one man in a thousand who quotes these figures ever quotes these other more meaningful figures for commercial family farms ($3,702 for 1958), perhaps because in most cases he does not know that they even exist.

It would be illuminating if average farm income from nonfarm as well as farm sources could be compared with the incomes of similar small business entrepreneurs in other sectors of the economy. But the author does not know of any such nonfarm data. Discussions of farm income policy, which usually means commercial family farm policy, will not be very accurate until they are based on commercial family farm income data.

The second point is of a different nature. It concerns the dispersion behind the United States average farm income data. Table 14 shows that there are wide differences among the average returns to operator and family labor in the different areas. In 1958, the average returns to operator and family labor ranged from −$239 in New Jersey egg-producing poultry farms to $12,536 in the irrigated High Plains cotton farms in Texas.[34]

Furthermore, most of these differences persist over long periods of time, even in contiguous areas. There is great variation from year

[33] The factory worker ordinarily would not have a "charge for capital" as such, but would have a return on his investments of his savings, comparable in some sense with a farm operator's return on his own savings invested in his farm.

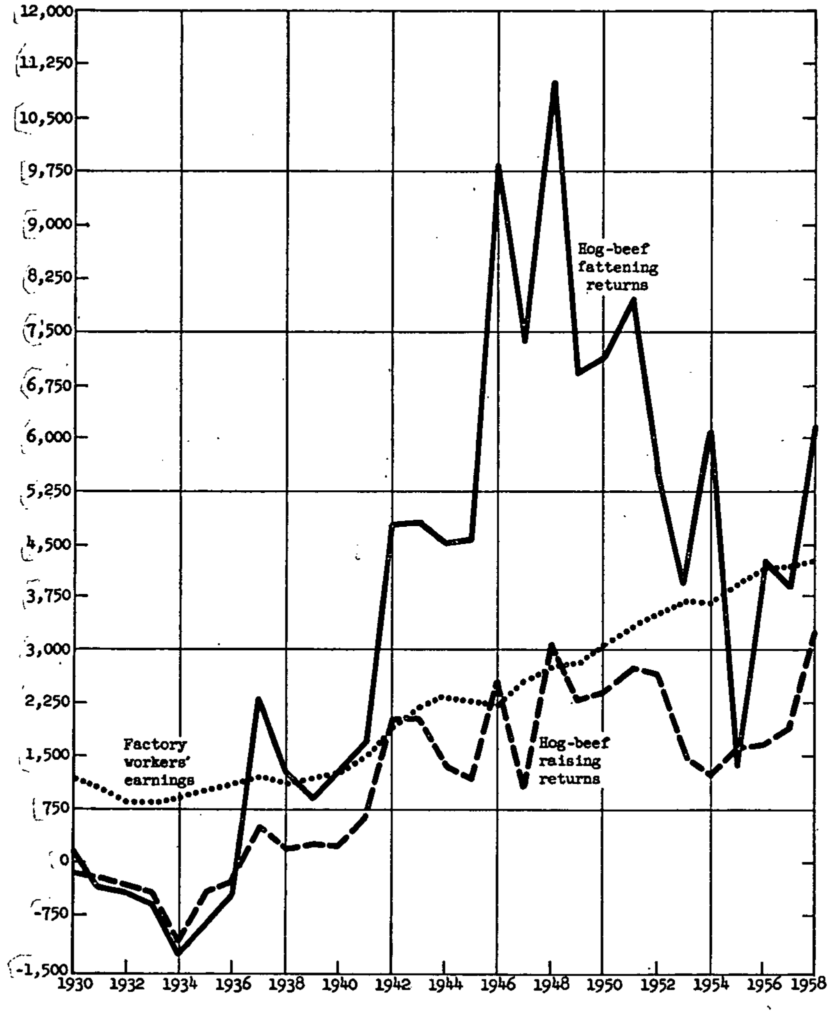
The factory workers' earnings are not perfect for comparison with the labor and management returns to the farm operator. The factory workers' earnings do not include returns to management as the farm returns series does. Also, factory workers are not strictly comparable with farm operators in some other respects. Ordinarily, they do not exercise much management; that is the prerogative of "the management." Furthermore, any income from other members of the family is not included in the factory workers' earnings, whereas they are included in the farm series if the other members of the family worked on the operator's farm, as they do in most cases. But the author does not know of any other authoritative series which is more nearly comparable with farmers' returns for labor and management than the earnings of factory workers.

[34] The average net farm incomes in 1958, not shown in the table, ranged from $1,344 for the small cotton farms in the Mississippi Delta to $17,819 for the irrigated High Plains cotton farms in Texas.

to year due to weather and other such causes, but by and large the incomes in most of the different areas stay in about the same relation to each other year after year. The high areas remain high and the low areas remain low.

The compilation of parity income ratios by areas would show the economic status of farmers, not only for the United States as a whole but area by area. This would facilitate accurate identification of the problem areas within agriculture.

FIGURE 10



A MEASURE OF PARITY INCOME

The preceding discussion of parity farm income leads to the following comment: The economic status of farmers can be more accurately measured by income per farmer than by prices alone. Several measures of farm income are compiled by the USDA. The one that reports the income of commercial family farms by type of farm in the chief producing areas could be compared with the incomes for comparable ability in other occupations. The ratios between the two, area by area and for the United States as a whole, could be used as income parity ratios.

Many problems would be involved in a shift from measures of parity prices to measures of parity incomes.[35]

PARITY PRICES AS BASES FOR PRICE SUPPORTS

We are now ready to appraise parity prices in their present widespread use as bases for the price-support and storage operations of the CCC. These are tremendous operations, as shown earlier in this report, running into billions of dollars.

It is clear that parity prices are quite unsuited to this purpose. They are subject to the same disabilities as the parity ratio—they are based on the same out-of-date 1910–14 base, unrepresentative of "the kind of agriculture that is likely to prevail for some years ahead." Modernized parity mitigates this shortcoming to some extent, so far as the relations among the prices of farm products are concerned, but leaves the basic situation—that the indexes for farm products as a group remain on the 1910–14 base—unaffected. The use of a more up-to-date base would remove one of the obvious shortcomings of parity prices as bases for loan rates. But a more basic shortcoming would still remain.

Commodity loans and storage operations can be used to stabilize prices against year-to-year variations in supply, if the loan rates are set at or a little below long-run average premarket levels. These levels reflect long-run supply and demand. But parity prices, even on a recent base, are not suited to this job. They reflect only changes in supply (i.e., in the quantities that producers stand ready to bring to market at different prices) and do that very imperfectly, since parity indexes reflect only the *prices* of cost items, not their quantities. In addition, as a group, parity prices ignore changes in demand entirely. They therefore, leave out three-quarters of the picture.

The size of the accumulated CCC stocks and the cost of acquiring and maintaining them has amply demonstrated that loan rates cannot for long be set above the long-run market levels determined by demand and supply. Parity prices which reflect demand and supply so imperfectly are obviously not suitable as bases for loan rates. Their use for this purpose has cost billions of dollars, only part of which has gone to farmers, and has brought the farm program into disrepute.

What can be used instead that would be any better? The USDA is understandably reluctant to give up even such an inaccurate instrument as parity prices if the alternative would be to throw the determination of the loan rates each year to the wolves of pressure groups bearing down upon Congress.

An objective basis, however, is available. Recent-period moving averages of open market prices could be used. A 3-year moving average of this sort is already in effect for corn. A similar average is being considered for wheat. This procedure brings together the forces of demand and supply into one price figure which would be

[35] Some of these problems are discussed in *An Alternative Parity Formula for Agriculture*, Iowa State University Research Bulletin 476, February 1960.

close enough to the long-run free-market price to serve as the basis for loan rates to stabilize prices at about that level.

Problems in the Approach to Income Parity

The parity-price ratio, and the parity prices for individual farm products, are evidently inappropriate for the purposes for which they are being used. One reason for this is that they were developed on the basis of what has turned out to be an incorrect diagnosis of the agricultural problem in the first place.

It is incorrect to diagnose the agricultural problem as a price problem, ignoring quantities and costs. In reality, the agricultural problem is an income problem; and it is not a *total gross* agricultural income problem, but a *net per farmer* income problem. This net per farmer income problem requires quite different programs from those that might solve a price problem.

What is needed is to develop and use new and more appropriate measures to deal with the farm problem. Using more recent price bases would at least bring the existing price indexes more up to date. Replacing them by per farmer net income indexes or actual dollar figures would be better, although it would take more time to work out the problems involved. Some of these problems are outlined below.

1. WEIGHTS DERIVED FROM COMMERCIAL FARMS

The quantity weights used in the existing parity price indexes could be based upon commercial farms (classes I through VI) rather than upon all farms as defined in the Census. It would not include the part-time and residential and subsistence farms, which numbered 1,682,000 in 1954, roughly one-third of the total number of all farms, 4,782,000. Even with class VI included, these farms account for only about 3.5 percent of the value of total farm products sold, but for 35 percent of the expenditures by farm operators for living. They thus give an unrepresentatively large weight to family living in the parity index which is chiefly relevant to commercial farmers.

