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MEASURES OF PRODUCTIVE CAPACITY

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ECONOMIC STATISTICS

OF THE

JOINT ECONOMIC COMMITTEE

CONGRESS OF THE UNITED STATES

EIGHTY-SEVENTH CONGRESS

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MEASURES OF PRODUCTIVE CAPACITY

MONDAY, MAY 14, 1962

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 call, in room 6226, New Senate Office Building, Hon. William Proxmire (chairman of the subcommittee) presiding.

Present: Senator Proxmire.

Present also: James W. Knowles, staff economist.

Senator PROXMIRE. This morning the Subcommittee on Economic Statistics of the Joint Economic Committee begins hearings on the measurement of productive capacity. The subcommittee regards this as a particularly appropriate subject for some exploratory hearings for a number of reasons.

First, the concept of capacity to produce and the ratio of actual output to capacity are in constant use in arguments about both the economic situation and outlook, on the one hand, and private and public policies, on the other.

Secondly, over the years the hearings of the Joint Economic Committee have revealed repeatedly that the problem of achieving and maintaining a balance between the expansion of productive capacity and the expansion of effective demand is one of the most difficult and baffling problems of economic policy.

Thirdly, while it is true that we have a number of different measures of productive capacity in individual industries for broad industrial sectors, there seems to be disagreement among experts as to the validity and usefulness of the different types of measures.

The subcommittee, therefore, in setting up these four mornings of hearings has invited a number of experts to discuss the problem with us, who are now working on the problem of measuring capacity. We have asked them to give their considered judgments as to the uses that are made or could be made of measures of productive capacity, the extent to which measures are now available, the coverage and reliability of existing capacity measures, and what should be done through public and/or private sources, if anything, to improve data on productive capacity.

As I have indicated, these hearings are exploratory. We are searching for light on the questions posed as a guide to this committee and other interested parties as to whether some further acceleration of research on the development of measures of capacity and their use would be in the public interest.

We do not expect to find final answers. Rather, we are looking for guidelines as to possible lines of promising work, possible agencies—public or private, or both—through which research might be undertaken. But, perhaps most importantly, whether further efforts in this direction at the present time warrant further study of this subject by this subcommittee, by agencies of the executive branch of the Government, or both.

This morning, we are privileged to open our hearings by hearing from experts of two organizations that have been working recently in this field. Each has followed a different approach to the problem of measurement of capacity.

Our first witness, Dr. Douglas Greenwald, manager of economic services, Department of Economics, McGraw-Hill Publishing Co., New York, has appeared before in connection with the committee's hearings on the economic situation and outlook.

We are happy to welcome him back. His organization has pioneered since World War II in a unique program to develop information about industry's plans for investing in new plant and equipment; also the degree to which manufacturing industries are expanding capacity.

Our second witness is an outstanding scholar, Dr. Daniel Creamer, associate director, Division of Economic Research, National Industrial Conference Board, who has pioneered in a different technique.

Dr. Greenwald, you may go right ahead. We are pleased to have you with us. You may proceed with your statement.

STATEMENTS OF DOUGLAS GREENWALD, MANAGER, ECONOMIC SERVICES, DEPARTMENT OF ECONOMICS, McGRAW-HILL PUBLISHING CO., INC.; AND DANIEL CREAMER, ASSOCIATE DIRECTOR, DIVISION OF ECONOMIC RESEARCH, NATIONAL INDUSTRIAL CONFERENCE BOARD

Mr. GREENWALD. The current hearings before this subcommittee on the measurement of productive capacity and the American Statistical Association's session on capacity in New York late in December 1961, which I chaired, clearly indicate that there is great interest and concern about industrial capacity, its utilization, and its measurement. At the meeting of the American Statistical Association, Margaret Matulis, an economist in the department of economics, gave a paper on capacity. My remarks, in large part, are based on her report.

Interest in capacity is not new to those of us who are scheduled to be participants in these hearings during the next few weeks. We have discussed, argued pro and con, and actually disagreed on this particular subject more than any other.

One thing we have all agreed upon: the amount of capacity and the utilization rate are key factors in evaluating the current economic scene and the short-run business outlook. The industrial operating rate correlates fairly well with profits, and we have used forward estimates of operating rates to provide rough gages of future profit levels. And if the old economic law of supply and demand is not as dead as the dodo now, then the operating rate should have an impact on industrial prices.

Measures of capacity are useful tools in determining the potential and future course of the economy. Spare or excess capacity today provides a relatively easy route to growth if, as a nation, we can quickly utilize it. If we cannot, then it has important implications for capital investment, one of the key sectors of the economy, during a subsequent time period.

The ups and downs of general business in the postwar period have been associated in general with the wide fluctuations of capital investment. Thus clues to the timing of turning points in expenditures for new plant and equipment become very significant. Two valuable forecasting devices we have devised at McGraw-Hill to do just this are the McGraw-Hill index of manufacturing capacity and the related measure of manufacturing operating rate.

When I have previously appeared before the Joint Economic Committee and discussed the outlook for private investment, I pointed out the role that increased capacity and the rate of operations would play in the short-run movements of capital investment. In my testimony of December 1960, I said:

> Confirming the general picture of expected moderate weakness in business investment (for 1961) is the supplementary data gathered in our survey. First and foremost is the fact that manufacturing companies, on the average, were operating at 79 percent of capacity at the end of September—a lower rate than in September 1957, at the beginning of the last recession. Since manufacturers have indicated they would prefer to operate at well over 90 percent of capacity, there appears to be excess industrial capacity. Thus a letup in the rate of expansion is clearly likely.

The McGraw-Hill Department of Economics pioneered in developing the first data on capacity. In 1947 my Department undertook the development of surveys that would (1) indicate the potential for private investment in new plant and equipment, and (2) throw light on the underlying forces that shape capital investment. In order to provide meaningful information, we ask qualitative as well as quantitative questions in our surveys.

At the very outset of our survey work, one of the areas of investment in which we became interested was capacity. In our very first survey, taken late in 1947 and released February 7, 1948, we asked our respondents the following question: "When your postwar expansion is completed, how much greater will your capacity be than it was in 1939?"

Since 1948, questions on recent and planned additions to capacity have been included regularly in the annual McGraw-Hill surveys. Since 1955 we have regularly asked companies to report the rate of capacity at which they were operating at the end of the preceding year. Also, in 1955, and at intervals over the years, we have asked a question on the preferred operating rate of companies.

The 15th annual McGraw-Hill survey, released April 27, 1962, only a few weeks ago, indicated that manufacturing capacity at the end of 1961 was 82 percent greater than in December 1950. It showed also that manufacturing companies plan to increase their capacity 4 percent in 1962, and another 10 percent in the next 3 years. If these plans are carried out, the McGraw-Hill manufacturing capacity index will reach 208 at the end of 1965, with December 1950, the base, equal to 100.

According to the McGraw-Hill survey, manufacturers were operating at an average rate of 83 percent of capacity at the end of 1961, compared with 81 percent in September 1961, and 77 percent in December 1960, and as high as 92 percent at the end of 1955. This year's survey reported that manufacturers, on the average, preferred to operate at 90 percent of capacity at the end of 1961. Earlier surveys indicated preferred rates of 89 percent, 90 percent, and 94 percent at the end of 1954, 1956, and 1959, respectively.

Senator PROXMIRE. May I interrupt for just a minute?

Mr. GREENWALD. Surely.

Senator PROXMIRE. This puzzles me a little bit. Why would not manufacturers want to operate even closer to 100 percent capacity?

By "preferred to operate," you are telling us they would express a preference of 89 percent, 90 percent, 94 percent. They would prefer, for example, as far as the first figure is concerned, to operate at 89 percent rather than 90 or 91, at 90 percent instead of 92 percent.

Why would they not prefer a full utilization?

Mr. GREENWALD. Well, actually, I go into that a little later on, but just to clear it up at the moment: As the operating rate rises, you tend to use some inefficient capacity, and inefficient labor as well as more costly materials. So manufacturers prefer to operate at a less than 100 percent rate.

Throughout our whole survey history, I think, only in the case of paper did we ever get an operating rate of 100 percent reported for any industry.

Senator PROXMIRE. Was there not a time when steel was operating for quite a while at 100 or even over 100?

Mr. GREENWALD. That is right.

Senator PROXMIRE. You mean to imply that in the capacity over 90, for example, or 94, or 89, in these various figures you have, the marginal cost is so great that additional production might be produced at less than a profit?

Mr. GREENWALD. That is right.

Senator PROXMIRE. Is that right? In other words, they have maximized their profits at these figures?

Mr. GREENWALD. That is right. I say just that a little later on.

From early survey experience, the department of economics decided to ask questions we could reasonably expect busy company executives to answer. Any questions that we would include in our surveys would be worded to permit simple and definite answers. Thus it was decided to let companies set their own definitions of capacity, and we only asked that the respondents stick to their definitions. This, of course, leaves open such questions as number of shifts of operations, treatment of low grade, standby capacity, and final assembly versus intermediate capacity. But, in general, companies follow a commonsense definition of capacity, such as maximum output under normal work schedules. This definition is indicated as the one most generally used by our respondents through interviews the Department has conducted throughout the 15-year history of its surveys.

We have often been asked the question, what makes capacity a more difficult concept than other economic terms? The simple answer is that the definition of capacity requires judgment and basic assump-

tions which vary considerably. Even given a workable definition, capacity figures for the economy as a whole would have to be constructed at present from a variety of sources and data. Many technicians are uneasy about such a lack of precision.

The definition of capacity varies from industry to industry and from company to company. The more diversified a company, the more difficult the definition becomes. And theoreticians have added a variety of definitions which they feel must be used in order to accurately state the case. All these concepts may serve a useful purpose, but they cannot all be used to show the same things.

The problems of defining capacity in continuous process industries, such as steel, may not pose a serious problem. But even the steel industry has ceased to publish capacity figures because the industry feels that such statistics do not present a sufficiently accurate picture of the industry. The result of this elimination of steel capacity statistics has been somewhat of a handicap to economists and financial analysts, but it has not stopped them from making their own, perhaps less accurate, estimates of steel operating rates.

But suppose we were to try to define capacity for a very diversified company producing over 8,000 different products? How many pages of definitions would we have to provide? Think of the work that would be required of the respondent. And would this yield any better information than we now get by the very simple assumption that a company knows what its capacity is and the rate of capacity at which it is operating?

There are those experts who maintain that, obviously, if the industry's product cannot be precisely defined, its capacity cannot be measured. For example, the research staff of the Board of Governors of the Federal Reserve System, in constructing a capacity index several years ago, could find only 17 major materials for which physical capacity could be specifically defined.

Despite the hazardous problems, concepts of capacity have been worked out, and they fall broadly into two categories. These are the engineering concept of capacity and the economic concept. In the engineering concept, capacity is estimated on the basis of existing plant and equipment, and assumes a given supply of labor, materials, and competent management.

One criticism is that increasing or decreasing cost of labor and materials are not accounted for in this definition. Another critic questions the validity of adding together both old and new equipment. An old machine, for example, might run at only one-fourth the efficiency of a new one, but engineering figures would, nevertheless, include the old piece of machinery in capacity estimates.

The estimates of capacity for steel and electric power are basically engineering estimates, because they are based on technical considerations such as number of ingot tons of furnace capacity or billion kilowatt-hours of generator capacity. In addition, there are stated assumptions about the number of shifts, the treatment of peak loads, allowances for holidays and maintenance but there is no comprehensive allowance for cost considerations. In other words, if costs are disregarded, production bottlenecks can be broken and capacity expanded considerably.

Others argue for the economic concept which attempts to allow for costs, demand, and alternative uses of resources. At some rate of output, companies within an industry develop a tendency to buy more capital goods for expansion. It is this particular output rate which is considered the capacity rate of an industry. Capacity for this purpose is an economic limit to the rate of output with the existing facilities. Under certain conditions of cost, the economic limit may also coincide with the technical limit—technical in the sense that no more could be produced with existing facilities regardless of the costs involved.

In my opinion, the indexes of the National Industrial Conference Board, Fortune magazine, and the Economics Department of the Wharton School of Business of the University of Pennsylvania represent the economic approach. The recent comprehensive capacity index of the Federal Reserve Board, based largely on McGraw-Hill data and used in the January 1962 Economic Report of the President, and the McGraw-Hill index, represent a combination of the economic and engineering approaches, while the Federal Reserve's 17 major materials index is strictly an engineering approach.

Here is a brief description of these four capacity measures. Later I will discuss in much more detail the McGraw-Hill measures.

Daniel Creamer will tell you in detail a little later this morning about the National Industrial Conference Board measure of capacity. In brief, it is based on the ratio of fixed capital to output. For this computation fixed capital is the total dollar value of plant and equipment, minus depreciation allowances, and corrected for price changes. Output is measured by gross operating receipts corrected for inventory changes and prices. Thus capacity is determined in terms of financial units adjusted for price changes rather than physical units. I should point out at this juncture that price deflators for plant and equipment are probably considered the least reliable of the various price indexes; especially is this true in the construction area.

Fortune magazine's method of measuring capacity of the private economy is based on the ratio of total stock to total output. For this computation the total stock is the total dollar value of plant and equipment, minus depreciation allowances, corrected for price changes and adjusted by a fixed annual efficiency factor. The total output is the total private gross national product corrected for price changes.

I should point out that a fixed efficiency adjustment factor would be useful for longrun capacity analyses, but not for shortrun comparison. Efficiency, similar to productivity, does not increase each year at an even pace.

Econometricians of the Wharton School of the University of Pennsylvania have developed a capacity index covering manufacturing, mining, and utilities. It is based on the Federal Reserve Board's index of industrial production. It assumes that a peak in the production index at any point in time is full capacity. It assumes that all available labor and facilities are being used. The line between two peaks in two different time periods is full capacity, and anything below is the utilization rate. This assumes that cost of labor and materials are in line with output and profit maximization.

The Federal Reserve's capacity index for major materials covers 17 basic commodities as of January 1 of each year. The index is based on capacity estimates of trade associations and a variety of other

sources. It represents the maximum unit volumes that can be produced for these commodities; for example, tons of paper, barrels of oil, and tons of steel. The individual commodity indexes are combined into a total by means of value-added weights.

The McGraw-Hill capacity index is a measure of growth of manufacturing capacity as compared with capacity in the base period, December 1950. It is solely a measure of capacity in terms of plants and equipment. It does not measure capacity in terms of available manpower or materials, which at times may also limit productive ability.

The McGraw-Hill index of manufacturing capacity is based on replies to our annual plant and equipment survey. Companies responding to this questionnaire represent about 40 percent of total manufacturing employment.

Senator PROXMIRE. Let us go back, now, for just a minute, and see if I understand these various measures of capacity.

First, you describe the National Industrial Conference Board measure of capacity. You say it is based on the ratio of fixed capital to output, total value of plant and equipment, corrected for price changes.

I do not want to delay you, but I think it is very much simpler for me if I can get a specific example in each case.

Let us take a particular plant which has a total value of plant and equipment before depreciation of $1 million. Depreciation allowances, let us say, of $200,000. Let us say that this is based on cost. Would that be proper? Correct?

Mr. GREENWALD. Yes.

Senator PROXMIRE. And there has been an increase in the price level which you would use, an increase in the price level of 5 percent. Then what you would do is take the $800,000 and then correct it for the 5 percent, and that would be $840,000, which would be the total value. Is that right?

Mr. GREENWALD. Well, if the price was going up, it would be the reverse.

Senator PROXMIRE. Oh; it would be the reverse. I see.

Mr. GREENWALD. I think you also have to account for the total plant and equipment. This million dollars that you started off with, you see, would have to be in terms of constant dollars.

In other words, they adjust the total stock for price changes over the whole period in question. If the base is 1929, this million dollar figure represents all the capital investment put in place during this period but adjusted for prices over time.