2. SEPARATE PARITY INDEXES

Consideration might well be given to computing separate parity indexes for some of the major farm products, in order to compare them with the single parity index now used for all farm products, measure their differences, and determine how great these differences are in relation to the costs of computing the separate indexes.

3. MORE RECENT BASES

The ancient 1910–14 bases now used in computing the parity price indexes could be replaced by bases that more closely represent "the kind of agriculture that is likely to prevail for some years ahead." New legislation would be required for this purpose.

To this end, the moving average of the most recent 10 years, already being used for the relations among the prices of individual farm products could be applied to the indexes for all farm products as a group. Alternative bases might be 1950–59 or 1955–59. This base then would apply both to the indexes of prices paid and to the indexes of prices received.

Parity prices on this base would be more useful as well as more representative of current conditions than parity prices on the present 1910–14 base. Most farmers are more interested in a measure of their economic status now compared with their average status over the past 10 years than they are their status in the horse-and-buggy 1910–14 period before most of them were born.

In principle, the weight bases could be the same as the price bases. But some features of this possible arrangement need to be considered.

a. If a moving average base, say for the past 10 years, were used both for prices and for weights, the index would not be an unequivocal price index. It would reflect changes in quantities as well as in prices.

Let us take the index of prices received as an illustration. Suppose that a drought or other disaster struck the country one year, and agricultural production declined 3 percent, as it did in 1947, and prices rose 17 percent, as they did then (although the drought was not the only reason why prices rose to that extent). The next year, the inclusion of 1947, when crop production was low, in the new 10-year average weights, would change the composition of the weights. The price index for 1948 therefore would reflect the change in the composition of the weights as well as the change in prices. Conceivably, prices from 1947 to 1948 might not change at all, but the price index would change because of the change in the composition of the weights for the different items in the price index.

This effect would be small, because the change in the composition of the weights for the 10-year moving average base would be only one-tenth as large as the change in the one year 1947. It might be considered preferable to have this small change each year rather than have the large one that takes place when the weight base is moved from one fixed period to the next (such as the 3-point decline that took place in January 1959 when the weight base for the index of prices paid was moved up from 1937–41 to 1955).

b. The weight base for the index of prices paid could not well be a recent moving average, for a very practical reason of cost. The quantities of the different goods and services purchased by farmers are determined by a survey, and surveys are expensive. A period of 18 years elapsed between 1937–41 and 1959, when weight data from the survey in 1955 permitted the most recent revision to be made. The cost of making a fresh survey every year, to include in a moving average base, would be prohibitive. B. R. Stauber of the USDA suggests that regular 5-year intervals between weight-base years would be a reasonable compromise between cost and obsolescence.[36] He further suggests that the revisions of the several major Government indexes be based on the same weight-base and price-base periods.[37] We endorse these suggestions,[38] with the proviso that the price-base periods for the agricultural indexes include 5 or 10 years, so as to average out most of the effects of the irregular variations in production and prices which result from irregular year-to-year variations in weather.

[36] B. R. Stauber, "The 1959 USDA Index Revisions and Some Related Policy Questions," *Journal of Farm Economics*, Proceedings, XLI : 5, December 1959, p. 1286.
[37] Ibid., p. 1288.
[38] Ibid., p. 1302, discussion by Geoffrey Shepherd.

4. MEASURES OF PARITY FARM INCOME

The fundamental difficulty with the existing price support programs is that they use indexes of price instead of indexes measuring value received on cost incurred, or net income. And the inaccuracy of parity price indexes as measures of economic status would remain, because they are only price indexes, not value-received and cost-incurred indexes, showing net income. Neither do they permit a breakdown by type of farming or economic producing areas to show the economic status of farmers in those areas separately.

One possibility would be to include efficiency modifiers for farm products as a group and for individual farm products in the parity formula. Separate parity indexes for individual farm products could also be included. These have been computed experimentally for cotton, as shown earlier in this report.

This would be a step toward the measurement of income. There is something to be said on psychological grounds for making progress a step at a time. But this step would result in only an approximation, and would involve difficult problems of how the gains from technology should be divided between producer and consumer. It might seem better to go to measures of income directly.

Indexes of gross and net income, by type of farming in different economic areas, would provide relatively accurate and detailed measures of farmers' economic status. The basic data for measures of this sort have been compiled for years by the ARS, USDA; they are published annually in bulletin form, but are not widely used. These measures could be refined and extended and used to replace the existing parity price indexes. These measures of net farm income, or measures of net returns to farm labor and management, area by area, could then be compared with the wages of industrial workers, or other nonfarm groups, with due allowance for differences in purchasing power and other intangibles, to provide measures of parity income with incomes in other occupations.

5. MOVING AVERAGE PRICE BASES FOR LOAN RATES

Many farmers are alarmed at the thought of using more recent bases, because that would reduce parity prices, which have been used as the bases for loan rates. These farmers fear that the loan rates would be lowered along with the parity prices. But experience with storage programs in recent years has demonstrated that parity prices are anachronisms, unsuited as bases for loan rates used with price stabilization programs.

More suitable bases would be recent moving averages of market prices, such as have been adopted for corn. These averages integrate the forces of demand and supply objectively into a single price figure, which is well suited to use as the basis for loan rates to attain the objective of smoothing out prices about their long-run market equilibrium level, without trying to raise that level.

This smoothing out of prices about their long-run market level is all that storage programs can do over the long run, and recent moving averages of market prices approximate this long-run equilibrium level closely enough to serve well as the bases for loan rates for this purpose.

Setting the loan rates about 10 percent below the moving average price would provide a high degree of stabilization yet still permit the storage programs to recoup some of their costs from the sale of their stored products at (ideally) 20 percent above their cost of acquisition, in years of short crops.

The moving average would have one shortcoming, in that it would always be a few years behind the times. This could be overcome by developing an index of demand, projected into the future and used to adjust the moving average price up or down as needed.

If the level of loan rates thus determined would provide incomes too low to be deemed acceptable, the causes of those low incomes would need to be determined and rectified by means appropriate for those causes.

The replacement of percentages of parity prices by moving averages of open market prices as bases for loan rates, would reduce the natural objection which farmers now feel toward the use of recent bases which would reduce the level of parity prices. For that reduction then would not reduce the level of loan rates.

STAFF PAPER 11

UNIT VALUE PRICING OF PRICES RECEIVED BY FARMERS

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Prices collected for the Index of Prices Received by Farmers are also used in the development of estimates of gross and net income. The prices requested from the voluntary reporters are average prices per unit of commodity sold, rather than the prices received for a particular grade or quality of the commodity. The U.S. Department of Agriculture has pointed out the nature and use of the prices in incomes estimation as follows: [1]

> . . . the term "prices received by farmers" has come to apply to the concept of an all-inclusive price— a price for what the farmer sells where he sells it, which reflects the impact of supply and demand relationships upon a commodity in total— in short, the average price for all grades and classes being sold by farmers at a given time.
>
> Closely related to this characteristic of the average price concept are the important uses made of the price data in estimating cash receipts by farmers on a monthly basis, and in deriving season average prices by weighting monthly prices by monthly sales.

Thus, insofar as unit value prices are reported, the Index of Prices Received by Farmers reflects not only changes in prices of the individual grades or qualities of each commodity, but also changes in the proportion of such grades and qualities within each commodity. If we were to extend the definition of a "commodity" to the component grades or qualities within that commodity, the present Index of Prices Received by Farmers overstates the price level when quality increases from the base period, and understates the price level when quality deteriorates. Problems of quality change in relation to price indexes are investigated in Staff Papers 2 and 3.

The focus in this paper is on the relation of the reported price to the requested average price. It may well be doubted that many buyers take the trouble to add total purchases and divide this sum by the total physical units purchased to arrive at a weighted average price. If the commodity has a basic grade for which the trade normally quotes prices as a basis for transactions or to indicate the price level, the reporters may respond with this price. Or the response may be mixed, with some reporting an average price and others a price for a basic grade. In any event, there is some uncertainty concerning the nature of the prices reported. At one time it was the practice to round down-

[1] United States Department of Agriculture, Major Statistical Series of the U.S. Department of Agriculture, *Agricultural Handbook* No. 118, Volume 1, Agricultural Prices and Parity, 1957, p. 4.

ward to compensate for reporters failing to consider lower quality marketings.[2] Although there is a review and editing process, the questionnaire returns comprise the basic data and, as such, play a key role in determining the quality of the price and income series.[3]

In the following sections, we examine the nature of the prices reported for corn, hogs, and eggs in selected areas of Illinois. Since secondary data are employed, the results are only suggestive of some of the general properties of the reported prices. A conclusive appraisal of the quality of the prices reported would, of course, require an appropriately designed sampling procedure and personal interviews of buyers.