Senator PROXMIRE. Yes. My main problem here is to relate the dollars that you put into the plant, on the one hand, with the gross operating receipts, on the other.

Mr. GREENWALD. I see. Well, this would be roughly the idea.

Senator PROXMIRE. So let us pursue this example a little further. The gross operating receipts, then, would be what, in order to get, say, 100 percent of capacity?

Mr. GREENWALD. Well, that is relative.

Mr. Creamer is the expert on this, so I will ask him to answer this question.

Mr. CREAMER. The deflator is a little more complicated than you have suggested, Senator. Mr. Greenwald has indicated some of the complexity.

If we assume at the end of 1961 the plant had a book value of $1 million, but these assets, these fixed assets, were acquired, let us say, over a 15-year period, and prices varied in each of these 15 years, you have to construct a price deflator that allows for this gradual change in prices, properly weighted by the amount purchased in each of these years.

Senator PROXMIRE. If you had a rising price level, then, you would have to deflate. I see.

Mr. CREAMER. That is right. And it gives weight to the prices of the various years according to the percentage of the facilities that are still in use as of the given time that you are measuring. So it is a sort of weighted price deflator, weighted by the value of the equipment still in place.

Now, the deflator for the output is a simpler one. Since that turns over annually, or more frequently, you can use the current price change to correct for the price rise.

Senator PROXMIRE. You see, the block I have in my mind now is on why you have to have this figure at all in order to relate some kind of gross receipts for a particular percentage of capacity.

Mr. GREENWALD. I guess the point is this: You are valuing this stock of plant and equipment over time. You are not considering it just for 1 year. But the computation is related over a whole sequence of years, so you do have to make these changes for prices.

Senator PROXMIRE. Let me just proceed with this example. Suppose you operate in 1950 with a million dollar plant, and you have gross receipts that year of $500,000, and then the next year $600,000, and the next year $700,000, and the next year $800,000, and so forth. Now, I am just not sure that I can understand the connection between the gross receipts as they arise and whether your plant is a million dollar plant, a $2 million plant, a $100,000 plant, or what the cost of the plant is. It is how you relate.

You see my problem?

Mr. CREAMER. Yes. And I think it may arise from the fact that Mr. Greenwald omitted one step in the determination of this capacity measure.

The capacity is determined by this relationship of capital to output in a period when we know, from other evidence, that manufacturing industries in general were operating at virtual capacity rates. Now, for this period, it would be 1953. Then by comparing the relationship of capital to output in succeeding years, in relationship to its relationship in the year when we know they are operating at full capacity, you can determine at what percentage of capacity they are operating. But there is this intermediate step of getting this relationship for a period of full utilization.

Senator PROXMIRE. The critical figure is the gross receipts figure. If in one year that figure is a million dollars, and that is near capacity, and the next year it is down to $800,000, then you relate those two figures, primarily?

Mr. CREAMER. Yes.

Senator PROXMIRE. Then the next, the Fortune magazine method, is a little simpler to me, because you relate the ratio of total stock to total output.

Mr. GREENWALD. There is some question in my mind. The Fortune editors talk about total stock to total output, and talk about it in terms

of the private gross national product. It is not clear to me when they refer to the total stock that they refer only to the dollar value of plant and equipment. The total stock, on the basis of their definition, should include consumer equipment and housing.

I think when Sanford Parker, the chief economist for Fortune, appears before you, you might get at the detail of that.

In other words, they are relating, as far as I can figure out, plant and equipment as the stock to output measured by the total private gross product, which is the sum of both consumer and business spending.

Senator PROXMIRE. I see. They are going to testify later. It would be interesting to see how they can put that together.

Mr. GREENWALD. It would be very important to get the detail of that.

The other point I mentioned with regard to the Fortune measure is that they use an annual efficiency factor. This is to take account of changes in efficiency in equipment over a period of time. They make an annual adjustment for this throughout the whole sequence of years.

I think just saying that this adjustment is a fixed percent year in and year out is not meaningful.

Senator PROXMIRE. So if you have a printing company and they buy a new press that will produce four times as fast, then you have to relate that to how that affects the overall efficiency of the whole plant.

Mr. GREENWALD. That is right.

Senator PROXMIRE. And you relate that also to the cost, and so on.

Mr. GREENWALD. That is right.

Senator PROXMIRE. Then the next is the Wharton method.

Mr. GREENWALD. This is a very complex method. As I see it, one of the problems, of course, is that this particular index does not fluctuate very much at all. It seems to me that in the industrial area there is much more fluctuation in actual operations.

Senator PROXMIRE. If I take this literally and maybe pull it out of context, you say, "It assumes a peak in the production index at any point of time is full capacity." Now under this definition you can conceivably have full capacity; although actually you are operating at three-quarters of what could be produced if you went all out and used your operation fully.

Mr. GREENWALD. Yes, sir.

Senator PROXMIRE. I understand that. Then the next and the last one is the Federal Reserve.

Mr. GREENWALD. This is a simple one, because it only takes into account 17 basic commodities.

Of course, there is a new Federal Reserve Board measure, which was used in the latest Economic Report of the President. I think, you should let Frank deLeeuw tell you about this measure when he testifies.

Senator PROXMIRE. This relies on the trade associations and other associations, and gets their estimate of capacity and comes up with an aggregate figure?

Mr. GREENWALD. And only for those 17 basic materials, because the associations themselves say, "This is the industry's capacity."

Now, of course, the steel industry has backed away from this, so I do not know what the Federal Reserve experts are doing about steel,

but perhaps they are making their own estimates for this industry.

Senator PROXMIRE. I see.

Mr. GREENWALD. Now, do you want to go ahead?

Senator PROXMIRE. Yes, you may go on with your statement. I am sorry to interrupt you.

Mr. GREENWALD. That is quite all right, sir. Companies are asked how much they expanded and how much they expect to increase the physical volume of their capacity. The exact wording of the first question is: At the end of the year, how did your capacity, measured in terms of physical volume, compare with what it was at the end of the previous year?

The second question is: If you carry out this capital expenditure program—for the current year—what will be the net change in your company's physical capacity?

The replies are on a company basis, not on a plant or establishment basis. Companies are thus classified by standard industrial categories in terms of their major product lines.

Individual industry indexes are constructed from year-to-year relative changes reported by the companies. For example, a chemical company may indicate it increased its capacity 7 percent from December 1960 to December 1961. Thus its relative index for December 1961 is 107. Or the reverse may occur. Another industrial company may indicate it decreased its capacity by 7 percent from December 1960 to December 1961. Thus its relative index for December 1961 is 93.

Each reporting company's relative importance in its industry is taken into account in computing 15 individual industry indexes. For these calculations we use employment as the weighting factor of relative importance. We have also used gross fixed assets as a measure of relative importance. But companies make available their employment data much more readily than they do their assets figures. The table on the following page shows the indexes for the 15 major industries as well as the total for manufacturing as a whole.

In addition, within diverse industries where our sample of respondents is particularly good, we compute capacity indexes for subgroups. For example, we can break out of the machinery industry capacity indexes for farm machinery, construction machinery, and metalworking machinery. We can estimate capacity for appliances and electrical apparatus, two parts of the electrical machinery group. In the case of chemicals, we can construct capacity indexes for industrial chemicals, drugs, plastics, synthetic fibers, and fertilizers. Thus we have a large number of capacity indexes not regularly reported. We publish these indexes occasionally in McGraw-Hill publications covering the metalworking and chemical fields, such as American Machinist/Metalworking Manufacturing, Chemical Engineering, and Chemical Week.

Now the 15 industries are on this table, and they range from iron and steel, as you can see, to miscellaneous manufacturing group. This is the table, incidentally, which would have been in our last survey of capital expenditures.

(Table I referred to follows:)

The 15 industry indexes and the total for all manufacturing are listed in the table below:

TABLE I.—*Index of manufacturing capacity* [1] *(December 1950=100)*

Industry	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	Planned		Percent increase		
												1962	1965	1960–61	1961–62	1962–65
Iron and steel	103	111	117	119	123	128	137	144	145	145	146	150	159	1	3	6
Nonferrous metals	110	121	133	140	150	160	169	177	182	195	203	207	215	4	2	4
Machinery	107	117	124	131	141	159	170	175	184	191	195	203	227	2	4	12
Electrical machinery	109	123	139	150	162	178	192	202	216	225	234	241	265	4	3	10
Autos, trucks, and parts	111	128	132	140	150	160	165	166	169	174	177	181	199	2	2	10
Transportation equipment (aircraft, ships, railroad equipment	114	147	172	181	195	216	225	245	252	267	272	288	311	2	6	8
Fabricated metals and instruments	104	109	116	122	131	138	145	152	161	171	178	190	217	4	7	14
Chemicals	110	122	134	142	152	163	176	186	195	207	219	230	253	6	5	10
Paper and pulp	104	112	119	125	133	140	148	155	164	172	181	186	205	5	3	10
Rubber	104	111	118	125	135	142	145	149	159	165	172	182	204	4	6	12
Stone, clay, and glass	108	113	116	121	129	140	150	155	161	166	171	176	185	3	3	5
Petroleum and coal products	104	109	117	122	126	132	136	141	144	147	147	148	149	0	1	1
Food and beverages	104	107	110	114	119	125	129	134	143	147	151	159	173	3	5	9
Textiles	101	102	105	103	109	111	113	116	121	122	126	132	148	3	5	12
Miscellaneous manufacturing	105	108	113	120	128	133	141	145	151	157	165	173	194	5	5	12
All manufacturing	105	113	124	130	139	148	156	163	170	177	182	189	208	3	4	10

[1] Weighted by 1957 value added weights used by Federal Reserve Board in its calculation of the industrial production index.

NOTE.—All data as of end of year.

Mr. GREENWALD. The overall manufacturing capacity index is calculated by weighting the individual industry indexes by their relative importance. The weights used to combine steel capacity with machinery capacity, chemical capacity, and the other major industry capacity figures into the composite index, are the value added weights developed by the Federal Reserve Board in its index of manufacturing production.

Prior to the development of our operating rate statistics in 1955, most students of capacity and utilization of capacity compared the McGraw-Hill capacity index with the Federal Reserve Board's index of manufacturing production. Chart I points up this relationship.

(Chart referred to appears on p. 13.)

Mr. GREENWALD. Since December 1950 (the base of our index), manufacturing production has increased considerably less than manufacturing capacity. According to the production index, manufacturing output was only 39 percent higher in December 1961, than in December 1950, an annual rate of increase of 3 percent per year, where the McGraw-Hill capacity index shows an 82 percent increase, an annual increase of 5.6 percent over the 11-year span.

It is reasonable that capacity should have risen faster than production during the early postwar years and the Korean war years, because many industries emerged from both wars short of capacity for sustained periods of really heavy demand. But after the gap between capacity and production widened, and quite a margin of excess capacity developed, the rate of capacity increases slowed down. Between December 1957 and December 1961, the average annual increase in manufacturing capacity was only 4 percent, according to the McGraw-Hill measure of capacity.

We began asking in our survey taken early in 1955 how much capacity companies were actually operating at the end of the year. This provided us with a check on the relationship between our index of capacity and the Federal Reserve's production index. We use the same computational methods to arrive at individual industry figures and total manufacturing operating rates, as indicated earlier for our capacity indexes.

Table II shows the operating rates for 15 individual industries and for all manufacturing from December 1954 to December 1961. Chart II points out the shifts that have taken place in operating rate and excess capacity since the end of 1954.

(Table and chart referred to follow:)

TABLE II.—*Actual operating rate*

[In percent]

Industry	1954	1955	1956	1957	1958	1959	1960	1961
Iron and steel	81	98	98	68	73	96	50	83
Nonferrous metals	87	95	92	74	77	77	72	79
Machinery	72	87	85	76	70	76	70	75
Electrical machinery	92	98	87	76	80	79	74	79
Autos, trucks, and parts	95	96	(1)	76	78	88	80	86
Transportation equipment (aircraft, ships, railroad equipment)	69	74	80	74	70	75	71	71
Fabricated metals and instruments	81	94	83	80	80	84	76	76
Chemicals	79	90	83	81	80	82	75	79
Paper and pulp	97	100	96	88	87	91	88	90
Rubber	93	91	88	80	78	84	76	93
Stone, clay, and glass	87	94	90	74	79	78	70	71
Petroleum and coal products	90	96	96	90	87	86	81	90
Food and beverages	82	88	80	80	82	83	81	82
Textiles	88	93	90	80	87	92	82	91
Miscellaneous manufacturing	(1)	(1)	85	80	84	89	83	89
All manufacturing	84	92	86	78	80	85	77	83

[1] Not available.

NOTE.—All rates as of end of year.

CHART I

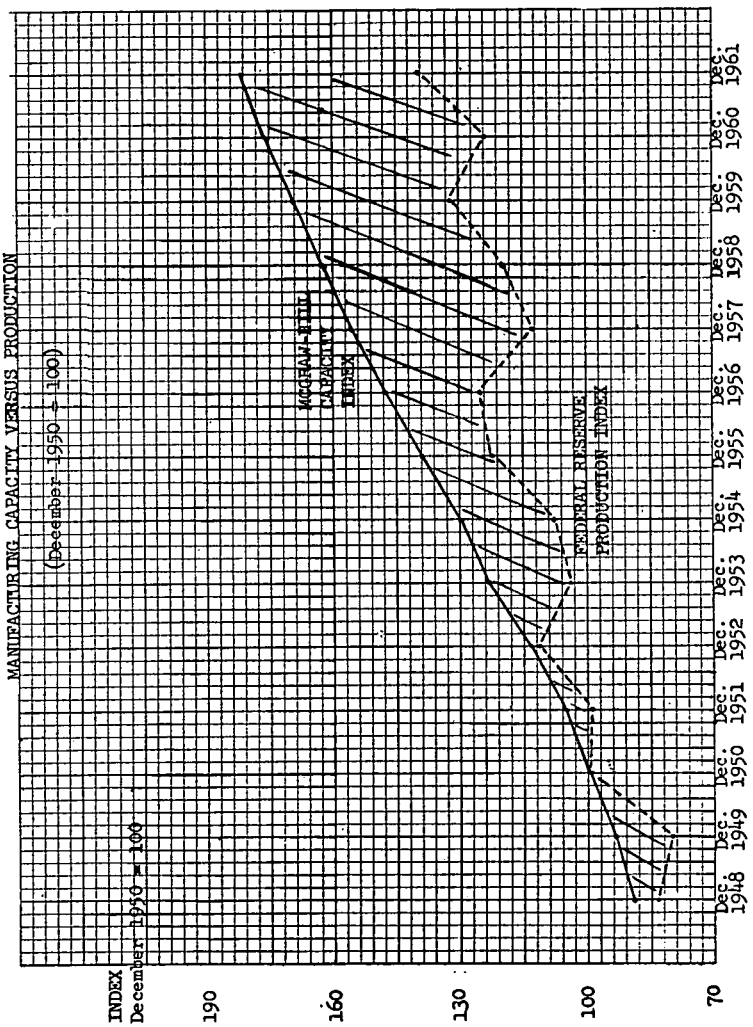
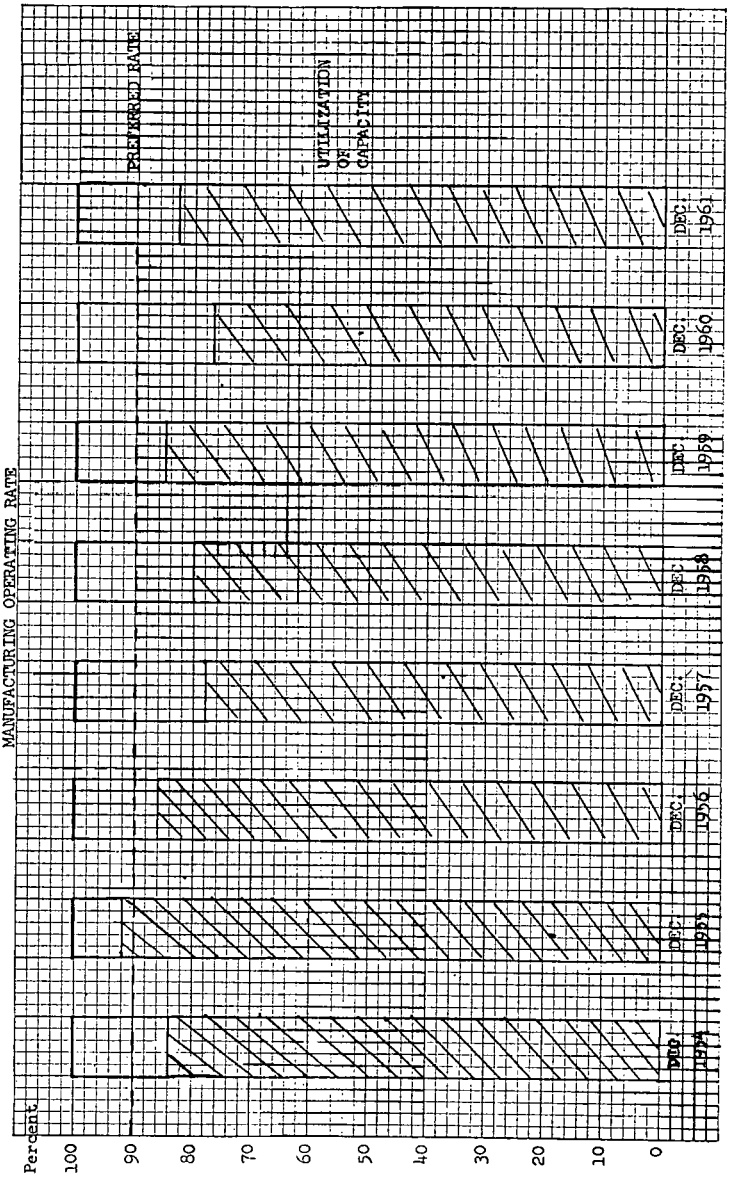

MANUFACTURING CAPACITY VERSUS PRODUCTION
(December 1950 = 100)
INDEX
December 1950 = 100
190
160
130
100
70
McGRAW-HILL CAPACITY INDEX
FEDERAL RESERVE PRODUCTION INDEX
Dec. 1948
Dec. 1949
Dec. 1950
Dec. 1951
Dec. 1952
Dec. 1953
Dec. 1954
Dec. 1955
Dec. 1956
Dec. 1957
Dec. 1958
Dec. 1959
Dec. 1960
Dec. 1961

CHART II

MANUFACTURING OPERATING RATE



Source: McGraw-Hill Department of Economics

Mr. GREENWALD. Also in the 1955 survey, companies were asked the rate at which they would prefer to operate. Again the definition was left up to the companies. We felt that most companies do not prefer to operate at 100 percent of capacity all the time, because this generally brings in high-cost facilities, overtime wages, and probably a lower rate of return. The preferred rate should be the quantity rate at which profits are maximized.

We have found that actual operating rates do not have to rise to the preferred levels before some companies have an incentive to start new expansion programs. At some low point they may anticipate future needs for more capacity and also be getting a rate of return sufficient to warrant new investment. This point may be around 85 percent of capacity, according to the McGraw-Hill measure of operating rates. Also, individual companies—or industries—need not wait for the manufacturing rate to approach 90 percent before they can justify expansion of their own facilities.

We have also attempted through our surveys to get at the age distribution of installed capacity. In the summer of 1958, we asked a large number of manufacturing companies about the age distribution of their total capacity at the end of 1957. The results were broken down into three age groups: Prior to December 1945, between December 1945 and December 1950, and between December 1950 and December 1957. At that time, 48 percent of installed manufacturing capacity dated back to World War II and before. About 19 percent had been built between the end of World War II and the beginning of the Korean war. Between December 1950 and December 1957, one-third of the total capacity had been installed.

We carried out a similar survey this year, and expanded it to cover all industry except gas utilities and commercial business. The results are rather striking.

The age of our current industrial capacity is as follows: 24 percent was built prior to December 1945; 16 percent was built in the period between the two wars; 27 percent was installed between December 1950 and December 1956; 33 percent is relatively new, installed since the end of 1956.

Senator PROXMIRE. Do you have any figures at all on Western European countries?

Mr. GREENWALD. No; we do not. It is our estimate, of course, that somewhere between 75 and 80 percent of Western European facilities are relatively new.

Senator PROXMIRE. Since December of 1950, or so?

Mr. GREENWALD. Yes. Of course, this is not too far out of line, compared with our latest survey of U.S. facilities.

The percentage of modern facilities in Japan is probably roughly the same as in Western Europe. We have been trying to get some good figures for Japan. The Japanese did make a survey in 1955, but it is so detailed that they did not come up with any aggregate figures. It is just on an industry basis.

In our 1958 survey, 48 percent of our manufacturing capacity was 12 years old or older, one-third had been built within 7 years. In our recent survey, 40 percent of our capacity was 11 years old or older, while one-third was built within the past 5 years.

American industry has made remarkable progress in modernizing its stock of plant and equipment in the last several years. But obviously quite a big job remains.

Senator PROXMIRE. I do not want to ask you policy questions at this point, because I want to go ahead with Dr. Creamer, too, but I do want to ask you if there was any particular reason in terms of change in the tax laws or anything else that has resulted in this current new rebuilding of our capacity.

Mr. GREENWALD. Well, we have never really asked our respondents this question. It would be my impression that the partial revision of depreciation methods in 1954 helped to spur investment in the years 1955–57.

Senator PROXMIRE. Just one more question.

Do you have any figures on how this situation compares with America's historical experience, say in 1890, 1910, 1920, 1930, 1940?

Mr. GREENWALD. I do not.

Senator PROXMIRE. Are there any reasonably reliable estimates on the situation?

Mr. CREAMER. Senator, are you asking for rate of growth in the stock of, let us say, manufacturing capital?

Senator PROXMIRE. No, I am asking about the newness of the capacity, whether this is marked progress not only from the situation of a few years ago but marked progress from the historical situation.

For example, we know the advance of the steel industry with Andrew Carnegie's tremendous innovations around the turn of the century or before the turn of the century, which was of great cost to many people, but was a great contribution to America's productive capacity. I am wondering if this is not of more significance from the point of view of the whole economy than that.

Mr. CREAMER. The rate of the increase in capital stock is related, of course, to how much of current capital stock is new. Some of my estimates for manufacturing might be relevant here.

The rate of increase in the stock, the net stock, of manufacturing capital, in constant prices, in the 1950's was the highest rate we had experienced since the decade of 1909–19. The rate since 1957, however, has been at a much lower level.

Senator PROXMIRE. That is remarkable. The only preceding year, or the only preceding decade, I should say, that is comparable, was the decade that embraced World War I.

Mr. CREAMER. Yes, according to these estimates.

Now, when you go back into the late 19th century, you had still higher rates. But, of course, you are starting from a much lower base.

Mr. GREENWALD. You also have to think, Senator, in terms of the emphasis on modernization as opposed to expansion. And this has been true in the last few years, at least in the manufacturing area. There has been a great emphasis on modernization. We have come up with some figures showing the breakdown of modernization versus expansion. Since 1958 the figures have been roughly 65 percent in favor of modernization and only 35 percent in favor of expansion.

Senator PROXMIRE. It is particularly impressive when it is seen that with most real modernization you are likely to get an expansion, too. You buy a new press, and you probably get one that will turn out a great deal more in a shorter time, because it is newer.

Mr. GREENWALD. That is true.

Senator PROXMIRE. And your statistics would suggest that practically all of the investment has been primarily in modernization?

Mr. GREENWALD. Not only that, but plans for the years ahead, for the next 3 years, as shown by our survey, would indicate that about 68 percent is going to go for modernization. So even a bigger proportion is expected to go for modernization than has taken place in the last few years. It is clear that industry plans to modernize, and have more up-to-date plant and equipment in the next few years.

Within a short period, as a matter of fact, the share that was built by December 1945, will go down sharply. It will be actually retired, or in terms of the total investment pie it will account for a smaller percentage.

Senator PROXMIRE. You may proceed.

Mr. GREENWALD. The fact that companies that participate in the McGraw-Hill surveys are generally the larger companies in their industries may affect the results. It is possible that very small and medium-sized companies may not have replaced their obsolete and antiquated facilities to the same degree as did large companies because of lack of financial resources or cost factors. But even used as a rough gage, the recent concentration on modernization of facilities has resulted in the abandonment of a large portion of producing facilities which were no longer economic, our survey shows.

Senator PROXMIRE. Not only would you have to modify in terms of the smaller companies on the basis of their profit figures and everything else, because the smaller companies are not probably modernizing and expanding as rapidly, but it would also be true of the nonmanufacturing segment of the economy.

Mr. GREENWALD. In our last survey, we expanded our coverage to take account of some parts of the utility industry and mining, areas which we did not cover in the 1958 survey.

I would like to submit for the record a table from our report on that particular phase of the study. It compares the 1957 and 1961 breakdowns by age and for our recent survey we have data going beyond just manufacturing. Although we did not cover small manufacturing companies in 1957 or in 1961 either, the relationship in terms of age of facilities would still be roughly relative.

Over the years, critics of the McGraw-Hill capacity index and operating rates have suggested that the growth of manufacturing capacity is overstated, and that the operating rate is too high. We attempted to answer these criticisms in 1958.

In a special survey conducted in July and August 1958, we asked a broad sample of manufacturing companies to report the increase in their physical capacity between December 1950 and December 1957. This survey provided a measure of the growth of capacity of a representative sample of the same companies for the entire 7-year period. During the late 1940's and the early 1950's, the index was not based on as broad a sample as was used beginning in 1954.

This special survey showed an increase of 51 percent in total manufacturing capacity for the time span between December 1950 and the end of 1957. This compared with a 49 percent increase in McGraw-Hill's published index, for the same number of years, but computed independently each year. In most individual industries the results from the special surveys were only a few points away from the regular industry indexes.

TABLE III.—*Age of industrial capacity*

Industry	August 1958 survey—Percent installed—			Current survey—Percent installed—			
	Prior to December 1945	December 1945 to December 1950	December 1950 to December 1957	Prior to December 1945	December 1945 to December 1950	December 1950 to December 1956	December 1956 to December 1961
Iron and steel	47	16	37	27	10	29	34
Nonferrous metals	47	13	40	21	13	31	35
Machinery	41	21	38	24	17	27	32
Electrical machinery	34	18	48	18	12	25	45
Autos, trucks, and parts	42	11	47	8	13	50	29
Transportation equipment	59	9	32	(1)	(1)	(1)	(1)
Aircraft	(1)	(1)	(1)	17	11	28	44
Other transportation equipment	(1)	(1)	(1)	43	13	18	26
Fabricated metals and instruments	54	17	29	25	13	29	33
Chemicals	30	23	47	21	15	31	33
Paper and pulp	49	17	34	23	16	30	31
Rubber	46	9	45	23	17	28	32
Stone, clay and glass	46	20	34	23	15	30	32
Petroleum and coal products	45	26	29	20	12	30	38
Food and beverages	58	19	23	26	19	26	29
Textiles	59	18	23	32	17	24	27
Miscellaneous manufacturing	51	21	28	28	19	23	30
All manufacturing	48	19	33	24	16	27	33
Mining	(1)	(1)	(1)	24	14	33	29
Railroads	(1)	(1)	(1)	39	19	23	19
Other transportation and communications	(1)	(1)	(1)	19	15	22	44
Electric utilities	(1)	(1)	(1)	23	13	29	35
All industry [2]	(1)	(1)	(1)	24	16	27	33

[1] Not available.

[2] Does not include commercial business or gas utilities.

There was some possibility of statistical bias in this special checkup. The main reason was that some companies participating in the checkup were not in regular McGraw-Hill annual surveys in the early 1950's, and these, in large part, were companies that became relatively big since then and, therefore, expanded faster than the average of their industries. The checkup, however, appeared to confirm the degree of change in manufacturing capacity as measured by the McGraw-Hill index.

There are several possibilities of upward bias in the McGraw-Hill capacity index and operating rate:

1. Mergers: Companies are asked to report only changes in capacity through new installation or retirement of plants and equipment, not changes resulting from acquisition or sale of facilities. Shifts in ownership do not represent changes in industrial capacity. Questionnaires are carefully edited to eliminate inclusion, by mistake, of capacity changes through merger; but some may slip through.

2. Diversification: With few exceptions, companies are classified by industries according to their principal product. Product diversification, however, has become increasingly important, and many companies are significant producers in two or more industries. Inclusion of a rubber company's new chemical plant in the rubber industry figure, for instance, would raise the rubber capacity index when it should be raising the chemical industry's index. And in many instances companies carefully indicate to us whether or not their figures include or exclude such additions to capacity. Many of these errors, however, are offset by diversification moves in opposite directions. The overall index is probably not much affected one way or the other.

3. Bankruptcies and retirements: The McGraw-Hill index probably does not fully reflect the withdrawal of facilities through scrappage, demolition, or abandonment. Our inquiries indicate that most companies do try to take account of retirements and report net changes in capacity. But bankruptcies pose a difficult problem, for these typically affect smaller firms that are rarely in the McGraw-Hill sample. Reduction of capacity through plant abandonments and bankruptcy has been a problem especially in the textile industry.

Senator PROXMIRE. That does not amount to a very large proportion, however, does it?

Mr. GREENWALD. No, sir.

Senator PROXMIRE. Are not bankruptcies primarily confined to pretty small businesses?

Mr. GREENWALD. Generally, this is true; but if you had an accumulation of these, it might have some impact on the overall figure.

4. Big company bias: The sample of participating companies in the McGraw-Hill survey is dominated by large companies, though diligent efforts have been made to include a greater representation of small- and middle-sized firms. Large companies, as a rule, account for a disproportionately large share of plant expansion, so their expansion rate may exaggerate the trend for the industry.

Through careful editing of questionnaires, continual broadening of the sample, and study of industry developments, the department of economics has made every effort to minimize these possibilities of bias. At most, they may mean that the capacity index overstates the growth of manufacturing capacity by about five points during the period of

11 years. But the results of our 15th annual survey indicating that manufacturing capacity has increased by about 80 percent since 1950 measured in physical volume, and that there is still spare capacity in manufacturing, remains, we believe, correct.

Our index of capacity and rate of operations have proven reliable forecasting tools in the past. Furthermore, they have the added advantage of being the simplest of the capacity measures to explain and analyze.

Senator PROXMIRE. Thank you very much. I will come back to you shortly. But you say in the last paragraph, "reliable forecasting tools in the past." Forecasting what?

Mr. GREENWALD. Forecasting the economy in general.

Senator PROXMIRE. In other words, you have a situation in which manufacturers are operating at a lower level of capacity, lower proportion of capacity, and it is diminishing. Then you would forecast there would be less capital investment?

Mr. GREENWALD. Yes, sir.

Senator PROXMIRE. You would forecast there would be less business activity. You would forecast you would probably have less employment?

Mr. GREENWALD. And smaller profits.

Senator PROXMIRE. On the other hand, if they were moving in the other direction, is there is a substantial lag of 6 months or a year between this and the general tenor of the economy?

Mr. GREENWALD. There is a lag, but we also have an indication of what is ahead.

Senator PROXMIRE. This runs ahead?

Mr. GREENWALD. Right. This would be a leading indicator in that respect.

For example, we ask a question: How much do you plan to add to your capacity during the coming year?

Senator PROXMIRE. Does it run a year ahead?

Mr. GREENWALD. Yes. This is based on plans. It is very helpful in making forward estimates.

Senator PROXMIRE. I see. Then what you are talking about is not the statistics that come in, where you compile and show the following year. You question the executives of the companies on what their plans are.