Corn Prices

Corn produced in the corn belt is marketed during the entire year and is usually stored on the farm until it is sold. The grade of corn is determined by maximum limits of percentages of moisture, cracked corn and foreign material, and damaged kernels as well as a minimum test weight per bushel.[4] During the early part of the marketing season (October to May), moisture discounts are usually the effective factor determining grade. Since natural drying normally reduces the moisture content below the maximum limit for No. 2 corn (15.5 percent) by May, any discounts in the latter part of the season are apt to be due to damage.[5]

As previously mentioned, the corn price requested by the voluntary reporters is the *average* price received by farmers. The questionnaire used in Ohio, Indiana, Illinois, Michigan, and Wisconsin for field corps (C.E. 5–84, C, 1/1/60) states:

> Please report average prices being received by farmers on or about the fifteenth of the month, considering all grades and qualities being sold; the reported prices should reflect premiums and discounts for test weight and moisture for grains, and other quality factors for each commodity for which you report a price.

To determine accurately this type of an average price requires that the local grain dealer (and he is the only one with the basic information) divide the value of his total purchases by the number of bushels purchased during some "sample" period prior to making the report. Since it may not be likely that the reporter would take the trouble to make the necessary calculations, one might expect that either the price for a standard grade be reported, or that some rather arbitrary adjustment would be made from this price to reflect the character of current marketings.

To investigate the nature of the reported average price, a comparison was made between the reported average price and a price for No. 2 corn quoted by a dealer purchasing from local elevators in east-central Illinois. This latter price is quoted as a net trackside

[2] Charles F. Sarle, *Reliability and Adequacy of Farm Price Data,* Department Bulletin No. 1480, U.S. Department of Agriculture, March 1927, p. 4.

[3] For a description of the review process see: United States Department of Agriculture, Agricultural Estimating and Reporting Services, *Miscellaneous Publication* No. 703, 1949, pp. 116–117.

[4] L. J. Norton, *When to Market Grain,* Department of Agricultural Economics, University of Illinois College of Agriculture Circular 711, 1953, p. 12.

[5] R. J. Mutti and Max Langham, *Effects of Moisture Losses on Costs of Storing Ear Corn,* Department of Agricultural Economics, University of Illinois Agricultural Experiment Station Bulletin 653, 1960, p. 8.

price each afternoon on market days and is valid until the opening of trade the following market day. For purposes of comparison the price quotations for the fifteenth of the month were taken (valid until the opening of trade on the following market day); if the fifteenth was not a market day, the price for the previous market day was used.

Two hypotheses are of interest. First, if the reporters respond to the questionnaire with the standard grade price quotation, we should expect to find the margin between the price reported as being received by the farmer and that received by the local grain dealer for the standard grade to be independent of fluctuations in moisture and damage. Second, if the reporters actually follow instructions, this margin will be related to moisture or damage in the manner in which dealers discount for such factors.

To test these hypotheses concerning differences between the reported average price and the quoted price for a specific grade, monthly data from the official inspection certificates on corn shipments from two local grain dealers were related to the calculated price differences.[6]

Moisture and damage data for shipments from the Peotone Farmers' Elevator Association were assumed to be representative of sales in the Northeast Crop Reporting District of Illinois, while data from the Fisher Farmers' Grain and Coal Company represent the East Crop Reporting District Of the total 1957–58 Illinois corn production, the Northeast district and the East district each produced 16 percent. In terms of total United States production, each district produced 2.2 percent during the two years, 1957–58. The present weight (1953–57 base) of corn in the Index of Prices Received is 5.5 percent.

The period from October 1950 to September 1957 was studied. Each annual marketing period was divided into a seven-month period (October through April), when moisture discounts are apt to be dominant, and the remaining period in which damaged discounts, if any, tend to be more important than moisture in affecting grade.

MOISTURE DISCOUNTS

During the October to April period the corn shipped from the two local elevators consistently tested above the maximum moisture content of 15.5 percent for No. 2 corn. The following regression equations were fitted:

Northeast Crop Reporting District

$$y=-4.34+\underset{(0.13)}{0.45}m \qquad n=56$$
$$\bar{y}=4.09 \text{ cents}$$
$$\bar{m}=18.7 \text{ percent}$$

East Crop Reporting District

$$y=-7.92+\underset{(0.12)}{0.69}m \qquad n=55$$
$$\bar{y}=3.83 \text{ cents}$$
$$=17.0 \text{ cents}$$

[6] Moisture data were obtained from Mutti and Langham, op. cit. Damage data are reported by Langham and Mutti, "Relation of Moisture Content of Corn Stored at Harvest to Subsequent Damage," *Illinois Agricultural Economics*, I, 25–31, January 1961.

y: Quoted net trackside price for No. 2 corn minus "average" price reported by Crop Reporting Service (fifteenth of month prices).
m: Percent moisture in shipments for month corresponding to price difference observation.

The standard errors of regression coefficients appear in parentheses under their respective coefficients.

As mentioned above, two hypotheses are of interest. The first is that the reporters uniformly respond with the price of a specific grade. To test this hypothesis, the regression coefficients should be compared with zero. The margin per bushel between the price paid by the local elevator and the price for which the corn is sold by the local elevator is assumed to be independent of the moisture content. Consequently, only the slope of the regression line is of interest. Since the following t-values are both significant at the 1-percent level, we may reject the hypothesis that reporters in these areas responded with a standard grade quotation:

Northeast district $t=3.46$ d.f. 54
East district $t=5.75$ d.f. 53

This indicates that, in the aggregate, the reporters do indeed make an effort to reflect the price discount effect of moisture content. Whether such effort is adequate is tested with the second hypothesis.

Testing the second hypothesis requires a comparison of the regression coefficients with the relevant discount schedules. Moisture discounts that prevailed during this period were as follows:

a. Three cents per bushel for each percent moisture in excess of 15.5 percent up to 20 percent.

b. Four cents per bushel additional discount for each percent moisture from 20 percent to 23 percent.

This suggests that the form of the function fitted should permit the difference between the reported average price and the No. 2 net trackside price to increase at an increasing rate with respect to moisture. Second degree polynomials were fitted but provided no significant improvement in fit over the linear functions presented above.

The discount schedule in force during this period means that the value of the coefficient appropriate to test the second hypothesis for the September–April period lies between 3 and 4. About one-third of the observations in the Northeast district are above 20 percent moisture, while less than 10 percent are above 20 percent in the East district. Using the lower discount rate of three cents per bushel for the test, the highly significant t-values presented below suggest that the reporters inadequately reflect the moisture variations in reporting the average price received by farmers:

Northeast district $t=19.61$ d.f. 54
East district $t=17.58$ d.f. 53

The t-values would, of course, be even higher under the hypothesis that the coefficient lies between three cents and four cents per bushel. Thus, the evidence indicates that the reported average price is significantly different from *both* the price for a specific grade and the average price as calculated from the prevailing moisture discount schedule.

An example will clarify the relation of the reported average price to the appropriately discounted price. Suppose that the price quoted by the local elevator to the farmer for No. 2 corn is \$1.30 per bushel. If the moisture content is 20 percent, the discount schedule in effect during the period studied would result in a discount of 13.5 cents per bushel or a price of \$1.65. If the reporters discount according to the relation estimated from sample data for the Northeast district, the discount would be only about two cents per bushel (4.5 percentage points times 0.45 cent per percent). Thus, the reported price of \$1.28 would be about nine percent too high.

DAMAGE DISCOUNTS

Discounts for damage are much less frequent than those for moisture. During the eight-year period studied, samples of carloads indicated that damage was the effective factor in determining discount in only 14 of the months in the Northeast district. In the East district, damage exceeded 5 percent (the maximum permissible for No. 2 corn) in only one month. Consequently, only data from the Northeast district were analyzed. The following regression was fitted:

$$y = -0.59 + \underset{(0.11)}{0.23}d \qquad n = 14, \quad \bar{y} = 1.43 \text{ cents}, \quad \bar{d} = 8.8 \text{ percent}$$

y: Quoted net trackside price for No. 2 corn minus "average" price reported by Crop Reporting Service (fifteenth of month prices).
d: Percent damage in shipments for month corresponding to price difference observation.

Again, two hypotheses are tested. The hypothesis that the reporters respond with a specific grade means that the coefficient 0.23 is to be tested against zero. The t-value of 2.09 ($d.f.=12$) is significant at the 50-percent level suggesting that reporters do reflect discounts for damage in their average price.

The discount for damage during the period studied was one cent per bushel for each percent damage in excess of 5 percent. Thus, the appropriate hypothesis for accurate discounting is that the regression coefficient equal one. The t-value of 7.0 is significant at the 1-percent level. As in the case of moisture discounts, the evidence from this sample indicates that the reporters understate the amount of the discount.

Hog Prices

Hogs are sold almost exclusively on a liveweight basis in the north-central states.[7] The questionnaire (C. E. 5–230, F, 1/1/60) for the north-central states soliciting prices for hogs requests that the price per hundred pounds be given for "Hogs, including sows and feeders as well as butchers, average price for all classes, liveweight." This request is probably more difficult to fulfill than in certain other commodities. This is due to the fact that the various classes of hogs are more likely to follow different marketing channels. For example, the terminal market in Chicago receives a relatively larger number of

[7] Richard R. Newberg, *Livestock Marketing in the North-Central States*, pt. I, "Where Farmers and Ranchers Buy and Sell," North Central Regional Publication No. 104, 1959.

sows than do local dealers. Thus, any single market outlet is not apt to get a representative sample of all hog marketings.