Mr. GREENWALD. Yes. They provide us with two measures that we can use to gage future operating rates, planned sales, and planned capacity. They tell us that over the year they expect a capacity increase of 4 percent and they expect sales to go up 7 percent. This would indicate if you go back to our operating capacity base that an increase of three points in the operating rate would take place over the year. Three points added to 83 percent, the rate at which we stood at the end of 1961, would result in 86 percent, as a rough estimate of the operating rate at the end of the year.

Senator PROXMIRE. So what this really is, is an aggregate of estimates?

Mr. GREENWALD. That is right.

Senator PROXMIRE. And have you found it pretty sound?

Mr. GREENWALD. I believe so.

Senator PROXMIRE. Their estimates of sales? Of course, that would not be as sound as the rest.

Mr. GREENWALD. The aggregate estimate is good. But the lower down you go from the aggregate, that is to the industry, subindustry, or company level, the more error enters into the calculation. So if we were going to project a future rate for steel, it would probably not be as accurate as if we were going to make an estimate of the operating rate for all manufacturing.

Senator PROXMIRE. Yes, sir.

Thank you very much, Mr. Greenwald. It was very competent and impressive testimony.

Senator PROXMIRE. Mr. Creamer, why do you not go right ahead, sir?

STATEMENT OF DANIEL CREAMER, NICB

Mr. CREAMER. The Conference Board's interest in capacity measures derives from its interest in the business outlook, particularly in the later stages of a business expansion. In a recession period and in the early stages of recovery or expansion, there is excess capacity, by definition, and there is little need for capacity utilization measures. The decline of the production index from the previous peak is probably a reasonably good gage of the degree of underutilization of capacity in recession and early expansion.

However, as expansion gains momentum—and at this stage it is usually based on inventory investment—it becomes highly pertinent to ask whether the momentum will be sustained or accelerated by stepped-up investment in plant and equipment. Full employment and substantial growth in real GNP per capita has occurred typically when a pickup in fixed capital investment has been superimposed on rising inventory investment. Whether this pickup occurs depends on a number of factors, not the least of which is whether the output of manufacturing industries is approaching a level that prompts a decision to expand capacity.

Equally important for this type of analysis is a determination whether excess capacity (and if so, how much) exists at the business cycle peak. This, too, can have an important bearing on the severity of the following recession and the character of the subsequent recovery.

Senator PROXMIRE. You say:

> This, too, can have an important bearing on the severity of the following recession and the character of the subsequent recovery.

If at the peak of the cycle there is very little excess capacity, then I would anticipate that the recession would be less severe. At the peak of the cycle you have a considerable excess capacity; is that correct?

Mr. CREAMER. I think that is correct. At least it is consistent with what has happened in recent years.

The Conference Board does not attempt to use capacity measures to explain price changes, or to determine the ability of the economy to produce should the economy again be mobilized for war. The latter requires an engineering concept of capacity, and the Conference Board measures an economic concept.

The engineering approach, in its pure form, attempts to measure productive capabilities of plants and machinery, without regard to the costs of complementary materials and the demand for the product. The economic approach, in concept at least, attempts to allow for costs, demand, and alternative uses of resources. Since most invest-

ment decisions occur in response to a profit-maximizing motivation which expresses its preferences and resource allocations through a pricing system, there can be little doubt that the economic measure of capacity would be more appropriate. However, the operational superiority of one approach over the other depends on the character of the underlying assumptions, and the feasibility of giving statistical content to the concepts.

Not relevant to the concept of economic capacity is the maximum that each separate industry could turn out if it had no regard for the need of temporary shutdowns for repairs, cleaning, and installation of new machinery, or if it could run overtime, double shift, or continuously be drawing labor from other places of employment. Rather, economic capacity must be determined in the context of practical operating considerations, such as the normal number of shifts and "down time" for maintenance and repairs.

Senator PROXMIRE. May I interrupt there?

Why do you assume that? You say "the normal number of shifts." For example, if you have availability of labor willing to work a swing shift or a graveyard shift, willing to come in, and competent labor, and it is unnecessary to increase your labor costs significantly, why should this not also be included as an indication of a capacity operation?

Mr. CREAMER. Well, using "normal," here——

Senator PROXMIRE. By "normal," you mean just one——

Mr. CREAMER. No; whatever is customary for the industry. This makes it unnecessary for the analyst to determine for the industry what it regards as a profitable number of shifts.

Senator PROXMIRE. I see the conceptual problem. I see the difficulty. But I am just wondering whether or not, as a matter of information for policymakers, you should not also have a measure which would indicate what would happen if you could put the available labor to work; especially in times like the present where we have substantial unemployment, including some unemployment of skilled people or semiskilled.

Mr. GREENWALD. May I interrupt?

This would be rather difficult, because your labor supply obviously would not balance with the demand from the various types of industries. We have that situation right now. You could say that we have a big demand for engineers and scientists. These people are not available. How would you take that into account when you have 4 million people unemployed?

Senator PROXMIRE. This depends on how detailed you can be in your analysis. It may be that this is not the need. It may be an automobile operation such as American Motors in Milwaukee, in which case they can have three shifts, or two shifts, depending on what they want, and it may be that the custom in the industry is to have two shifts. I know they have gone to three shifts. They have been able to get the labor. There is some complaint of the efficiency of the labor.

Mr. GREENWALD. Yes. That is the point I wanted to interject here. It usually does entail rising costs. That is, there is a premium wage rate for the graveyard shift, and usually they work with less efficiency on the late shifts, compared with the daytime shifts. So while this may be feasible under certain conditions of demand, it may not be one

that they wish to use for a sustained period. But in any case, what is meant here is whatever is customary for the company or the industry in that peak period.

Senator PROXMIRE. You see, in so many manufacturing industries, it would seem to me, you have such a heavy burden in overhead cost that it would be unlikely, I would think—although I must say I am very much impressed by your statistics—it would be unlikely that if you had the demand you could not operate three shifts, at least you could not operate close to what you might call 100 percent of capacity, and make money out of it. After all, all you have to do is cover your out-of-pocket expenses in order to come out, including in the out-of-pocket expenses ordinary wear and tear, and so forth.

Mr. GREENWALD. Of course, if you add extra units these become high-cost units. This is where a company starts making its decision as to whether it wants to go ahead and increase operations.

Senator PROXMIRE. That is why I started emphasizing the third shift concept.

Mr. GREENWALD. Of course, competition also enters into the situation a little bit, too. That is, if companies feel that they want to go out and get a bigger share of the market, there is no question in my mind that they could and would operate at a hundred percent of capacity; whereas other companies in the same industry might make a decision not to go out for the extra business.

Senator PROXMIRE. You have a situation in the automobile industry, for example, where you have one company, American Motors, that might come along and have a colossal increase in production. They have had over the last 5 or 6 years, as you know; using facilities which at least generally are pretty much the same as they used before, but greatly increasing their shift operations. Their profits have increased very greatly. Perhaps this is not typical.

Mr. GREENWALD. Of course, I think what you are referring to is that the operating rate has gone up substantially, even under the normal definition. That is, several years ago it might have been operating at 50 percent of capacity, and today it may be operating at 90 percent of capacity, and still doing it in the same way; but they are still running below 100 percent of capacity by quite a margin.

Senator PROXMIRE. I do not want to continue too long on this, but my understanding is that there might have been a tendency a few years ago, 4 or 5 years ago, to say American Motors would be operating on the basis of the way you define this in your paper, Dr. Creamer, at close to 90 percent of capacity, operating one shift as most other automobile manufacturers are, or one and a half shifts, depending on how you define it, and making a little money, but not making much.

Now it has vastly expanded and is making a tremendous amount of money, and they are operating three full shifts, in fact doing a lot of Saturday work. They must be paying a lot of time and a half, and so forth. But they might have put some new machinery and equipment in. They have bought at least one substantial facility.

And I am just wondering if this is not a conservative conception, that if you take the custom in the industry and define that as full capacity——

Mr. CREAMER. Well, now, this would be custom at the peak. And in the case you cite, of American Motors, if this happened, as it did,

you would get a declining capital to output ratio, which means, then, that they are using their plant with greater efficiency.

Now, this increase in efficiency would be incorporated into the measure of capacity; and relating then the resulting output to this new measure of capacity, you would come up with your utilization rate, and the method of measurement is such that you would come up with a hundred percent, or close to a hundred percent utilization rate, based on increased capacity.

Mr. GREENWALD. May I add one other thing, Senator?

I would like to call attention to a table in our survey. This is table III that I am submitting for the record. This refers to the age of industrial capacity in the auto industry, and although I cannot say whether or not American Motors is in the sample of companies reporting to McGraw-Hill, the figures represent the industry as a whole.

And the point that I would like to make is that in the automobile, trucks, and parts industry, 42 percent of the plant and equipment, in the survey taken in 1958, dated back to December 1945 and before; while according to the current survey only 8 percent of the plant and equipment dates back to December 1945 or before. And if we add the 13 percent that was installed between December 1945 and December 1950, the industry has only 21 percent of its current plant and equipment that is 11 years old or older. Whereas in the earlier survey, somewhat less than 42 percent would be 11 years old or older.

The automobile industry, as a matter of fact, is the industry that has become the most modern of all in this respect.

Senator PROXMIRE. It is a strange mix, you see. I approach it as one who stands outside the plant gate and shakes hands with the workers as they go to work. And you have these old buildings built years ago, and I have been through all the plants. The changes are internal, within it, and the change is a matter of organization to some extent, and I suppose they do use substantial new equipment.

But I still feel it is a matter of utilizing available labor more effectively than it has been used before.

Go right ahead, sir.

Mr. CREAMER. Still another condition is imposed on the measurement of economic capacity. In aggregating capacity estimates for individual industries, one should be sure that they are mutually compatible. That is, if all industries attempted to operate simultaneously at these capacity rates, there should be no bottlenecks of labor and material shortages to frustrate the attempt.

These two conditions provide some criteria for judging capacity measurements. They can be judged also by how well a practical difficulty in estimation is solved, namely, the determination of precisely which plants and equipment are to be included. Is everything in existence to be included; or only what is in operation? How, in other words, are we to handle obsolete, high-cost equipment that is retained as standby facilities?

As this brief discussion suggests, the concept of capacity is elusive, and the measurement problems are numerous and difficult. For these reasons, actual measures of capacity are bound to be approximate at best. And this is our rationale for not being content with the only across-the-board estimates that have existed, namely, those prepared by the economics department of McGraw-Hill.

Because of the inherent errors of estimating, it should be helpful to have at least one additional and independent set of capacity and capacity utilization estimates. Should the movements in one set confirm the movements in the other set, the findings of both can be accepted with greater confidence. If one contradicts the other, additional research is clearly called for.

The Conference Board's approach to the problem of measurement is through changes in the relation of fixed capital to output, both expressed in constant prices. In this special sense, it is based on the technological relationship of a stock of capital and the output derived from it. The derivation, however, is not in terms of physical units and engineering relationships, but in terms of financial units reflecting economic choices and values.

The basic data are the reports by accountants of business operations and transactions as they are recorded in corporate balance sheets and profit-and-loss statements. While the accountant's precepts and practices for this purpose may not be perfect, the same must also be true of those of the industrial engineer. The assumptions of one profession in summarizing business operations are probably no more arbitrary than that of the other.

More specifically, how can the relation of capital to output provide the information we seek? In this context, capital means fixed capital, that is, structures and equipment. The volume of structures and equipment is measured by the value (net of depreciation) placed on these assets by manufacturing enterprises in their balance sheets, corrected for price changes. Output is taken at the cyclical peak and is measured by gross operating receipts corrected for changes in inventories and for price changes.

Senator PROXMIRE. You say "the cyclical peak." In other words, if at a cyclical peak they are operating below the capacity measurement, you would still consider that the standard?

Mr. CREAMER. Yes, because that is one of the things we would like to know. Have they achieved capacity operations?

Senator PROXMIRE. This seems to contradict something you said a little earlier in your paper, when you indicated that if at the cyclical peak industry is operating near capacity, it will have a serious effect on what is going to happen later. It will have an implication on what is going to happen later. Now, it seems to me the scenery is being shifted a little bit.

Mr. CREAMER. No; we do not equate the operation at cyclical peak with capacity operations.

Senator PROXMIRE. I see. All right. Fine. I assumed from that sentence that you did. You do not?

Mr. CREAMER. No, not necessarily.

In general, the procedure is to establish a fixed capital-output ratio for each industry classification for a benchmark year, a year which independent evidence indicates was a period when capacity was virtually fully utilized.

Now, in that particular benchmark year, that assumption is made, that the cyclical peak represents virtually full capacity.

Senator PROXMIRE. Is it not extremely difficult, in view of what has happened to our economy in the last several years, to get such a benchmark year that can be recent enough to give you an adequate basis?

Mr. CREAMER. Well, that conceivably can cause trouble in its measurement, but I think we can still use the experience of the early 1950's for this purpose.

Senator PROXMIRE. That goes back to 1955 for the automobile industry.

Mr. CREAMER. For many industries, yes. But I do not think enough has happened to the capital structure of manufacturing to disqualify that as a base period. In due course it undoubtedly would be disqualified. You would have to find another basis.

Senator PROXMIRE. Thank you.

Mr. CREAMER. A significant rise in this capital-output ratio of an industry above the benchmark ratio in a subsequent year would be evidence of excess capacity—unless the technological changes in the interval were strikingly capital intensive (for example, require more capital per unit of output, both in constant prices) which could be established from other evidence. On the other hand, a significant decline in the fixed capital-output ratio suggests that structures and equipment are being operated at greater efficiency. The additional capacity from this source is incorporated in the measurement.

This procedure has the merit of incorporating actual operating practices into the capacity measurements. For example, the length of the typical workweek, standby reserves of equipment for seasonal and cyclical peaks, downtime for repairs and maintenance, et cetera, are all reflected in the measures.

The procedure also meets the test of mutual compatibility, at least in the peak quarter of the benchmark year. At that point most manufacturing industries are operating simultaneously at virtually full capacity. However, the fact that peak levels are not sustained for long may mean that the compatibility is more apparent than real.

What are the results of this approach? These measures indicate that between 1948 and 1955, with brief interruptions, there had been a sustained period of full utilization of capacity despite continuous and rapid rates of growth in capacity. These results are consistent with other data showing a sustained rise in prices, a high level of profits, and widespread optimism about the outlook for the near future.

The Conference Board measures, as well as those of the McGraw-Hill, show that by the end of 1956 there was considerable excess capacity and that large capital expenditures in 1957 only served to aggravate the existing imbalance. But so sanguine was management that it was not until the last quarter of 1957, the onset of the recession, that it recognized the creation of this excess capacity.

This excess was so substantial that with little or no addition to facilities the existing stock of capital was more than sufficient to accommodate the new peak level of manufacturing production reached in the first half of 1959. Since this 7 percent rise in production (quarterly peak to quarterly peak) did not trigger a significant expansion in capital expenditures, the recovery from the 1958 recession failed to reach boom proportions.

Senator PROXMIRE. Then what you are saying is that because of the fact that there was excess capacity after 1955, the recovery at that time did not move ahead, because there was less capital investment during this period than there would have been if the operations of the economy had been close to capacity?

Mr. CREAMER. Yes.

Senator PROXMIRE. This is a specific example of the theory that you were giving us earlier?

Mr. CREAMER. Yes, and I should have mentioned here that the increased relative severity of the 1958 recession, say, compared with the 1954 recession, can be traced in large part to the fact that at the 1957 peak you had this considerable excess capacity; whereas at the 1953 peak you had virtually no excess capacity.

However, at the 1959 business peak, the level of unused capacity was much lower than the level at the 1957 peak. To me, this is an important factor explaining the relatively milder recession of 1960.

A critical question that confronts the business analyst is this: What is the level of capacity utilization now, and what is its probable impact on the level of capital expenditures in 1962? Answers to these questions will provide some clues to whether the business expansion will continue, and, if it does, at what rate.

At the end of 1961, according to the Conference Board measures, 6 of the 10 nondurable goods industry groups were operating at virtually full capacity, and the remaining 4 with only moderate excess capacity, but among the 13 durable goods groups only 5 achieved a reasonably full utilization of capacity. Thus, unused capacity continued to exist in 12 of the 23 industry groups, and these were using 42 percent of manufacturing stock of plant and equipment.

Senator PROXMIRE. Would you give us just a general idea of the relative importance of these 12, the 23 industry groups that you were using——

Oh, I see. You give that.

Mr. CREAMER. Yes.

Senator PROXMIRE. These 12, then, were less than half, 42 percent; is that correct?

Mr. CREAMER. With excess capacity, yes.

Senator PROXMIRE. OK, fine; that is the question I wanted to ask you. I missed that clause.

Mr. CREAMER. For 4 years, caution has been engendered by excess capacity, stable wholesale prices, and keen foreign competition. For this reason there is not sufficient pressure on capacity to generate a boom in capital goods, in my judgment. The planned expenditures for plant and equipment and expected rise in output recently reported by the Department of Commerce and McGraw-Hill for 1962 can be used to extend the Board's 1961 estimates. If the expectations on both counts are realized, the Conference Board measures indicate that the pressure of output against capacity will mount. After allowance for depreciation and obsolescence, we estimate that little or no addition to capacity will occur in 1962, while output, on the average, is expected to expand by 7 percent. Should these expectations be fulfilled, it would be reasonable to anticipate a still higher level of capital expenditures for manufacturing plant and equipment in 1963.

Senator PROXMIRE. I do not quite understand. You say for 4 years caution has been engendered by excess capacity and stable wholesale prices. I can understand as to those factors. And keen foreign competition? I should think keen foreign competition might have at least a double effect. There might be a tendency to modernize to meet that competition, to buy plant and equipment so that you could meet the

production of the efficient plant in Germany and England, and so forth.

Mr. CREAMER. My point there was to contrast it with the situation you had prior to 1957, where, because of the inability of Western Europe and Japan to compete effectively at that point—since they had not fully rehabilitated their industry—domestic manufacturers would expand their capacity in response to increased demand and know that they would not have to share this increased demand with foreign competitors.

That situation has changed, and I think the existence of a higher peak demand in a given quarter will no longer trigger a decision to expand capacity. They want to find out first whether this is going to be sustained for a much longer period before they will make this decision.

And I think part of that is due to increased foreign competition in domestic markets as well as foreign markets; whereas in the early 1950's I think a sharp rise in a given quarter frequently led to an investment decision to expand.

Senator PROXMIRE. Your judgment, then, is that the most important element of competition in terms of its impact on investment in plant and equipment is on the caution side?

Mr. CREAMER. Yes.

Senator PROXMIRE. Rather than on the incentive it provides to modernize and buy equipment yourself which can meet competition and reduce your costs?

Mr. CREAMER. Well, particularly if the emphasis is on capacity, I would say, certainly it creates caution. Where the primary need is for modernization, as you suggest, it probably is a stimulating factor.

Mr. GREENWALD. Senator, may I add something to that?

Senator PROXMIRE. Yes.

Mr. GREENWALD. Whenever you have emphasis on modernization, you really do not get any kind of a boom in capital investment. A boom in capital investment comes from expansion.

Now, the point that Mr. Creamer made is true——

Senator PROXMIRE. You were saying earlier that about two-thirds of the investment has been made for modernization, and about one-third for expansion?

Mr. GREENWALD. Yes, sir; that is why we have had no boom.

Senator PROXMIRE. And you are saying this has not been a booming situation at all?

Mr. GREENWALD. That is right.

Senator PROXMIRE. And this is true, you would say, no matter how intense or serious the competition may become?

Mr. GREENWALD. Yes; I would say that, because industry will still emphasize modernization. Modernization accounted for 68 percent of investment in 1961. But investment in 1961 was low. When we go back to the year 1957 when there was a large amount of investment, only 48 percent was devoted to modernization and 52 percent to expansion. This resulted in an alltime high investment figure of nearly $16 billion in manufacturing.

Senator PROXMIRE. Of course, these terms are a little bit ambiguous.

Mr. GREENWALD. Yes, but what I am getting at is that you do not have a boom in capital expenditures ever unless you have a big expansion underway.

The other point I wanted to make was that since 1955 or so, American companies have been going overseas to invest. And this has taken away some investment in the United States. But they have gone overseas to get a share of faster growth than we have in the United States, so this has been important to them in that respect.

Now, if we added together the investment going overseas and the investment being made in the domestic area, overall capital investment may not have significantly gone down in the last few years. It has held at a relatively high level.

Senator PROXMIRE. Dr. Creamer, you end on a kind of a left and a right, here. Your next to the last sentence says:

After allowance for depreciation and obsolescence, we estimate that little or no addition to capacity will occur in 1962, while output, on the average, is expected to expand by 7 percent.

You are saying that you would expect that through the rest of this year you would not anticipate that there would be much of an increase in investment in plant and equipment. Is that correct?

Mr. CREAMER. Above the normal depreciation.

Senator PROXMIRE. An increase?

Mr. CREAMER. No net increase.

Senator PROXMIRE. Then in your next sentence, you say:

However, if you expand production, if the anticipated expansion comes off, then it would be reasonable to anticipate a higher level of capital expenditures to plant and equipment in 1963.

That adverb "still" is a little bit confusing, because, you see, in the preceding sentence you say it is not going to be impressive in 1962, but then you say it will be still better. It will be better than unimpressive in 1963?

Mr. CREAMER. Well, the 1962 expenditures are considered to be some 12 or 13 percent higher than in 1961. And I think the "still" refers to that.

Senator PROXMIRE. I suppose the difficulty is that the estimates at the beginning of the year were rosier than they are now, but they are still an improvement over 1961.

Mr. CREAMER. Yes.

Mr. GREENWALD. The 11- and 12-percent figures we are talking about, 1962 versus 1961, are in current dollars. If we make the adjustment for price changes, you would find that in 1957 or 1956 we were at a peak in constant dollar capital expenditures compared to estimates for 1962 which take into account a 12-percent increase. Thus, industry would have to go a long ways further to return to the real peak in capital investment.

Senator PROXMIRE. It is interesting to me, Mr. Creamer, that there is no hedging of any kind, no anticipation one way or the other, of what would happen if the Congress passes or the administration recommends an investment credit.

The people in the administration feel—I happen to disagree—that this would make a great difference. What is your judgment?

Mr. CREAMER. Well, I should say it is nothing I have really thought much about. And I know Mr. Greenwald in their last survey asked this question of their respondents, and I would like to pass the ball.

Senator PROXMIRE. I am very familiar with what the Wall Street Journal found when they asked the 68 companies whether it would affect them. They said they would welcome the windfall, but it would not affect their policies much.

Mr. GREENWALD. We did not get that kind of answer in our survey.

Senator PROXMIRE. What did your survey show?

Mr. GREENWALD. Our survey showed 9 out of 10 companies will do absolutely nothing this year, that is in 1962, about this tax credit program. The 1 out of 10 companies that said they would do something, said they would do quite a bit, as a matter of fact. So this turned out to be roughly, in our investment figures, $300 million for the year as a whole. $300 million is less than 1 percentage point of the total investment that is going to be made.

Senator PROXMIRE. That is just what the Wall Street Journal found. The same thing. In other words, it would not have any significant effect.

Mr. GREENWALD. It would not have very much effect.

Now, another way of looking at this, of course, is to see what happened to the textile and apparel manufacturers in terms of the more rapid writeoffs that they were given last October and November. We found in our survey that these two industries have actually increased their investment plans considerably since we took our fall survey.

This suggests that a revision of Bulletin F would have a bigger impact on investment than the tax credit.

Senator PROXMIRE. That is closer to what the administration is doing, anyway. As I understand, they are now taking a long look at steel, and they are going to take a long look at a number of industries, and they are providing for a more rapid depreciation provision, and Congress may substitute that.

And that is quite different, as you know probably better than I do. The investment credit is a different kind of approach.

Mr. GREENWALD. Our planned figure of 11 percent was based on present plans of companies. That figure does not assume that either of these two programs will occur. The $300 million reported to us as additional investment if the tax credit plan were passed would have to be piled on top of the 11 percent, and this is why, when I forecast capital investment for 1962, I use an increase of around 12 percent. Our surveys are based on the plans of companies, and we only report the plans.

Senator PROXMIRE. You find the plans are quite accurate?

Mr. GREENWALD. In aggregate they are pretty good.

Mr. CREAMER. One comment with respect to the evidence of increased investment in apparel and textiles, owing to the revision of their depreciation schedule: I think it is also relevant that those are two industries, according to our measures, that have been operating at full capacity. So I think a combination of circumstances is required—operations close to capacity and investment incentives—and I would suspect in many of the industries the operation level is too low for the proposed incentive to have much impact.

Senator PROXMIRE. Would you be inclined to feel how close an industry is operating at capacity, that is, how substantial effective demand is in this particular field, is substantially more important than either the depreciation policy of the Government or any other change in the tax system, such as the investment credit?

Mr. CREAMER. Well, certainly it is very important. Whether it is more important, I just do not know. But it seems to me in estimating its impact, you certainly have to give considerable weight to the capacity utilization factor.

Senator PROXMIRE. I would certainly assume from your testimony that you would feel that way, in view of the fact that you have given very little consideration to Government policy.

Now, I understand why it is difficult. These Government policies are so unpredictable.

Incidentally, I think your paper is a very fine one. And very little emphasis was given to Government policy, but very heavy emphasis to how close they are to capacity.

Mr. CREAMER. In part, this is a sort of an occupational handicap. The Conference Board, by charter, does not get into policy considerations or forecasting.

Senator PROXMIRE. How possible is it to extend this estimate of primarily the manufacturing area into the rest of the economy, to give us a picture of the total prospects and potentialities?

Mr. GREENWALD. In terms of the survey type of work as we do it at McGraw-Hill?

Senator PROXMIRE. Yes.

Mr. GREENWALD. It is possible. Of course, again, it would be in terms of larger companies, if we were doing it, because it would be practically impossible for us to deal with 4.8 million businesses in the United States. So this could not be done. We would have to qualify all of our results in terms of the kind of sample we covered.

In our past survey we attempted to expand our coverage slightly in the mining area and in the utility area. We came up with some numbers on operating rates which we are not publishing as yet. However, I think we can do this on a regular basis in the future.

In other words, by covering a broader industrial area and getting answers to our questions, it seems to me that it is quite likely that McGraw-Hill could provide the same kind of results about operating rates, and increases in capacity for the industrial economy as it now does for manufacturing.

Senator PROXMIRE. What proportion of the capacity is embraced by your surveys, would you feel? Say, as to the gross natural product?

Mr. GREENWALD. We define it in terms of employment. This is the way we usually measure our coverage.

In terms of employment, including commercial business, we have about 30 percent or more. In manufacturing, 40 percent. In terms of heavy capital investment industries, 50 percent and over.

Senator PROXMIRE. You say you had 40 percent in manufacturing; but you can project this with your qualifications, as is very proper?

Mr. GREENWALD. For the manufacturing industry, yes, sir.

Senator PROXMIRE. You can probably project this for most of manufacturing and come close to it?

Mr. GREENWALD. Yes, sir.

Senator PROXMIRE. This would not be true in the commercial area, though?

Mr. GREENWALD. No, in the commercial area, we have a relatively small sample. It represents the large banks, insurance companies, de-

partment stores, chainstores, and so on. We would need many more companies in our sample to get the same percentage coverage in commercial business that we now have in manufacturing.

Senator PROXMIRE. There are certain fundamental assumptions for both you gentlemen in your estimates of capacity. One of them is that you assume capacity objectives in terms of maximizing profits. Another is stable prices. Another is that you have peace and not an emergency economic response to a world crisis, such as we have had in previous wars.

No question about it that the economy could expand at a far greater rate if it really had to, and if we had a war emergency situation. You are not even attempting to cope with that situation.

Mr. GREENWALD. No, sir.

Senator PROXMIRE. Does the experience of European countries in recent years make you feel that perhaps your estimates are conservative, in view of the fact that these countries have expanded and grown at great rates—West Germany, Japan, and of course all of the Western European countries, and have done so while increasing the standard of living of the people without runaway inflation? Does this make you feel this country could expand?

Mr. GREENWALD. As far as investment, I would say it is fairly obvious that if you relate investment to the GNP, we are only investing about 6½ percent in constant dollars. And this is a relatively low proportion. We should be investing somewhere in the neighborhood of 7 or 7½ percent, which would give us something like $42 billion of investment at the current level.

For 1962, we are talking about $38 billion of investment. So there is a gap of $4 billion in terms of overall capital investment.

Now, the demand is not there at the moment, so that you could ask, "This $4 billion—why bother?" If every industry still has plenty of available capacity to move output up quickly, you would have to argue pretty strongly that the Government would have to do something about easing the squeeze on profits in order to provide industry with incentive to spend more money for plant and equipment.

Senator PROXMIRE. Now, if you look at this as you have, indicating that you probably are going to get more modernization than expansion, what does this do to our very, very serious unemployment problem? As I understand it, a great deal of this modernization is in automation. We have seen this in steel and automobiles and coal mining and a tremendous number of industries.

Mr. GREENWALD. It is going to be very severe. No question about it.

Senator PROXMIRE. The unemployment situation might be more serious in the future than in the past?

Mr. GREENWALD. Yes.

Senator PROXMIRE. I talked to a group of, I think, quite enlightened labor leaders just yesterday, at some length, in Milwaukee. And, with very great reluctance, some of them were feeling they would have to look in the direction of a shorter workweek. And, of course, we are all very reluctant to think about that, because it is a scarcity approach, and it is most unsatisfactory to most people in Congress and others.

Mr. GREENWALD. We have to remember that the long-term trend is to the shorter workweek.

Senator PROXMIRE. Yes; but the long-term trend has been interrupted for about 25 years.

Mr. GREENWALD. That is true in manufacturing.

Senator PROXMIRE. We have had the 40-hour week now for a long time.

Mr. GREENWALD. But if you go back over the last three decades or so, if you take the whole economy—of course, a large proportion of the shorter workweek has come in the agricultural area, where a rapid productivity change has taken place. On the whole, I think hours of work have dropped down 2 to 2½ hours every decade.

Senator PROXMIRE. You can still make an awfully good argument as to farmers. In my State farmers average 11½ hours a day, 7 days a week, but it is hard to get much below a 40-hour week without getting into some pretty serious social problems, do you not feel?

Mr. GREENWALD. Well, in some cases the worker can take his gains in increased leisure time, or he can take it in increased pay. However, you can carry this to the point where leisure time is not that important any more to the worker. He needs an increase in pay. Then the emphasis would be less on a shortening of the workweek and more on an increase in wages.

Senator PROXMIRE. Mr. Knowles?

Mr. KNOWLES. I want to point out that a good part of this shortening of the worktime is not in terms of the workweek, but in terms of the work year; including the spreading through industries, which have already had the 40-hour week, of more holidays and vacations, with the length increased by an increment for seniority in some cases. This means that even industries which had a standard 40-hour week throughout the period of the last decade nevertheless had a shortening of hours per work year.

I am a little bit puzzled by one thing in these two pieces of testimony. McGraw-Hill's survey shows that although something on the order of two-thirds or better of the expenditures this year will be for modernization, nevertheless in manufacturing you will get close to a 4-percent expansion of capacity.

Mr. Creamer's results from using virtually the same kind of increase in investment—the same kind of numbers, in other words, but using his technique—comes up with no increase in capacity for the year.