In the absence of a local price for a specific weight or other classification, a comparison is made between the average price paid to farmers reported by the Illinois Cooperative Crop Reporting Service, and a terminal market price, in this case, Chicago. Since the Northeast Crop Reporting District includes Chicago, average prices received by farmers for hogs in this district were believed to be closely enough related to the Chicago market to furnish a meaningful comparison. Chicago is the only terminal market located in the Northeast district and although data are not available on market outlets for this particular district, a survey in 1956 indicated that 51 percent of the slaughter hogs sold by Illinois farmers went to terminal markets.[8] The Northeast district in 1957 and 1958 produced about 27 percent of the total production in Illinois, or about 3.5 percent of the total U.S. production. The present weight (1953–57 base) of hogs in the Index of Prices Received by Farmers is 10.3 percent.

As in most areas of commercial hog production, there is a seasonal pattern of production. Despite a decline in the seasonality of production, the larger fraction of the total number of sows farrowing continues to be in the spring (Table 1). This means that there will also be a seasonal fluctuation in the size distribution of marketings on a weight per animal basis. Even if one considers only barrows and gilts there is evidence of a definite seasonal pattern in the percentage mix of the weight groups.

TABLE 1.—*Percent of Sows Farrowing in Spring Season, Northeast Crop Reporting District of Illinois, 1950–59* [1]

Year	Percent	Year	Percent
1950	69.1	1955	64.1
1951	66.3	1956	63.8
1952	67.6	1957	60.1
1953	67.7	1958	56.0
1954	64.8	1959	57.5

[1] *Illinois Agriculture Statistics.*

Since difference in hog prices per hundred pounds are chiefly based on the weight of the animal (Table 2), this seasonal fluctuation in consist should affect the month-to-month *difference* between an average price per pound for all hogs and the price for a specific weight. Thus, our interest is not in the seasonal pattern of consist proper, but in the fact that its existence permits testing the hypothesis that reporters when asked for an average price respond with a price for a specific grade.

[8] Ibid., p. 51.

TABLE 2.—*Average Hog Price Per 100 Pounds, Chicago, 1946–50* [1]

	Good and choice barrows and gilts					Good and choice sows (pounds)	Good sows (pounds)
Weight	160–180	180–200	200–220	220–240	240–270	330–360	400–450
	Dollars per 100 pounds						
Average price	21.40	21.81	21.89	21.78	21.46	19.10	18.28

[1] *Livestock and Meat Statistics, 1957*, United States Department of Agriculture, Statistical Bulletin No. 230, 1958, p. 240.

The Livestock Market News Service publishes weekly average prices for the various classes of slaughter hogs sold in terminal markets. In lieu of explicit averaging by the voluntary price reporter, it might be hypothesized that he would report an average price for all barrows and gilts or perhaps the price for a common weight bracket, 200 to 220 pounds. Consequently, differences between the reported average price for the Northeast district and the Chicago price for all barrows and gilts as well as the Chicago price for 200- to 220-pound barrows and gilts were calculated. Since the marketing charge per 100 pounds is not likely to be affected by the season, it need not be considered. The midpoint of each weight range in the Chicago data was taken. For comparison, the price for the week including the fifteenth of the month was chosen. If the fifteenth were on a Sunday, the average for the previous week was taken. Data for the ten-year period, January 1950 through December 1959, were examined. The ten-year average differences by months are reported in Table 3. The expected pattern is apparent; the biggest difference occurs in July, a month in which large numbers of sows farrowing spring litters might be expected to be sold. This would tend to depress the average price in relation to the price of barrows and gilts.

TABLE 3.—*Average Difference by Months Between Chicago Price for Barrows and Gilts and Average Price Received by Farmers as Reported by Illinois Cooperative Crop Reporting Service, Northeast Crop Reporting District, 1950–59*

[Dollars per hundred pounds]

Month	Chicago price for all barrows and gilts minus average price received by farmers	Chicago price for 200–220-pound barrows and gilts minus average price received by farmers	Month	Chicago price for all barrows and gilts minus average price received by farmers	Chicago price for 200–220-pound barrows and gilts minus average price received by farmers
January	0.35	1.05	July	1.42	2.00
February	.14	.70	August	.92	1.20
March	.20	.53	September	.53	.63
April	.32	.66	October	.21	.29
May	.35	.95	November	.13	.36
June	.82	1.48	December	.20	.74

Further, the analysis of variance of the price differences (Tables 4 and 5) indicates that the differences among months are significant. The analysis of variance took into account the year-to-year variation (Table 6) in price differences. The highly significant F-values furnish evidence of a deliberate effort on the part of the price reporters to deviate from the price for a specific group when they respond to the request for a unit-value type of price.

TABLE 4.—*Analysis of Variance of Difference Between Chicago Price for All Barrows and Gilts and Average Price Received by Farmers for All Hogs*

(See Tables 3 and 6)

Source of variation	Degrees of freedom	Sum of squares	Mean square
Months	11	16.99	1.54
Years	9	2.46	.27
Error	99	24.68	.25
Total	119	44.13	

$F=\frac{1.54}{0.25}=6.16$, significant at the 1 percent level.

TABLE 5.—*Analysis of Variance of Differences Between Chicago Price for 200- to 220-Pound Barrows and Gilts and Average Price Received by Farmers for All Hogs*

(See Tables 3 and 6)

Source of variation	Degrees of freedom	Sum of squares	Mean square
Months	11	26.51	2.41
Years	9	3.79	0.42
Error	99	28.38	0.29
Total	119	58.68	

$F=\frac{2.41}{0.29}=8.31$, significant at the 1-percent level.

TABLE 6.—*Average Difference by Years Between Chicago Price for Barrows and Gilts and Average Price Received by Farmers as Reported by Illinois Cooperative Crop Reporting Service, Northeast Crop Reporting District, 1950–59*

[Dollars per hundred pounds]

Year	Chicago price for all barrows and gilts minus average price received by farmers	Chicago price for 200- 220-pound barrows and gilts minus average price received by farmers	Year	Chicago price for all barrows and gilts minus average price received by farmers	Chicago price for 200- 220-pound barrows and gilts minus average price received by farmers
1950	0.75	1.16	1955	0.36	0.90
1951	.52	.82	1956	.34	.64
1952	.25	.73	1957	.48	.84
1953	.61	.87	1958	.34	.69
1954	.59	1.21	1959	.41	.96

Again, we are interested not only in whether the reported "average" price deviates from a price for a specific component of the commodity, but also whether such deviation is adequate to reflect changes in the consist of marketings. Unpublished data on the weight consist of barrows and gilts in the Chicago market together with available estimates of sows marketed in midwestern markets were used to construct the estimates of consist in Table 7. Although the data refer to only one year, some insights can be gained concerning the nature of the reported average price.

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TABLE 7.—*Estimated Consist of Numbers of Hogs Marketed in Northeastern Crop Reporting District, Illinois, 1958* [1]

Weight class (pounds)	Percentage distribution of all barrows and gilts, 160–300 pounds, and sows											
	January	February	March	April	May	June	July	August	September	October	November	December
160 to 180	2	4	3	3	4	4	4	6	3	2	2	2
180 to 200	4	6	8	7	7	9	11	16	15	8	6	5
200 to 220	19	27	30	26	19	21	25	32	32	30	26	24
220 to 240	33	30	29	30	28	24	24	19	26	31	30	27
240 to 270	26	20	17	20	23	18	14	12	14	19	23	26
270 to 300	10	8	7	6	7	6	4	3	2	3	5	8
Sows	6	5	6	8	12	18	18	12	8	7	8	8
Total	100	100	100	100	100	100	100	100	100	100	100	100

[1] Based on H. J. Tippet, "An Analysis of Western Illinois Hog Pricing, 1958," unpublished M.S. thesis, University of Illinois, 1959, Table 10, p. 49 and Table 15, p. 55.

To construct an average terminal market price for each month, the estimates of consist in Table 7 were first converted to percentages of total weight marketed. This was done by using the midpoint of each weight class as the average weight for that class and the monthly average weight for sows published by the Livestock Market News Service. By multiplying these percentages by the midmonth prices for their respective classes, the monthly average prices were calculated. To put these terminal market prices on a farm basis, a charge of 80 cents per hundred pounds was deducted for transportation, commission, yardage, and insurance. Shrinkage was not included as a deduction from the terminal market price. In Chart 1 the constructed average price is plotted as a deviation from the average price reported by the Crop Reporting Service. The constructed average is consistently lower, the largest deviations being in May and June when the sows, with their relatively low price per pound, are at their seasonal peak in volume. With respect to the general level during the year, the reported average price more closely approximates the estimated farm price for 200–220 pound barrows and gilts. When the two "average" monthly prices used in Chart 1 are weighted by the monthly index of marketings, the constructed average farm price for 1958 is $19.30 while the Crop Reporting Service average is $20.14, indicating a possible overstatement of the average prices received by farmers. The simple average of the monthly prices for 200–220 pound barrows and gilts is $20.22.

The evidence in hog price collection is similar to that in the reporting of corn prices; the reported average price lies between a price for a specific grade or quality at the higher end of the quality scale and an average price estimated from other data.

Egg Prices

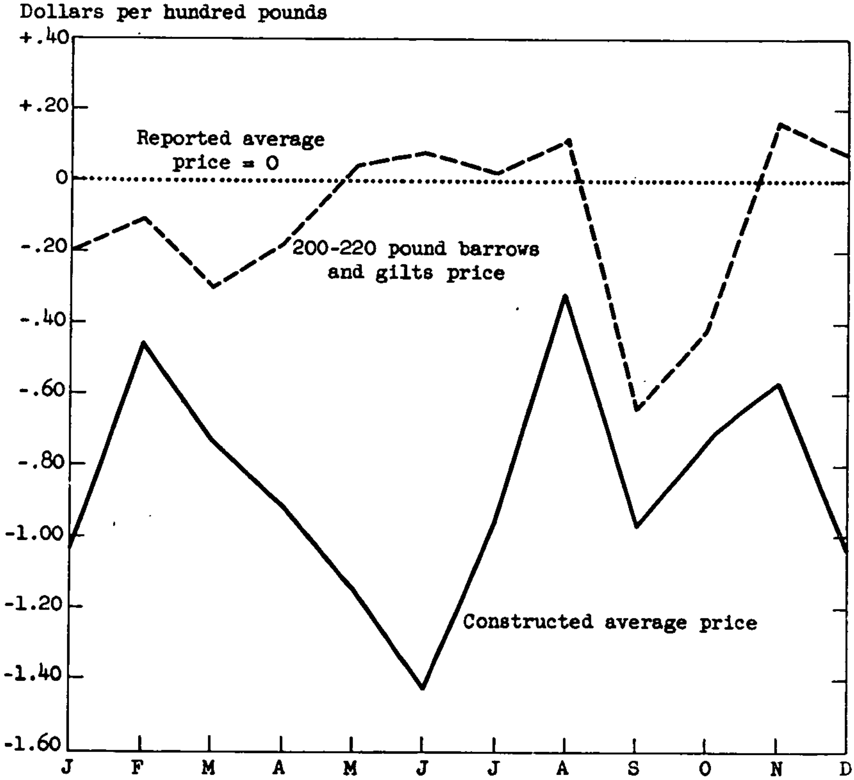
The voluntary price reporters in the north-central states responding to the mailed questionnaire (C.E. 5–230, F, 1/1/60) are asked to report the average price per dozen paid to farmers for "Eggs, all grades and sizes" on or about the fifteenth of the month. A question arises regarding the efforts of reporters to account for the seasonal change in the size and quality consist of egg marketings. It is no doubt easier to report, for example, the price for Grade A Large White (a common grade and size) than to estimate, however approximately, some type of an average reflecting the mix of current marketings.

It is well known that there is a seasonal fluctuation in the size and quality mix of egg marketings. An increase in the proportion of pullets in laying flocks in the autumn causes an increase in the proportion of smaller eggs. Similarly, seasonal temperature fluctuations may, under some conditions, affect quality. This suggests that one should expect a seasonal pattern to be evident in the *difference* between an average price per dozen for all eggs marketed (the type of price requested of voluntary reporters in price collection for the Index of Prices Received by Farmers) and a price for a specific quality and size.

For a period of time the Illinois State Department of Agriculture collected and published egg prices pertaining to local markets. (This report was discontinued in 1960.) In contrast to the unit-value prices collected by the Crop Reporting Service for the Index of Prices Re-

CHART 1

Deviation of Constructed Average Farm Price and Estimated Farm Price for 200-220 Pound Barrows and Gilts from Average Price Received by Farmers in Northeast District (Reported by Illinois Cooperative Crop Reporting Service), 1958



ceived by Farmers, these prices were collected for eggs of a specified size and quality. A comparison was made between the price quoted in these reports for Grade A Large White eggs in northern Illinois and the average price collected for the Index. The Illinois State Deportment report was issued semiweekly and the date selected for comparison was the price quoted for the fifteenth of the month or taken from the report immediately preceding the fifteenth if there were no report for that date. The area specified as northern Illinois is roughly comparable to the Northwest, Northeast, Central, and East Crop Reporting Districts. Consequently, the average prices reported for these districts were weighted by production data from each district to develop an average price for an area corresponding to northern Illinois. In 1957 and 1958, this area produced approximately one-half of the Illinois egg production which, in turn, represents about 5 percent of the national production. The weight for eggs in the Index of Prices Received is 6 percent.

The mean differences between the two reports for the six-year period are presented in Table 8. The very large mean differences in the fall months strongly suggest that reports do in fact reflect the changing seasonal consist. Since there was some year-to-year variability in the differences for each month, it is of interest to examine the analysis of variance in Table 9. It is seen that the variation in mean price differences among months is significantly greater than the variation in price differences within months after the year-to-year effect (Table 10) has been removed. Although the six-year period is rather short to ascertain a trend, the average differences by years (Table 10) might be interpreted as evidence of a quality improvement due to the average price approaching the Grade A Large White price.

TABLE 8.—*Average Difference by Months Between Local Price for Grade A Large White Eggs as Reported by Illinois State Department of Agriculture and Average Price Received by Farmers for All Eggs as Reported by Illinois Cooperative Crop Reporting Service, Northern Illinois, 1954–59*

(Grade A Large White price minus average price)

[Cents per dozen]

Month	Difference	Month	Difference
January	0.55	July	3.72
February	1.78	August	6.85
March	2.32	September	10.82
April	1.57	October	8.98
May	.93	November	5.82
June	2.17	December	1.38

TABLE 9.—*Analysis of Variance of Differences Between Local Price for Grade A Large White Eggs and the Average Price Received by Farmers for All Eggs*

(See Tables 8 and 10)

Source of variation	Degrees of freedom	Sum of squares	Mean square
Months	11	767.3	69.8
Years	5	101.5	20.3
Error	55	234.6	4.3
Total	71	1,103.4	

$F=\frac{69.8}{4.3}=16.2$, significant at the 1-percent level.

TABLE 10.—*Average Difference by Years Between Local Price for Grade A Large White Eggs as Reported by Illinois State Department of Agriculture and Average Price Received by Farmers for All Eggs as Reported by Illinois Cooperative Crop Reporting Service, Northern Illinois, 1954–59*

(Grade A Large White price minus average price)

[Cents per dozen]

Year	Difference	Year	Difference
1954	5.3	1957	3.9
1955	5.4	1958	3.9
1956	2.6	1959	2.3

It appears that the voluntary price reporters do make an attempt to comply with the request on the mailed questionnaire. Whether such attempt is adequate cannot, of course, be determined without considerable detail on the physical mix of marketings themselves. Given this type of data one might construct an average price to compare with the reported price.

However, obtaining quality and size data is complicated by the fact that all eggs do not go through the grading process, some being sold as "current receipts." This means several types of market outlets would need to be sampled. Further, there may be a lack of uniformity among stations in applying the grading standards, requiring a larger sample than might otherwise be necessary. At one Illinois grading station, the percent of Grade A Large in the total number of eggs graded dropped from 69.0 percent in 1947 to 50.9 percent in 1954. One of the explanations for this drop is the tightening of grade tolerances.[9]

Summary and Conclusions

The price collection system for the Index of Prices Received attempts to secure "average" prices per unit for the commodities entering the Index. The limited evidence presented here indicates that the reported prices for three commodities deviate from the price for a specific grade within that commodity thus indicating a degree of success in obtaining an average price. However, in the case of corn the reported average price, although significantly different from a No. 2 price, was estimated to be *closer* to the No. 2 price than to an estimated average price. In the hog price analysis, the reported average price was also between the price for a specific weight bracket and a constructed average price. Data were unavailable to indicate whether the significant price adjustments (from the price for a standard size and quality) made by reporters in egg prices were adequate to reflect changes in consist of marketings.

It appears that the observation of Sarle in 1927 concerning the failure of reporters to consider adequately lower quality marketings may still be correct at least for some commodities.[10] The accuracy of the reported average prices needs to be investigated by personal interview. Such investigation is one phase of the current Ohio Price Enumeration Project being conducted by the Agricultural Estimates Division of the Agricultural Marketing Service.

If the results of such studies indicate a general pattern of the reported average price being between a basic grade price and an average price computed with appropriate within-commodity quantity weights, then consideration should be given to asking the reporters to report *both* a specific grade price and an average or unit value. If the reporter actually attempts to find an average, he must also know the basic price which is applicable to that fraction of the marketings being sold at that price.