It seems to me there is disagreement to a substantial extent, because the difference between zero and 4 percent in this type of number is an enormous difference.

And so I wonder, Dr. Creamer, if you can explain how this happened.

Mr. CREAMER. Well, in terms of our measurements, it comes about through the depreciation allowance and the correction for the price change. As the company's stock of capital is comprised more and more of recent acquisitions, this tends to elevate the deflator and therefore cuts down on the stock of fixed capital.

Now, if companies in fact are using their fully depreciated equipment for operation, then we are understating capacity, and we may be writing off too much.

Mr. KNOWLES. This is because you are using the net capital stock rather than the gross?

Mr. CREAMER. Yes. On the other hand, if the innovations are as rapid as some sources tell us, it may not be much of an understatement.

Mr. KNOWLES. Have you made any experiments trying to use the gross, rather than the net?

Mr. CREAMER. No, not in this context. In the historical approach I did, but not for the short run.

Mr. GREENWALD. Where did you get your estimates for 1961?

Mr. CREAMER. We extrapolate the Statistics of Income, the balance sheet data, the last one being for 1959, by the relative changes in the quarterly financial report.

Now, while in the past it has been a pretty good extrapolator, that is the relative movements in that series have been very close, for fixed capital, to the relative movements shown by statistics of income, but in any one year they might be off, although it is quite a good sample.

Mr. GREENWALD. As a matter of fact, the current information, then, is probably based on the big companies, too.

Mr. CREAMER. But they have a representative sample.

Mr. GREENWALD. Yes. I am just saying that you are probably using the same kind of companies that we are using.

Mr. CREAMER. But I suspect they make a greater effort to get representation in medium and smaller size companies. That is, it is a scientific sample which apparently is not one of the McGraw-Hill samples.

Senator PROXMIRE. May I ask, along the same general line, comparing the two approaches: Why in general is the National Industrial Conference Board capacity higher than the McGraw-Hill index? And why was the McGraw-Hill index lower in some specific industries, such as nonferrous metals?

Mr. CREAMER. Senator, are you looking at the relative movements from the base period?

Senator PROXMIRE. Yes, I am looking at the research report from the conference board comparing NICB with McGraw-Hill for 1953 through 1959 for all manufacturing, and in 1956, for example, it is 95 for NICB, 92 for McGraw-Hill, and so on. And then you have a reversion situation for nonferrous metals.

Mr. CREAMER. To try to answer your last question first, we have had a lot of trouble in applying this measurement to the nonferrous group.

Senator PROXMIRE. This is on page 73. Perhaps you are familiar with that chart?

Mr. CREAMER. Yes. And they have never been too happy with it. And using it for this current period, I would come out with a measure of virtually full capacity operations, which is obviously wrong.

So you select an industry for which this method does not work, given the data we now have.

Senator PROXMIRE. In general, can we expect the differences in overall capacity utilization to continue in the future as they have in the past? Is there anything built in, any difference in policy, that results in this?

Mr. CREAMER. Probably yes. But on the other hand, I think this is a point which others have made, that for the general changes, the general sweep, of what is happening, you get much the same results, at least for total manufacturing, regardless of the three measures

you use, the McGraw-Hill, the Conference Board, and the Federal Reserve.

All three would have shown this increase in excess capacity in 1956, its aggravation in 1957, its gradual decline since the 1957 peak, but with still an important part of the industry with considerable excess capacty. And that to us is a fairly reassuring aspect of this work.

Mr. GREENWALD. It is not true, though, for Fortune and the Wharton School.

Mr. CREAMER. No. Particularly the Wharton School does have some serious deficiencies.

Mr. GREENWALD. They are much higher.

Mr. CREAMER. That is for short run.

Senator PROXMIRE. There is a difference between you two gentlemen, or between your organizations. Which would be considered the most meaningful for purposes of policy? Which approach?

Mr. GREENWALD. That is a good question.

Mr. CREAMER. I would deliberately hedge it by saying you ought to look at both, and see if you get a consensus of movement.

Senator PROXMIRE. I am saying if you do not get a consensus.

Mr. CREAMER. Well, I would favor the McGraw-Hill, I think.

Mr. GREENWALD. I think you would have to use the McGraw-Hill method.

Mr. CREAMER. Because ours is rather removed from the company level itself. It does entail a considerable amount of processing. But it is a way of getting some results which in the past have appeared reasonable without survey work, and in that sense it is a relatively cheap way of getting some indicators.

Mr. KNOWLES. I think I would make, as a technician, one observation on this, and that is that it would be particularly true that McGraw-Hill might well be more sensitive in the short run, in any given year, the very latest years. It is closer to the business planning process; and so it is more likely to be an accurate reflection of relative movements over the last year or so, further away from benchmark data, whereas on the other hand, I would expect the two movements, the two ways of measuring, to be very closely together for any period for which the National Industrial Conference Board, Mr. Creamer, managed to get the up-to-date report from the basic source, which in this case is the Statistics of Income of the Treasury. Since this source is about 2 years behind, this means Mr. Creamer inevitably is taking some technical risks in extending his series up to the current year, and there is no counterpart of this in the McGraw-Hill method.

So if you were looking at broad, sweeping changes over a long period of time, the patterns eventually will come out to look very much the same; but in the last year or so, right up to date, you might find McGraw-Hill is faster in giving you some kind of a shift in the relationship, because it gets its result by asking the business managers themselves what the current situation is.

Senator PROXMIRE. You get a very interesting divergence. I stressed the differences. Obviously there is a very great similarity. In 1957 you had precisely the same, both 92. But you get that interesting and very sharp difference that same year when you coincided on all manufacturing. And NICB said 87 percent of capacity, for

example, for rubber, and McGraw-Hill said 96 for rubber. That is a very great difference. And you get almost as great in petroleum and coal products and a few other categories. But you come up with the same overall position.

Mr. GREENWALD. Part of it is the timing. That is, our figures are for the end of the year.

Mr. CREAMER. I shifted your figures. These are the quarterly peak in these particular years, and I shifted your output, your implied output measure, to arrive at a peak output, so in that sense they are comparable.

I might point to an effort to try and test which difference might be closer to what happened by comparing both measures, with the changes in capital expenditures for these industries reported by the Department of Commerce and the SEC. And in a slight majority of cases, the Conference Board measures were in closer conformity to changes in capital expenditures than the McGraw-Hill measure. That is, what you might regard as the accumulated additions to capacity since 1953, for example, and between 1957 and 1959.

But it is not completely independent, because in order to use this as a measuring rod, you have to put it on a net basis—these accumulated capital expenditures. And to do that I used my own depreciation estimates. So my depreciation estimates appear twice, in the so-called independent test, and in my own measures.

But it does indicate, as I say, in the majority of industries that our estimates were closer to what you would expect, looking at the additions to plant as registered by these capital expenditures data.

Mr. GREENWALD. Except that you have some problems as to which part of this investment was going to modernization and which to expansion in terms of increased efficiency, if you can measure this efficiency factor.

Senator PROXMIRE. Gentlemen, this has been extremely helpful and informative testimony. I am very grateful to you both for coming up.

As you can see, the time is 12 o'clock. We will have a vote on cloture in a very few minutes, and I have to go to the floor.

On Tuesday, May 22, a week from tomorrow, we have coming before us Mr. Frank deLeeuw, who represents the Federal Reserve System; also Professor Lawrence Klein of the Wharton School of Finance and Commerce who is going to talk about the Wharton School Econometrics Unit proposal.

I want to once again thank you very, very much.

Mr. CREAMER. Senator, may I submit a somewhat fuller and more technical statement?

Senator PROXMIRE. By all means. How long a statement is that?

Mr. CREAMER. It runs to 10 pages.

Senator PROXMIRE. That will be included in the record at this point.

(Statement referred to follows:)

STATEMENT BY DANIEL CREAMER ON THE USE OF CAPITAL-OUTPUT RATIOS TO MEASURE MANUFACTURING CAPACITY

At least one economist gives as a reason for his interest in capacity measurements the possibility of using capacity as a basis for an estimate of the stock of capital—the problems of measuring the latter are regarded as insuperable. Others (and I count myself among them) despair of measuring capacity directly and estimate capital stocks as a basis for a measure of capacity.

There are at least two procedures for estimating capital stocks at two or more points in time. One procedure starts with (1) an estimate of net capital stocks in constant prices in the initial year, (2) adds gross capital expenditures in constant prices for each year of the period, and (3) subtracts depreciation in constant prices for each year. This is generally referred to as the "perpetual inventory" method. The estimate of net capital stocks in the initial year (step 1) may be based on balance sheet data for that year or on the accumulated net capital expenditures (steps 2 and 3) for years preceding the base year, the number of years for the accumulation must, for this purpose, equal the average length of life of capital in the industry of interest.

The other procedure estimates net capital stocks in constant prices from balance sheet data for each year of interest.

The technical difficulties that confront the estimator following either procedure are formidable but, in my judgment, not insuperable. The difficulties stem from the durable character of fixed capital. Since machines, buildings, and other devices last more than one accounting period, at any point of time there is a distribution of capital of different ages that are difficult to combine. The first set of estimating problems arise in finding a common denominator for combining various pieces of capital in existence at a given point in time. The second set of problems relate to the evaluation of gross capital for each accounting period—that is, adjusting for price changes. The third set emerge from the estimation of depreciation in order to reduce gross capital to net capital.

No estimator, I am sure, would claim that he has developed a wholly satisfying solution to the three sets of problems. Some, however, argue that a less-than-complete solution is usable. For example, there is Prof. William Fellner's argument on this point which I find both convincing and congenial. Professor Fellner has argued, "Such numerical appraisals of the 'size of the stock' possess inevitable weaknesses. * * * The physical character of the capital goods cannot help changing in the course of the investment process. * * * With the changing character of the goods produced in successive periods, valuation in constant prices becomes a logically objectionable procedure. Yet when we state that the capital stock is rising at a rate different from that at which the supply of cooperating factors increases, then, of course, we mean physical capital. We must try to eliminate price changes from our series.

"The objection cannot be answered to the satisfaction of the logical purist. * * * In all such cases we must require that the general results of the statistical computations should accord with intelligent judgment or common observation. If they do accord with general judgment, we may perhaps rely more confidently on technical procedures for discovering details in a movement which would not be disclosed by common observation. This is how we are forced to proceed in such matters." [1]

Armed with this sort of rationalization I use estimates of capital-output ratios to derive estimates of capacity and capacity utilization.

First, however, a few background considerations may be helpful. The definition of capacity which, I find, provides the most analytical insights into business cycle problems, is the one proposed by Almarin Phillips. Professor Phillips suggests that "Given a particular conglomerate of capital (in the physical sense) in a sector of certain range of output rates for the product would be carried on with the existing facilities, there being no tendency to add capital due to output variations alone. At some rate of output, however, there will be a tendency to buy more capital goods. New investment is induced. It is this rate of output which is to be called the 'capacity' of a sector. * * *

"Capacity, for this purpose, is an economic limit to the rate of output with the existing facilities of a sector. It is the rate after which capital additions would tend to be made. Under certain conditions of cost, the economic limit may also coincide with a technical limit—technical in the sense that no more could be produced by the establishments in the sector with existing facilities regardless of the costs involved." [2]

Professor Phillips provides not only a working definition of capacity but also the essence of the distinction between the two approaches to measurement—the technological or engineering and economic. The technological approach, in its pure form, attempts to measure productive capabilities of plants and machinery

[1] Op. cit., "Trends and Cycles in Economic Activity" (Henry Holt & Co., New York, 1956), p. 197.

[2] Almarin Phillips, "The Concept and Measurement of Capacity" (mimeographed, no date), p. 2.

without regard to the costs of complementary materials and the demand for the product. The economic approach, as the name suggests, in concept at least, attempts to allow for costs, demand, and alternative uses of resources. Since most investment decisions occur in response to a profit-maximizing motivation which expresses its preferences and resource allocations through a pricing system, there can be little doubt that the economic measure of capacity would be more appropriate. However, the operational superiority of one approach over the other depends on the character of the underlying assumptions and the feasibility of giving statistical content to the concepts.

Irrelevant to the concept of economic capacity is the maximum that each separate industry could turn out if it had no regard for the need of temporary shutdowns for repairs, cleaning and installation of new machinery, or if it could run overtime, double shift, or continuously by drawing labor from other places of employment. Rather economic capacity must be determined in the context of practical operating considerations such as the normal number of shifts and "downtime" for maintenance and repairs.

There is another condition imposed on the measurement of economic capacity. In aggregating capacity estimates for individual industries, one should be sure that they are mutually compatible. That is, if all industries attempted to operate simultaneously at these capacity rates, there should be no bottlenecks of labor and material shortages to frustrate the attempt.

These two conditions provide some criteria for judging capacity measurements. They can be judged also by how well a practical difficulty in estimation is solved, namely, the determination of precisely which plants and equipment are to be included. Is it all that is in existence or all that is in operation? That is, how to handle obsolete, high-cost equipment that is retained as standby facilities?

THE CONFERENCE BOARD ESTIMATES OF CAPACITY

The approach to the problem of measurement is through changes in the relation of fixed capital to output, both expressed in constant prices. In this special sense it is based on the technological relationship of a stock of capital and the output derived from it. The derivation, however, is not in terms of physical units and engineering relationships, but in terms of financial units reflecting economic choices and values. The basic data are the estimates by accountants of business operations and transactions as they are recorded in corporate balance sheets and profit-and-loss statements. While we cannot argue that the accountant's precepts and practices for this purpose are perfect, this must also be true of the industrial engineer. The assumptions of one profession in summarizing business operations are probably no more arbitrary than that of the other.

More specifically, how can the relation of capital to output provide the information we seek? In this context, capital means fixed capital; i.e., structures and equipment. The volume of structures and equipment is measured by the value (net of depreciation) placed on these assets by manufacturing enterprises in their balance sheets, corrected for price changes. Output is taken at the cyclical peak and is measured by gross operating receipts corrected for changes in inventories and for price changes.

In general, the procedure is to establish a fixed capital-output ratio for each industry classification for a benchmark year which independent evidence indicates was a period when capacity was virtually fully utilized. A significant rise in a subsequent year in the fixed capital-output ratio of an industry above the benchmark ratio would be evidence of excess capacity—unless the technological changes in the interval were strikingly capital intensive (i.e., require more capital per unit of output, both in constant prices) which could be established from other evidence. On the other hand, a significant decline in the fixed capital-output ratio suggests that structures and equipment are being operated at greater efficiency. The additional capacity from this source is incorporated in the measurement.

This procedure has the merit of incorporating actual operating practices into the capacity measurements. For example, the length of the typical workweek, standby reserves of equipment for seasonal and cyclical peaks, downtime for repairs and maintenance, etc., are all reflected in the measures.

The procedure also meets the test of mutual compatibility, at least in the peak quarter of the benchmark year. At that point most manufacturing indus-

tries were operating simultaneously at virtually full capacity. However, the fact that peak levels were not sustained for long may mean that the compatibility was more apparent than real. Indeed, those business cycle analysts who attribute the culmination of business activities to the emergence of structural (vertical) maladjustments would be obliged to argue this way. For our purposes, it is not necessary to judge the validity of this explanation; it is sufficient that capacity operations were achieved for at least one quarter. For periods other than benchmarks, however, our procedure does not insure that the derived capacity measurements are mutually compatible.

Exhibit I illustrates the arithmetic derivation of peak capacity and percent of capacity utilization for 1957.