Since for many commodities this price is probably well known, it would require little effort to report. Further, the average price to be reported would more likely require a deliberate attempt on the part of the reporter, when reporting the average price, to deviate in the

[9] E. E. Broadbent, *The Evolution of Graded Egg Marketing in Illinois*, University of Illinois Agricultural Experiment Station Bulletin 619, 1957, p. 26.
[10] Sarle, *op. cit.*, p. 4.

correct direction and amount from the price for a specific grade. The requesting of additional information may reduce the number of responses, but this may be compensated for by an improvement in accuracy. This is an empirical question which would need to be answered by investigation. The suggestion of requesting two prices refers, of course, only to those commodities in which there is a grading system having an adequate degree of geographical uniformity. Specific prices for subclasses (not necessarily grades or qualities) of some commodities are now being collected. For example, production and sale of wheat is now estimated in terms of winter wheat, durum, and other spring wheat. Plans have been made to divide the commodity "hogs" into "barrows and gilts" and "sows" for the North Central States. In all, over half of the commodities in the Index of Prices Received by Farmers have components which are priced separately in at least some areas.

Any improvement in the accuracy of the average prices will improve income estimates and, if one accepts unit value prices for use in price indexes, also the Index of Prices Received by Farmers. Availability of a specific grade price at the farm level would also permit an analysis of the difference between the Index of Prices Received by Farmers and a price index for specific grades which does not reflect changes in quality. If the corn price analysis is indicative of a pattern in the reporting of other commodities, this difference is likely to be small as compared with the difference between income estimates based on the reported average prices and income estimates based on accurately determined average prices.

STAFF PAPER 12

THE MEASUREMENT AND ECONOMIC IMPLICATIONS OF THE INCLUSION OF INDIRECT TAXES IN THE CONSUMERS' PRICE INDEX

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Real wages, measured by deflating money wages with consumer prices, is the most frequently employed criterion of the rate of exchange of labor services for consumer goods and services.[1] As a result, real wage changes are used to measure changes in the terms of trade of labor inputs for final products. It is the thesis of this paper that this measure is (1) conceptually incorrect and its use has led to (2) biased estimates of real wage changes in the United States.

Real wages, measured by deflating money wage rates with consumer prices, measures wage rates gross of direct taxes and net of indirect taxes. Consequently how governmental expenditures are financed necessarily affects real wage measurements. Biased real wage measurements have been produced by this disparity in the treatment of indirect and direct taxes. The effects of this disparity have been magnified by (1) the growth in the fraction of national output not subject to indirect taxes, and (2) the exclusion of governmental services from the Consumers' Price Index.

Factor Cost to Final Product Price Relationships and the Choice Between Direct and Indirect Taxes

How governmental expenditures are financed, in particular the choice between direct and indirect taxes, ought not per se to affect real wage measurements. Yet if the relationship of wages to prices is used to measure real wages, with wages defined by wage rates inclusive of wage supplements and prices by an index number of consumer prices, then changes in tax policy can produce measurement errors. It can be shown that measured real wages will change as a result of a change in the volume of governmental expenditures financed through indirect taxation.

Economic theory implies that the producers of products subject to indirect taxes will, when hiring agents of production, base their calculations upon the market prices of their products net of taxes. Therefore if indirect taxes exist, then there must also exist a gap between the market value of final products and their factor cost. This is the same as saying that the sum of the payments to the cooperating agents of production must be less than the value of the final product.

[1] For example, see Albert Rees, "Patterns of Wages, Prices, and Productivity," in *Wages, Prices, Profits, and Productivity*, The American Assembly, Columbia University, 1959.

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Since direct taxes do not, whereas indirect taxes do, create a gap between the market value of final products and their factor costs, the direct-indirect tax choice must affect the relationship between rates of return to productive agents and final product prices. Indirect taxes imply a lower level of measured real factor returns than direct taxes. Therefore the choice of indirect taxes implies lower measured real wages. This must occur if the price index used to deflate money wages reflects prices to consumers, i.e., is a consumers' price index of the type computed by the Bureau of Labor Statistics.

The direct-indirect tax choice implies either reducing (a) disposable after-tax income, or (b) the size of pretax income through a reduction in the rate of return to factors. In either case, after-tax real income and hence by hypothesis real wages properly measured are unchanged. However real wages measured by deflating money wages with consumer prices is changed. The reduction in pretax factor incomes lowers measured real wages; the reduction in after-tax disposable income does not. Therefore a measurement error results.

The implications of the direct-indirect tax choice can be put more technically. When real wages are defined as money wage rates deflated with consumer prices, then the choice of indirect taxes implies (1) a market demand for labor that is smaller, and (2) a market supply that is larger than the corresponding demand and supply functions associated with direct taxes. The demand function is lower because the marginal productivity of agents, for all levels of output and for all combinations of inputs, decreases for the firm. Alternatively, the imposition of indirect taxes can be viewed as an increase in business costs and therefore lowers what employers are willing to pay, measured by the ratio of wages to prices, for productive agents.

Similarly the choice of direct taxes implies the existence of a gap between what employers pay for labor and what employees receive. The wage costs of employers exceed the wage receipts of employees, and this difference is accounted for by direct taxes. Only for indirect taxes are the wage costs of employers the after-tax wage receipts of employees. As a consequence, if labor supply functions are to properly reflect the opportunity costs of leisure, then the supply functions associated with indirect taxes must be greater than those associated with direct taxes. To summarize, the choice of indirect taxes implies a lower demand and a greater supply of factors. Changes in both demand and supply conditions operate to decrease the measured real returns of agents. Yet this result is consistent with identical after-tax real incomes to factors with no change in the quantity of labor hired.[2]

Clearly, to obtain real wage measurements that are unaffected by the direct-indirect tax choice, either real wages ought to be measured before or after all taxes. If wage rates are to be measured before taxes, then indirect taxes must be excluded from the consumers' price index used as a deflator. This implies measuring consumers' prices net of taxes, i.e., using the same final product prices used by producers

[2] Compare a proportional income tax with a completely general sales tax upon the final products of the economy and savings and assume both taxes yield the same receipts and have the same collection costs.

The effects of this direct-indirect tax choice upon the relationship of factor costs to final product prices has none of the usual Pigovian implications because it is an artifact of the limitations inherent in the conventional measurements of real wages rather than a result of actual economic differences between direct and indirect taxes.

to determine the number of agents they will hire. Alternatively, if wage rates are to be measured after taxes, then factor returns must be measured net of direct taxes. This implies using the same wage rates used by suppliers of labor in determining how to allocate their resources between leisure and work.

Given the fact that government services are usually if not invariably excluded from indexes of consumer prices, only one of these criteria constitutes a feasible alternative. This is measuring real wages before all taxes. Measuring real wages net of taxes implies that changes in the volume of governmental expenditures and taxes will change measured real wages. Increases in taxes and expenditures will lower measured real wages; decreases in taxes and expenditures will raise them. If real wage measurements are to be unaffected by changes in the volume of governmental expenditures and taxes, then they must be measured before all taxes.

One may object to the conclusion of this analysis—that there is a net differential effect on the market prices of productive agents attributable to indirect taxes—on the grounds that the choice between direct and indirect taxes usually involves differences in both collection and welfare costs. However, to alter this conclusion it is necessary to argue that indirect taxes are more efficient and/or cheaper to collect than direct taxes and that this difference is so large that it decreases the total returns to agents by an amount greater than the indirect tax proceeds. If that were true, and the usual argument runs the other way, then the inefficiencies and/or collection costs associated with direct taxes could produce a reduction in the market prices of factors on a par with that produced by indirect taxes.

The foregoing analysis has shown that real wage changes, as they are conventionally measured, need not coincide with changes in the economic welfare of wage receivers. Through the use of indirect taxes, these can be either positive or negative; it is possible to change sharply measured real wages with no change in actual after-tax real wage rates. Yet it is possible to show that this identification of actual or correctly measured real wages with the usual real wage measurements has influenced the behavior of trade unions and governments. In the early post-World War II years, some governments employed business subsidies to change wage-price relationships in order to increase measured real wages. This same identification of real wage rates with the relationship of wages to prices explains the widespread use of consumer price indexes for wage escalation. This occurs despite the possibility of producing labor shortages or surpluses through the use of indirect taxes when money wages, adjusted to reflect the productivity gains of labor, are escalated with an index of consumer prices.

This naturally raises the question: How important is this argument quantitatively? To what extent have changes in the use of indirect taxes distorted the usual measurements of real wage changes? If they are to be of value, then one must show that they are correlated with the measurements correct in principle. This implies that the value of the conventional measurements of real wages as a proxy variable for what is in principle correct is a function of how stable the indirect tax component of the final product of the economy has been.

Net national product represents a measure of what in principle the cooperating agents would be paid in the absence of indirect taxes. Therefore the ratio of indirect taxes to net national product measures the gap between factor costs and the market value of the final product of the economy. Alternatively, this ratio can be viewed as a measure of the fraction of the final price of goods and services that is paid to the agents of production. The ratio of indirect taxes to net national product has risen from about 9 percent in 1929 to 15 percent in 1957. In particular, this percentage rose sharply between 1929 through 1933; its rise during these four years equals that over the entire twenty-eight. The rise from 9 to 15 percent implies that the returns to the cooperating agents of production must have declined from 91 to 85 percent of net national product. Therefore (6/91) or 6½ percent represents an estimate of the bias in the conventional measurements of real wages attributable to the growth in indirect taxation.

This estimate represents an incomplete accounting of the bias in the conventional measurements of real wages attributable to the growth of indirect taxation. The part of the bias unaccounted for is produced by (1) excluding from the Consumers' Price Index those goods and services provided by governments that are not explicitly sold, and (2) the concentration of indirect taxes upon the output of the nongovernmental sector of the economy. As a result, the gap between the value at factor cost and at market of the output of the nongovernmental sector of the economy is greater than it is for governmental output. For estimating the bias in the conventional measurements of real wage changes, it is the change in the gap between the value at factor cost and at market of the goods and services included in the Consumers' Price Index that is relevant.

Growth in indirect tax receipts relative to output implies a rise in the prices of goods and services included in the Consumer's Price Index vis-a-vis those excluded if the output of the governmental sector of the economy is neither subject to excise taxation nor included in the index of consumer prices. Consequently, some of the increase in the Consumers' Price Index since 1929 is a relative price effect on a par with the change in the butter-margarine price ratio caused by an excise tax on margarine. This relative price effect would not have occurred if there had been no growth in indirect taxes, i.e., if the marginal governmental expenditures were financed through direct taxation.

Quantitative estimates may be made of the magnitude of this bias in the Consumers' Price Index. For this purpose, two measures of the private output of the economy are employed. One is net national product less expenditures of governments for employees. The other is net national product less all governmental expenditures. In 1929, a little over 9 percent of the total output of the private sector of the economy, as measured by net national product less the costs of government employees, was acquired through indirect taxation. This implies that, on the average, governments received 9 cents for every dollar of sales of private output in the economy.

In 1957, slightly more than 16 percent of the total output of the private sector of the economy, as measured by net national product less the costs of employees of governments, was acquired through indirect taxation. As a result, governments received on the average over 16 cents for every dollar of sales of private final output in the economy.

This change from 1929 to 1957 in the indirect tax component of the output of the private sector implies that there has been a decline from about 91 percent of the output of the private sector going directly to agents of production to about 84 percent. Consequently, a bias of about 7½ percent is implied for measuring actual real wage changes between 1929 and 1957. If one uses a broader definition of untaxed output, if one uses the purchases of goods and services by governments as a measure of untaxed output, then the gap between the prices of private goods at market and at factor cost is even greater. This broader measure of government output implies a bias in measuring real wage changes of about 9½ percent.

This analysis indicates that the spread between output at market and at factor cost increased on the average from 9 to 15 percent. For the goods and services priced by the Consumers' Price Index, the increase was from about 9 to 16 to 18 percent. Therefore, an error of 1½ to 3 percent is attributable to relative price effects.[3] It also suggests an overall bias in measuring real wage changes of 7½ to 9½ percent when 1929 is compared with 1957.

This estimate of the bias in the conventional measurements of real wages eliminates the influence of how governmental expenditures are financed upon measurements of relative changes in real wage rates. It was obtained by holding constant, at the 1929 level, the ratio of indirect taxes to consumer prices. Thereby, the effects of the growth in the fraction of final product prices represented by indirect taxes was isolated and its implications for conventional measurements of changes in real wages estimated.

This procedure does not eliminate the bias in the conventional real wage calculations for measuring absolute changes in real wages over time. In a progressive economy with rising individual productivity, constancy in the ratio of indirect taxes to prices implies that some of the productivity gains of labor are being captured by governments through indirect taxation. Therefore, absolute changes in measured wage rates will represent less than actual changes, although relative changes in real wages will be correct. The larger the ratio of indirect taxes to output or the higher the rate of progress in an economy, the greater is the error in measuring absolute changes in factor returns.

To properly measure absolute changes in real wages, it is not enough to hold constant the effects of indirect taxes upon real wage measurements. Their influence must be completely eliminated. This implies asking what real wage measurements would have been if all wage receipts were gross of taxes. In 1929, the indirect tax receipts of all governments show that measurements of the absolute level of real wages were 91 percent of what they would have been in the absence of indirect taxes. By 1957, these measurements represented just 84 percent of worker output. This decline associated with rising worker

[3] The output of the economy going through the public sector is not immune from taxation. For example, when the Defense Establishment buys military equipment, the producer of this equipment is subject to the corporate income tax and local property taxes. Consequently, it appears the higher estimate overstates the effects of the growth in the public sector upon the indirect tax rate for consumer goods.

An error in the other direction may be caused by implicitly assuming that the tax rate upon investment goods is the same as it is on consumer goods. If in fact it is lower on investment goods, then the withdrawal of resources from private to public consumption implies sharper increases in the tax rate on consumption goods than suggested here.

productivity implies large errors in estimating absolute changes in real wages. This actual increase in real wages between 1929 and 1957 was 24 percent greater than the increase measured by conventional techniques.[4]

The evidence presented here indicates that the usual real wage measurement procedures lead to low estimates of increases in real wages between 1929 and 1957. The error in measuring absolute changes in real wages is roughly three times as great as the error in measuring relative changes. Given the existing methods of computing real wages, the reluctance of economists to employ the conventional measurements of absolute changes in real wages appears to have some justification. For measuring relative changes in real wages, this evidence is consistent with the belief that measured and actual real wage changes are correlated. However, the absence of perfect correlation also suggests that the acceptance of the conventional measurements of real wages can be a source of frictions and misunderstandings in the labor market. If tax policy leads to an unstable relationship between indirect taxes and net national product, then conflicts are likely to occur in the labor market that could have been avoided through the use of direct taxes such as personal income taxes.

Employment Effects of Indirect Taxes

This analysis suggests that the sharp increase in the ratio of indirect taxes to output in the early thirties should have created frictions in the labor market. Income tax receipts, with no change in tax rates, fell sharply as a result of the decline in money income. Because of the desire of governments to balance budgets and maintain expenditures, there was a sharp rise in the fraction of all output acquired through indirect taxes. Consequently there was pressure downwards on money wages from two sources, the fall in prices and the shift from direct to indirect taxation. This substitution of indirect for direct taxes intensified the adjustment problems in the labor market associated with the decline in prices. Therefore it must have contributed to the severity and duration of the depression.[5]

For an economy in which money wages are rigid downwards, stable prices and indirect tax increases can be incompatible with full employment. If the depressing effects of indirect tax increases upon money wages are not offset by the productivity gains of labor, then rigid money wages and full employment are inconsistent with stable prices. If the quantity of labor supplied is perfectly elastic with respect to the prevailing money wage, then output and employment can be changed in the absence of changes in either governmental expenditures or consumer prices. The substitution of direct for indirect taxes will increase output and employment, and conversely. This suggests if wages (either money or real wages, as they are usually defined) are rigid downwards, then direct taxes ought to be favored over indirect taxes.

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[4] This calculation is based on the data contained in Table I, p. 15, in Rees, op. cit.

[5] During the Civil War, indirect taxes were sharply increased and consequently measured real wages declined. However, this decline was associated with a marked rise in money wages attributable to the issuance of greenbacks. As a result, there was on balance no pressure downwards on money wages at this time. See Reuben A. Kessel, and Armen A. Alchian, "Real Wages in the North During the Civil War: Mitchell's Data Reinterpreted," *Journal of Law and Economics*, vol. II, October 1959, p. 95.

OTHER ECONOMIC AND MEASUREMENT EFFECTS OF THE INCLUSION OF INDIRECT TAXES IN CONSUMER PRICES

The choice of indirect in preference to direct taxes usually produces not only a rise in the prices of public vis-a-vis private goods, but also relative price changes among private goods. Cigarettes, liquor, gasoline, travel, furs, cosmetics, etc., tend to be relatively heavily taxed and indirect tax increases typically produce a rise in the prices of these goods relative to all private goods. Because the weights of the various components of the Consumers' Price Index are relatively stable over time, heavily taxed goods tend to be overweighted and lightly taxed goods underweighted relative to true post-tax consumer expenditures. Stability of weights implies that the goods whose relative prices increase are overweighted. The substitution effect, the replacement of taxed with untaxed goods in consumer expenditures, is accounted for inadequately. Clearly, insofar as relative price changes are attributable to indirect taxes, their inclusion in consumer prices implies an upward bias in prices. This bias would not exist if either indirect taxes were excluded from the Consumers' Price Index or if direct taxes were used.

Because of the relative price changes that usually confront consumers as a consequence of the imposition of indirect but not direct taxes, the use of indirect taxes implies that output and employment opportunities will fall in taxed industries. If the resources relinquished by the industries taxed become unemployed, then a decrease in output and a rise in prices is implied. An increase in unemployment attributable to the imposition of indirect taxes implies that the prices of untaxed components of the index remain unchanged. Therefore if the prices of taxed goods rise, then the overall index of consumer prices gross of taxes must also rise. The restoration of full employment, i.e., the subsequent absorption of resources relinquished by the industries taxed, implies a fall in prices.[6] This rise and fall in prices would not be recorded if excises were not included in consumer prices, or if direct taxes were used as an alternative to indirect taxes.