EXHIBIT I.—*Derivation of percentage of capacity utilized at the 1957 peak, by all manufacturing and by major branches*

	Fixed capital 1957 in 1929 prices (1)	Lowest fixed capital-output ratio in benchmark or any year (2)	Estimated capacity output (1)÷(2) (3)	Actual peak output, 1957, at annual rate (4)	Percentage of capacity utilized at the peak (4)÷(3) (5)
All manufacturing	*Millions* $51,061		*Millions* $206,295	*Millions* $183,860	89
Motor vehicles	3,221	0.187	17,225	11,552	67
Nonferrous products	2,200	[1].475	4,632	3,715	80
Tobacco products	146	.038	3,842	2,815	73
Stone, clay, and glass products	1,892	.337	5,614	4,303	77
Rubber products	558	.139	4,014	3,331	83
Electrical machinery	1,542	.135	11,422	9,688	85
Iron and steel products	4,976	.479	10,388	8,936	86
Paper and allied products	2,610	.443	5,892	4,909	83
Scientific instruments	584	.198	2,949	2,616	89
Beverages	940	.123	7,642	6,803	89
Machinery, excluding electrical	3,279	.224	14,638	13,365	91
Lumber and wood products	1,639	.582	2,816	2,297	82
Fabricated metal products	1,969	.187	10,529	8,940	85
Petroleum and coal products	10,074	.444	22,689	20,614	91
Transportation equipment, excluding motor vehicles	1,610	.239	6,736	6,622	98
Chemicals and allied products	5,524	[2].364	15,176	14,695	97
Furniture and fixtures	324	.111	2,919	2,768	95
Apparel	305	.037	8,243	8,151	99
Printing and publishing	1,279	.267	4,790	4,655	97
Food products	3,191	.114	27,991	26,976	96
Textile-mill products	1,779	.199	8,940	8,944	100
Leather and leather products	147	.062	2,371	2,360	100
Other manufactures, including ordnance	1,272	[2].263	4,837	4,805	99

[1] This is based on 1957 fixed capital and 1956 output. For several years prior to 1957, the aluminum branch had been substituting the generation of its own power for purchased power. This change in capital structure is assumed to have been accomplished by 1957. Since 1956 output was higher than 1957 output, the former is used as better representing the relation of fixed capital to output at peak levels of output. For some evidence of the structural change in aluminum, see the "Annual Report of the Aluminum Co. of America," 1957, pp. 14–15, and the "Annual Report of the Reynolds Metals Co.," 1954, pp. 15–16.

[2] In these industries, 1953 is taken as the benchmark year, since for the first time Government-owned, but privately operated facilities are included in the stock of fixed capital.

NOTE.—Industries arrayed in order of the percentage increase in fixed capital-output ratio from 1953 to 1957 beginning with the largest.

Source: Col. 1 from table G–1; col. 2 from table 3; col. 4 from table G–3 of "Capital Expansion and Capacity in Postwar Manufacturing," S.B.E. No. 72, the Conference Board, 1961.

LOWEST FIXED CAPITAL-OUTPUT RATIO IN BENCHMARK OR ANY SUBSEQUENT YEAR

It should be noted that any improvement in the efficiency of capital is brought into the computation through the entries in column 2, the lowest fixed capital-output ratio in the benchmark or any subsequent year.

Obviously, the computation is dependent on the accuracy of the underlying estimates of fixed capital and output both in constant prices. A brief description of these estimates follows:

Fixed capital in constant prices: The starting points are the book values of land, structures, and equipment as carried on the corporate balance sheets submitted to the Internal Revenue Service. The latter tabulates these data by

industry classifications and publishes the tabulation in Statistics of Income: Part 2. The building blocks then are capital stocks and not capital expenditures. However, it can be shown that capital expenditures by manufacturing enterprises cumulated between benchmark years closely approximate the book values of fixed capital stock from balance-sheet data at the end of the interval.[3] Thus, both approaches are about equally accurate in terms of gross book values, but the capital stock approach makes it possible to distinguish manufacturing subbranches.

Since there is a lag of 1 to 2 years in the Statistics of Income tabulations, current stock figures are derived by extrapolating the latest Statistics of Income data—the 1958 tabulations are the latest at this time—by the relative changes in the capital stock figures in the Quarterly Financial Reports released jointly by the FTC–SEC.

Net capital stock is derived by subtracting book depreciation from the book values of gross capital stock. The excess depreciation under the 5-year amortization of emergency facilities is estimated and added to the net capital stock. No adjustment, however, is made for the more rapid depreciation on assets purchased after 1953 by the application of declining balance or the sum-of-the-years'-digits-depreciation formulas.

Despite the well-known deficiencies of book depreciation, as a measure of capital consumption, it is used as the best available approximation. The only operational alternative is the derivation of net capital stocks by applying a curve of survival rates to annual acquisitions of structures and equipment. Those who use the survival rates usually admit that retirements are retarded in periods of business recessions and accelerated in periods of business expansion and adjust their findings accordingly, usually in a qualitative fashion.[4] This variation in retirements is reflected in the capital accounts of the firm and there seems no point in the estimator substituting his judgment on the timing of certain types of capital consumption (e.g., obsolescence) for that of management.

Net capital stocks so derived relate, for all practical purposes, to all corporations and are raised to the level of all firms by the ratio of value added for all firms to that of corporations reported in the Census of Manufactures, 1954.

The next step is to translate net capital stock in book values into constant values. The general procedure for deflating the book values of fixed capital is to derive a composite index of prices underlying book values of buildings and of machinery and equipment for each industry group. A construction cost index weighted by volume of construction depreciated over 50 years is used to represent changes in the book value of land and buildings. This component of the composite index is identical for all groups.

For machinery and equipment a price index of general machinery and equipment is used for all groups. In each group, however, the index is weighted by volume of machinery and equipment produced, depreciated according to length of life typical for a given industry as reported by the Internal Revenue Service. Because of these changing industry weights we obtain a different deflator for machinery and equipment in each industry group.

These two components are combined into a composite index, one for each group. The weights used measure the relative importance of plant and of machinery and equipment in the structure of fixed capital in each industry group as disclosed by the estimates of the Office of Business Economics, U.S. Department of Commerce.

Output in constant prices: It is essential that the numerator and denominator of the ratio be compiled according to identical industry classifications and rules of industry allocations. For this reason output is based on the gross operating receipts reported by corporations to the Internal Revenue Service. Gross receipts adjusted for changes in inventories equals output in current prices. This adjusted total for all corporations is also raised to the level of all firms. Output in current prices is expressed in constant prices by dividing the former by appropriate indexes of wholesale prices. This procedure has avoided the downward bias inherent in the FRB index of manufacturing production.[5] However, the revised FRB index is used as an extrapolator of our output series in

[3] See, for example, Creamer, Dobrovelsky, and Borenstein, "Capital in Manufacturing and Mining, Its Formation and Financing" (NBER, 1960), app. A, pp. 205–207.

[4] See, for example, "Capital Goods Review" (MAPI), No. 14, May 1953, p. 2. MAPI were the originators of the curve of survival rates.

[5] The most recent revision of the FRB index indicates that the bias in the unrevised index amounted to 3.7 percent by 1957 and to 8 percent by the second quarter 1959.

order to obtain current figures. Since the level is determined by our deflated series, the bias of the FRB index can have little effect on our current-year estimate of output.

FRB indexes are also used to convert annual output into peak output. This is accomplished by multiplying the deflated output by the ratio of the production index of the calendar quarter with the highest output to the average index for the year. This makes possible a comparison of real net capital stock with peak output. In certain years, 1957, for example, annual output would reflect 6 months of business activity at less than peak activity.

Appraisal: These capacity estimates, based as they are on deflated net capital stocks by industry branch, attempt the impossible according to some other estimators. Thus Lawrence Klein regards as insuperable the difficulties in the way of deriving a meaningful estimate of capital consumption or a capital stock deflator that gives appropriate weight to the various prices of pieces of capital surviving at a given point in time. D. C. Streever, moreover, has argued that capacity estimates by subbranches of manufacturing cannot be developed from accounting-based data.

Our answer on both counts is the one that Professor Fellner has given. That is, rough approximations can be derived. The results of these derivations can be tested for their "reasonableness" and if they pass this test, they contribute useful data for analysis. The reasonableness of these estimates has been discussed elsewhere.[6]

In addition to the general methodical problems of this approach, mention should be made of a limitation that is peculiar to the use of changes in the fixed capital-output ratio to measure changes in capacity and rate of capacity utilization. Our procedure is such that in an industry characterized by a declining fixed capital-output ratio the actual peak output is implied to be identical with capacity output. That is, such industries are regarded as being operated at full capacity at cyclical peaks. This was probably true during the decades of the fifties,[7] but unlikely to have been true, say, in 1937.

By way of conclusion, let me summarize the merits of this approach as they appear to me. (1) The results pass the test of reasonableness, at least for the decade of the fifties. (2) Across-the-board estimates for 28 manufacturing branches can be prepared and these can be prepared quarterly with a lag of about one-quarter. (3) They provide a framework for incorporating data on planned capital expenditures and expected output making possible an estimate of the expected degree of balance or imbalance between capacity and output three quarters hence. Thus in April 1957 the Conference Board estimates would have shown that considerable excess capacity in many branches existed at the end of 1956 and that the expected capital expenditures for 1957 would only further aggravate a serious existing imbalance. For the analyst concerned with the short-run outlook, projections of this sort should be helpful when the expansion phase is approaching its average postwar duration.

Mr. CREAMER. Thank you.

Senator PROXMIRE. And the committee will stand in recess until Tuesday, May 22.

(Whereupon, at 12:02 p.m., the subcommittee was recessed, to reconvene on Tuesday, May 22, 1962.)

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[6] See, for example, D. Creamer, "Capital Expansion and Capacity in Postwar Manufacturing," SBE No. 72 (NICB, 1961), app. F.

[7] As supporting evidence, the lowest capital-output ratios occurred in 1955 when they did not occur in 1948 or 1953, except for such declining industries as textile mill products and leather goods; 1948, 1953, and 1955 are all years of virtually full utilization of capacity. See table 3 and discussion on pp. 31–32 in SBE No. 72, op. cit.

MEASURES OF PRODUCTIVE CAPACITY

TUESDAY, MAY 22, 1962

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

The subcommittee of the Joint Economic Committee met, pursuant to call, at 11 a.m., in room 6226, New Senate Office Building, Senator William Proxmire (chairman of the subcommittee) presiding.

Present: Senators Proxmire and Douglas.

James W. Knowles, staff economist; John R. Stark, clerk; Hamilton D. Gewehr, and John Chadwick, staff members.

Senator PROXMIRE. The committee will come to order.

We are honored to have this morning Mr. Lawrence R. Klein of the Wharton School of Finance and Commerce.

Mr. Klein, would you come to the witness table?

Proceed in your own way, Mr. Klein.

STATEMENT OF LAWRENCE R. KLEIN, PROFESSOR OF ECONOMICS, WHARTON SCHOOL OF FINANCE AND COMMERCE, UNIVERSITY OF PENNSYLVANIA

Mr. KLEIN. As I understand it, the purpose of these meetings is to improve our measurements of industrial capacity, and we look upon that as the kind of research we have been doing at the Wharton School, that is, a study relevant in showing the efficiency of rate of operations in our economy and the kind of growth potential that we have before us. We have been interested in measuring capacity for various side reasons. We think it is rather important in explaining capital formation, and we use it in our forecasting schemes that have been built to show the econometric structure of the economic system.

We have found the kind of measure that we have built to be a very useful variable in our statistical models of American economy.

The idea of the concept of capacity has been used a great deal by economists in recent years, but there is not terribly much agreement yet on exactly what we mean by capacity, on what kind of concept we can use. I think this has a lot to do with the different kinds of answers that we are getting. I think one might conclude at the present time that the American economy is operating at any point between possibly 80 and 95 percent of its capacity. Our index, in particular, is usually on the high side. Our latest figure is 94 percent as of the first quarter of 1962. The latest figure that I have seen of McGraw-Hill Publishing Co. was 83. There is a big spread between these two numbers.

Senator PROXMIRE. What are the two numbers, again? Yours is——

Mr. KLEIN. Ninety-four.

Senator PROXMIRE. And theirs is 82?

Mr. KLEIN. Eighty-three. Theirs was yearend 1961 and our last figure is first-quarter average for 1962.

Senator PROXMIRE. First-quarter average?

Mr. KLEIN. Yes; that would be the average of January, February, and March of 1962.

Senator PROXMIRE. I see.

Mr. KLEIN. Now, we must decide the meaning of these different concepts. The McGraw-Hill index, which you have probably heard about already in these hearings, is measured on the basis of questionnaire reports of businessmen as to what their capacity is and what percent of capacity their current operation represents. In this particular type of measure, where each individual respondent does not pay particular attention to the workings of the rest of the economy, I feel that we may get measures of our productive capacity that are too high in the overall result. If one firm or one industry tries to reach a high output that it considers to be capacity output, it will bid away materials and scarce factors of production from other firms. Capacity, as we understand it, is to be an economic concept and not an absolute physical or engineering concept.

Therefore, if costs rise considerably as a result of operations in the neighborhood of what firms now think is capacity, their conception of what capacity ought to be, that is, what they think a good rate of operations ought to be, might change very much. I want to use a concept of capacity that takes the economic situation into account.

Now, if I had a kind of an ideal measurement, I would measure cost, what the economists call cost functions, for each industry in the economy. I would, in particular, recommend this for what we call the two-digit manufacturing industries, plus a few others, which would give us approximately 30 industrial groupings.

If we had estimates of cost functions for each of these 30 industrial groupings, we would then try to find what the economists would call an ideal rate of operations, as a minimum point on each of these cost functions. We have done a little bit of research on this particular method and we plan to do more. It is not a practical scheme for the moment, although it is a kind of scheme at which we might aim.

Our present practice is to use 30 groupings that now make up the Federal Reserve Index of Industrial Production, and select peaks from the quarterly, seasonally adjusted plottings of these industrial group indexes, over the whole postwar period.

We establish trend lines through the peaks and call this trend capacity output. This is just a name for it, but we think it has deeper meaning and intend to analyze it further.

Senator PROXMIRE. Let me just ask—are these business cycle peaks in terms of production?

Mr. KLEIN. Yes; they are in terms of production as measured by the Federal Reserve index.

Senator PROXMIRE. The particular business cycle peak is 100 percent capacity?

Mr. KLEIN. Yes; but this is not to be confused with the peak that say, the National Bureau of Economic Research would call the refer-

ence peak as being the fixed date for all activities within the economy——

Senator PROXMIRE. Because yours is specific within each of the 30 industrial groups?

Mr. KLEIN. That is right. We say that any particular industry could reach 100 percent at the peak, but in fact, industries do not really peak at the same time, so that the average of our measures at any point where there is general consensus of a business cycle peak has never been more than about 96 percent.

Senator PROXMIRE. Just so I understand, however, you might conceivably have a situation in which a plant was operating say at 75 percent of its physical maximum utilization, with machinery idle, with space idle, etc., with a number of plants in this particular industry in this position; with labor available and yet it could conceivably be defined on your basis, on the basis of the Federal Reserve Board's analysis, as a peak period at 100 percent capacity for your purposes; is that correct?

Mr. KLEIN. In principle, yes. It never works this way in practice. We chose this particular method of capacity trend lines through peaks because we looked at certain industries that produce well-established capacity series on engineering bases. One of the principal series has been the steel index, recently discontinued. The independently estimated capacity points for that series for a long period of time tended to pass through the peaks of the output series. We looked at the electrical kilowatt index and those of other industries in the same way and decided on this basis. The trend line passes through peaks tended to be close to capacity. It is very unlikely that we will get a business cycle peak when you have the kinds of figures that you mentioned, 75 percent——

Senator PROXMIRE. Why couldn't we have had such a situation if the economy should be operating as it did back in the thirties?

Suppose you did this beginning in 1930 through 1940, then we might have gotten a conception of 100 percent capacity operation, a conceptual theory, at least, and then you come along with the tremendous effort that we made in World War II. In the latter period we would have been operating at far above 100 percent capacity, maybe 180 or 200 percent capacity.