CONCLUSIONS

The choice between 1929 and 1957 of indirect taxes as an alternative to direct taxes has produced two classes of measurement errors in the usual calculations of real wages. Both have operated to produce low estimates of real wage changes. The rise in the fraction of all output acquired through indirect taxes has decreased the ratio of wages to prices, particularly the ratio of wages to the prices of goods and services measured by the Consumers' Price Index. This decrease was caused by factors independent of the forces that affect the economic productivity of workers. It was largely a consequence of financing decisions, i.e., the choice between direct and indirect taxes by governments. As a result, estimates of changes in real wages have

[6] What happens to the general level of prices as a result of the direct-indirect tax choice is related to the welfare costs of the method of taxation chosen. Insofar as the real balances held are a function of real income, the tax with the greater welfare costs will be associated with higher after-tax prices. The relationship between the pre- and post-tax price level is more complex. In addition to the welfare effects, one must consider what value the community places on the public goods that supplant private goods. The balanced budget multiplier theorem produces its inflationary effects by implicitly assuming the public regards such a substitution as equivalent to a fall in real income.

been too low. This bias has been estimated to be between 7½ and 9½ percent for measuring relative changes in real wages. For measuring absolute changes, the error was roughly three times as large. The concentration of indirect taxes upon particular classes of consumer goods has led to increases in measured consumer prices in excess of actual increases. Stability in the weights of the components of the Consumers' Price Index when indirect taxes have been unevenly applied has led to an overweighting of goods whose relative prices gross of indirect taxes have risen.

If one is willing to accept the proposition that money wages are rigid downwards, then the choice of indirect as an alternative to direct taxes when prices are stable or falling implies pressure to reduce money wage rates and hence risks of unemployment. Stable prices, money wages rigid downwards, and an increase in indirect taxes large enough to produce a decrease in the marginal private product of labor are inconsistent with full employment in the labor market. A marked increase in the use of indirect taxes was associated with a severe rise in unemployment and a sharp fall in prices during the early thirties. Insofar as money wages are rigid downwards, fiscal policy must have intensified the severity and magnitude of the great depression.

Although an index of consumer prices exclusive of indirect taxes represents a step in the direction towards more correct real wage measurements, it leaves unsolved the problems associated with the exclusion of government services from the Consumers' Price Index. This omission remains an important source of possible error. The volume of government services produced has grown secularly as measured by the growth of expenditures for government services relative to all expenditures. Consequently the restriction of the Consumers' Price Index to measuring the prices of the output of the private sector of the economy while the public sector has been growing relative to the private sector suggests a decrease in the relevance of this index over time. In turn, a decrease in the relevance of real wage calculations is implied.

Computational Notes

For analyzing the effects of the inclusion of indirect taxes in consumer price indexes, all taxes can be usefully divided into two categories. These are (1) taxes that affect wage rates and other factor rates of return relative to final product prices, and (2) taxes that do not affect this relationship. Final product prices, for this purpose, are prices paid by consumers.

In the first category are excises, property taxes, sales taxes, custom duties, licenses, corporate income and other business taxes. The surplus of governmental enterprises is equivalent to a business tax, and business subsidies are equivalent to a negative business tax. These taxes are all in some sense "included" in final product prices. In the second category are personal income, gift, death, and poll taxes. These taxes are not "included" in final product prices and therefore do not affect the relationship between factor costs and final product prices in the same way, if at all, as taxes of the first kind.

Only for payroll taxes does the usefulness of this dichotomy breakdown. Governmental receipts derived from payroll taxes are often regarded as part of worker compensation for the purpose of computing real wages. Sometimes only payroll taxes "paid" by employees are treated as worker compensation, and employer contributions are ignored. When all payroll taxes are regarded as employee compensation, then changes in the volume of payroll taxes do not affect measured real wages. For the purpose of computing the biases in the usual real wage measurements, it was assumed that all payroll taxes are part of the compensation of wage receivers.[7]

The data used are from *National Income*, 1954, Tables 4, 8, and 9, appearing on pages 164, 170, 171 and 172 and from *U.S. Income and Output*, 1958, Tables I–17, III–1, III–2, appearing on pages 138, 164, and 165. Indirect business taxes, corporate income taxes and surplus of governmental enterprises were regarded as taxes and business subsidies as negative business taxes. These were all classified as indirect taxes.

TABLE 1

[In millions of dollars]

	1929	1957
NNP	$95,819	$402,585
Total compensation of governmental employees	5,093	42,869
Output of private sector at market	90,726	359,716
Indirect taxes	$8,519	$57,963
Indirect taxes/output of private sector at market (percent)	9.39	16.11
Total governmental expenditures	$8,482	$85,687
Indirect taxes/output of private sector at market (percent)	9.75	18.29

[7] Rees, op. cit., treats all payroll taxes as employee compensation. This is not typical. If payroll taxes are not considered employee compensation, then the biases in the customary calculations of real wages exceed the estimates presented here.

TABLE 2

[In millions of dollars]

	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944
Net national product	95,819	82,564	68,105	50,851	48,803	57,803	65,267	75,247	83,034	77,444	83,257	92,470	116,781	148,978	181,647	199,386
Indirect business taxes, Federal	1,193	1,045	894	924	1,619	2,181	2,181	2,251	2,406	2,216	2,322	2,627	3,567	4,049	4,944	6,171
Corporate profits, Federal	1,224	744	423	328	462	644	820	1,252	1,337	895	1,285	2,635	7,333	11,065	13,616	12,484
Indirect business taxes, State and local	5,810	6,110	5,965	5,844	5,436	5,634	6,009	6,412	6,751	6,938	7,043	7,384	7,729	7,720	7,791	7,956
Corporate profits, State and local	145	98	75	57	59	100	131	157	165	134	156	199	277	350	458	465
Subsidies less current surplus of Government enterprises	−85	−116	−173	−164	−251	−580	−730	−413	−465	−578	−927	−915	−666	−769	−861	−1,371
Current surplus of Government enterprises, State and local	+232	+239	+222	+209	+233	+297	+327	+374	+405	+402	+442	+495	+564	+610	+678	+719
Total taxes	8,519	8,120	7,406	7,198	7,558	8,276	8,738	10,033	10,599	10,007	19,321	12,434	18,804	23,025	26,626	26,424
Taxes/NNP (percent)	8.89	9.83	10.87	14.16	14.49	14.32	13.39	13.33	12.76	12.92	12.40	13.45	16.10	15.46	14.66	13.25
Government purchase of goods and services	8,482	9,791	9,218	9,033	8,031	9,764	990	11,816	11,712	12,816	13,320	14,073	24,751	59,717	88,617	96,529
Government expenditures/NNP (percent)	8.85	11.86	13.53	17.76	16.46	16.89	15.31	15.70	14.11	16.55	16.00	15.22	21.19	40.08	48.79	48.41

	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Net national product	201,009	197,580	218,110	240,831	238,870	264,551	304,763	320,791	337,631	334,303	365,483	384,533	402,585	--------	--------
Indirect business taxes, Federal	7,128	7,896	7,874	8,090	8,158	9,032	9,530	10,525	11,194	10,055	11,040	11,601	12,212	--------	--------
Corporate profits, Federal	10,234	8,649	10,679	11,813	9,723	17,098	21,569	18,639	19,419	16,466	20,869	21,381	20,655	--------	--------
Indirect business taxes, State and local	8,394	9,417	10,767	12,315	13,479	14,715	16,112	17,615	19,009	20,096	21,825	24,030	25,432	--------	--------
Corporate profits, State and local	455	462	604	670	602	767	878	820	803	765	958	1,041	994	--------	--------
Subsidies less current surplus of Government enterprises	−1,516	−1,619	−571	−645	−738	−1,156	−1,280	−1,011	−842	−1,165	−1,635	−2,789	−3,135	--------	--------
Current surplus of Government enterprises, State and local	+756	+784	+798	+816	+920	+952	+1,093	+1,165	+1,273	+1,408	+1,602	+1,744	+1,805	--------	--------
Total taxes	25,451	25,589	30,151	33,059	32,194	41,408	47,907	47,753	50,856	47,614	54,659	57,008	57,963	--------	--------
Taxes/NNP (percent)	12.66	12.95	13.83	13.73	13.48	15.65	15.72	14.89	15.06	14.24	14.96	14.83	14.83	--------	--------
Government purchase of goods and services	82,867	30,498	28,382	34,536	40,159	39,027	60,460	76,044	82,830	75,254	75,592	78,838	85,681	--------	--------
Government expenditures/NNP (percent)	41.22	15.44	13.01	14.34	16.81	14.75	19.84	23.71	24.53	27.51	20.68	20.50	21.28	--------	--------

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