Mr. KLEIN. Those figures exaggerate the actual situation. Of course, if we had done this in the 1930's, this would have made 1937 a peak and possibly again the last prewar peak would have been 1941 for certain industries, and that would have made the index look low. Now, in fact, we have done this only in the postwar period because we knew we were jumping off at a point that was rather good. The economy reached its real peak of output, I think, during the war period, 1944. We never realized such a high utilization of civilian capacity as we did then. We then had the figures for 1946–47 compared with the 1944 war period with which to establish our postwar trends through the peaks. So that I think we are on fairly sound ground in the postwar period having that jumping-off point from full capacity.

I would certainly feel ill at ease using this particular technique back through all of the 1930's.

The one particular idea that has come about in discussion of our measure has been that we ought to try to measure the intensity of peaks as well as the actual dating of the peaks and I have thought recently that we might measure this by statistics that are called diffusion indexes showing percentages of different series coming to peaks in reference cycles established by the National Bureau of Economic Research. This may tend to show the intensity of any particular peak, and we could raise the value of our trendlines above our business cycle peaks by an amount that is indicated by the diffusion index. Where the diffusion index is weak, we raise our trendlines more for peaks than where it is strong.

In this way I think we could introduce some particular correction for our index in very recent years.

Now, I have looked very carefully at some of the other indexes that pass trendlines considerably above the peaks of the industrial output components to compare them with ours, which goes very near the peaks, for the period since 1957. I think for the period from 1952 to 1956 or 1957, most of the different series compare rather well and it is only in the present period that a divergence occurs.

Senator PROXMIRE. What does the present period cover? From what year? Where does the divergence begin to appear?

Mr. KLEIN. About 1958 or 1959——

Senator PROXMIRE. 1958 to the present time?

Mr. KLEIN. You see, many people would argue that the business cycle peaks reached, after the recovery from the recession of 1957–58 were peaks reached with underutilization of capacity of the sort that you mentioned, but of considerably different magnitude—nothing like the figure of 75 percent that you have mentioned.

Now, it seems to me unreasonable to conclude, as some of these other series do, that 1957, for example, had a peak in the beginning of the year in which capacity was utilized at a lower rate than at the preceding peak, because 1957 was the end of an era of a great capital goods boom in this country. Most of the measures of idle capacity have been concerned with the measurement of capital formation and investment. According to theory and statistical practice, we have found it to be very unlikely that we would have such high rates of capital formation in an era or a series of years in which there has been excess capacity. So I would tend to argue that the period leading up to the beginning of 1957 must have been a period of high utilization of capacity, giving rise to the investment boom which ended in that period, and this is what our index does indicate.

Now, our index has been used, as I said earlier, with our statistical or econometric model of the American economy and we have found extremely high correlations or strong relationships between capital formation and the rate of capacity utilization as we have measured it. It has been an extremely strong statistical variable in our investment patterns.

We have one other kind of check on our series. I am very glad that Senator Douglas has entered the discussion, because in a sense, this tries to build on the kind of work that he once established, measuring what economists would call production functions. In our statistical model of the American economy, we have tried to establish relationships between private GNP, that is, private production, employment,

and capital with time trends for technical progress. In our particular measurements, we did not use the stock of capital in existence, but tried to get a measure of the amount of capital utilized by multiplying capital by our index of capacity utilization.

Having a relationship between normal output and utilization of capital, we established an input-output or production relationship for the economy as a whole. When we carry that forward—its last year of measurement being 1958—to the present period and feed into the relationship the total labor force, except for frictional unemployment—that would be 97 percent of the labor force—and total stock of capital, assuming full utilization, we get also a figure of capacity output in relationship to actual output that compares very closely to our index for the first quarter of 1962. We come up with an estimate of a degree of capacity utilization of 94 percent, which is the same thing that our index shows.

I would argue that these independent kinds of estimate from production relationships, from capital formation relationships, and from study of trendlines through peaks in different industries where well-established capacity series exist, have given us some degree of faith and belief in our particular measures as being not a bad measure of capacity utilization at the present time.

I would say of the different suggestions that have been coming up in the past few months that I would like to follow up on this idea of measuring the strength of the business cycle peaks. That would increase our index a bit.

Now, in the McGraw-Hill index in which businessmen are queried as to their rate of capacity utilization, there is an added question on preferred rate of capacity utilization, which is interpreted to be a rate which gives the best rate of return for business.

Now, I think this is a realistic figure, and I think some McGraw-Hill economists feel the same way, that this is a measure that is attainable.

It has been attained in the past, and their actual measure of full capacity utilization is not an attainable measure for all industries together, because this would raise costs and cause considerable inflation throughout the economy.

Now, if we would regard their preferred rate as an attainable rate of full capacity, then their current operating rate of 83 percent, compared with the attainable rate of 90 percent which they estimate now, is very close to our figure of 94 percent.

Senator DOUGLAS. Dr. Klein, might I interrupt?

Mr. KLEIN. Yes.

Senator DOUGLAS. Do I understand your method to be one in which you say that at the peak of the business cycle, there is no unused capacity?

Mr. KLEIN. Specific cycles, yes. Not the business cycle generally.

You see, in the business cycle generally, our index has never risen to a point higher than 96 percent. But in any particular industry, and this includes 30 component industries of the Federal Reserve index, we define capacity as a point of peak output in terms of the specific cycle for that industry.

Senator DOUGLAS. Well, you mean you take the most favorable quarter for a given industry?

Mr. KLEIN. No; we make a time trend of such quarters.

Senator DOUGLAS. Yes; and take the most favorable quarter for that industry?

Mr. KLEIN. Yes.

Senator DOUGLAS. And then get a composite average for the 30?

Mr. KLEIN. For all 30.

Senator DOUGLAS. And that would not be the same time quarter?

Mr. KLEIN. We average all 30 in the same time quarter, but they do not all come to 100 percent utilization in the same time quarter. That means if we average the actual rates of operation in the given quarter of certain industries, that average has only once exceeded 96 percent in the postwar period. It reached 97 percent in early 1947.

Senator PROXMIRE. Well, even in 1944, you probably would not have 100 percent in this sense? Is it not true that you would always have some industries that would be operating at less than their previous peak?

Mr. KLEIN. Yes. Well, this was much less true in 1944. There was much less general——

Senator PROXMIRE. Why do you call this "capacity"? I have a dictionary in front of me and it says "capacity: power of receiving, containing, or absorbing extent of space," and so forth, and then says, "maximum output."

I think that is probably the closest in the dictionary to it.

It seems to me something like "expectable utilization standard" would be closer to what you gentlemen are working toward at Wharton, because I think you would agree immediately with me that in these cases the peak does not definitely indicate the level at which they could operate if there were a greater demand or would operate for a greater demand. It is not equated as McGraw-Hill has it, as I understand it, with maximizing profits.

Mr. KLEIN. Well, if you say maximizing profits is their preferred rate, which they call the rate associated with the best rate of return—if you call that full capacity, which is a figure of 90 for the end of year 1961, and find their actual rate of operations as a percentage of physical or maximum physical output, which is 83 percent, the ratio between 83 and 90 is practically the same thing as our index for the fourth quarter of 1961 and first quarter of 1962.

They are very close.

Senator DOUGLAS. There is a certain degree of corroboration of your methods from the figures from 1957, which I take it you used pretty largely, in this table 1 which you have submitted in your prepared statement. The average for the four quarters would be approximately 93½.

Now, if we take the percentage of unemployment, it is true that is for the labor force as a whole——

Mr. KLEIN. Yes.

Senator DOUGLAS. The percentage for the labor force as a whole is 4.3 percent. This would probably have to be raised by seven-tenths of a percent. But if it were to be confined to the group which seeks salaried work—wage and salaried work, excluding the self-employed—that would be raised to five. Then if you take into account involuntary part-time unemployment, those working less than the standard number of hours worked per week, that would bring it up to a little more

than an additional 1 percent. We got a figure of unutilized labor for the year of a little over 6 percent. This corresponds roughly with your figure of lack of utilization of the productive capacity. So I think on this point, you have a good deal of support. I have often wondered when the estimates come out, industry only using 30 percent of capacity with, say, 6 or 7 or 8 percent of unemployed, what would happen to the unemployed? We would still have 12 percent idle capacity, which obviously is not quite true.

Mr. KLEIN. Well, you see, one of the motivations for doing this kind of research is to enlarge our view of economic efficiency beyond the statistics of unemployment or beyond the statistics of idle freight cars, vacant houses, or whatever kind of slack statistic that we can get.

Now, there is a good correlation, a very strong correlation between our measure and the rate of unemployment, as you say—a very close correspondence and a very high correlation. However, there are periods when our index moves somewhat differently from——

Mr. PROXMIRE. The last 4 years are among those periods, from what you have just said?

Mr. KLEIN. Yes. Well, at the moment our index has been going up when the rate of unemployment has been falling. But I would guess that the jumps we have been taking are considerably bigger than the rather fractional falls in the unemployment rate. The unemployment rate fell by about eight-tenths of a point, I think, while our index was rising two or three points.

Senator DOUGLAS. Yet, Dr. Klein, we know as a matter of observation that at the peak period of a prosperous cycle, the most prosperous you can imagine, there are idle factories and idle tools and machines within a factory. Now, are the conclusions from this—first, are these the high cost factories and the high cost, inefficient machines, or is there a tendency for business consistently to overinvest as compared with the labor which is available to use on capital instruments?

Mr. KLEIN. Well, I do not really know the answer to that, but I would guess it is rather the inefficient firm, in the sense that it becomes too costly to use these materials in the situation of tight labor market when there is little unemployment. This is, of course, one of the reasons why I am so concerned about the problem of estimating capacity for any individual segment of the economy, any individual firm or any individual industry, and then averaging them together as though it were an index for the whole economy. Because these particular firms that you mentioned would find it very difficult to operate under high-cost conditions of full capacity. Therefore, that idle equipment would just remain idle and should not be counted as part of our potential capacity. It is a very difficult kind of calculation for that reason.

Now, as far as the dictionary definition is concerned, I think that is not really the kind of concept we have been looking for. I do not think we ought to be interested in that. We are not really interested in the maximum physical output that we can attain, because in any particular industry, if we really have to break some production barrier we can do so, by channeling all of our resources into that particular sector of the economy. What we want to know is some overall measure where the economy could function, could function in a fairly normal state of affairs, and that would mean normal vacations, normal maintenance, and not very strong inflationary pressures.

If we take measures that are too high when put together for all the different industries, we may be getting a very unrealistic figure of capacity. There would be a potential that could be reached only under extreme national exertion.

Senator PROXMIRE. I have no quarrel at all with your argument or with your measure, as long as it is understood what it is. But I think in terms of public policy, those of us in Congress who have responsibility for—at least we feel that responsibility to some extent for unemployment and for measures of this kind—that if your measure is not understood and it is indicated that we are operating at 93 percent of capacity, people feel, well, that is pretty good, there is not much to worry about. Or if we move ahead more rapidly, we might be in a very inflationary position. The feeling might develop that the unemployment situation is one that cannot very well be solved because we are operating so close to what you gentlemen have chosen to call capacity.

The dictionary says capacity is something else. You see, there is a confusion on public policy measures. I think your concepts are very helpful for what you said it is designed, forecasting; but in terms of public policy, I think it should be handled with great care in the kind of information you are giving us this morning. I hope we can disseminate this understanding sufficiently among our colleagues so that when they evaluate the Wharton measure they know what it means.

Mr. KLEIN. Of course if you turn the unemployment figure upside down and say 94½ percent of our population is employed, it looks pretty good.

Senator PROXMIRE. Of course, we can argue on this and Senator Douglas has argued more eloquently than any Member of Congress. He has pointed out that the unemployment figure is deceptive, because you include in your labor force people who own their own jobs although income may be low or even negative. You include people who work 1 hour a week, and this 5 percent of 5½ percent unemployed is, in my judgment and the judgment of other people, probably essentially an understatement.

Mr. KLEIN. I would like to just say a few words about what I think could be done to improve these measures. I think our measure may be a little high and some of the other measures that may be used for the economy may be low. Somewhere in between, I think we are converging on better estimates.

Now, the kinds of research programs that we are undertaking are programs that are designed to look at each of these 30 industrial sectors, or as many of them as we can get good data for, to see to what extent these trend lines through the peaks could be raised a little bit above the peaks, to what extent it is feasible to talk about these trend lines as being so many percents or so many index points above the peaks instead of being at 100 percent of each particular peak. That would mean a general raising up of all of our trend lines, raise our total capacity estimates a bit, and would lower our percentage utilization a bit.

Now, this would not take account of the difference between the period since 1957 and the period just preceding it. To handle that difference, then, I would recommend that we look into something like

the suggestion that has come up of using a measure of strength of business cycle peaks, to see if these later peaks should be adjusted compared to the earlier ones. I suspect that if we were to carry through this research program along these lines, we would come out with something that is a little bit lower in terms of degree of utilization than our present index. We might have overstated things by 2 or 3 points, but I think not by much more. I do not think it is really sound to say that our rate of operations is around 85 or 83 percent now. I think that is a highly unsound figure.

But I would not necessarily rule out something like 90 or 92 percent.

Senator PROXMIRE. You say it would be highly unsound, even though McGraw-Hill makes its assumptions clear on what they are trying to measure and the basis for their measurement? You still feel this is an unsound measure?

Mr. KLEIN. It is an unsound measure if it is looked upon as a national goal that we are going to try to reach 100 percent.

If we say the rate of operations is 83 and we ought to be striving for 100, this is unsound in the sense that we do not realize the precise magnitude of the economic problem in front of us. This would be a measure that would cause us to push too high, possibly.

Senator PROXMIRE. I would say that almost any kind of measurement is likely to be unsound in that sense. On the other hand, if you recognize what they are measuring, they have gone to businesses and the businesses whom they have queried have said we could increase another 15 or 17 percent to maximize our profits, then why is it not perfectly sound to assume from that that in this particular area, where you polled, allowing for the inadequacy of your polls, allowing for 83 percent of your capacity, the estimates are true?

Mr. KLEIN. They are not saying that they would maximize profit. They say that they would maximize profit, or have the best rate of return, at 90 percent. They actually operate at 83, they would have their best rate of return at 90. Now, those two figures must be used together and not singly. If you use the 83 figure singly and forget about the 90 figure, it looks as though they could push toward 100.

Now, I do not deny that any particular industry could push for a jump from 83 to 100, but I do deny that all together could do it. There just are not that many resources to go around.

Now, we have taken up various technical problems about averaging these rates for the different component industries, and here I think there is a promise of some new type of research being done and some new results coming out. We have looked into schemes of averaging the components so that any set of outputs by individual industries will be compatible with other industries needs for production at full capacity output.

Senator DOUGLAS. Dr. Klein, I assume that you are taking for granted the existing length of the workweek, the existing shift systems——

Mr. KLEIN. Yes.

Senator DOUGLAS. The existing distribution of the total population employed and so forth?

Mr. KLEIN. Yes.

Senator DOUGLAS. Of course, when a national emergency to which Senator Proxmire referred develops, the actual length of the workweek is extended and you get fuller utilization of capital. Furthermore, you draw in a large number of women, young people, old people, and so forth. So that the supply of labor at any one time is not fixed.

Mr. KLEIN. I think that is quite right, and our measure is really designed to be a measure of capacity under normal peacetime operations when the economy is functioning as it in fact has in the past at maximum periods, and it would be an understatement of a full mobilization level of capacity where people are moved from one industry to another and the labor force is expanded and the workweek is lengthened and depreciation or maintenance requirements are disregarded—maintenance is disregarded and depreciation is allowed to go on without replacement.

Senator PROXMIRE. Disregarding emergency mobilization, the work force moves kind of like an accordion. Even in peacetime, there is no question that where you are moving up in the cycle and production increases and so forth, you not only call in more people who were out of the work force, you call in people who are underemployed, for example, marginal farmers off the subsistence farm. There is no question that we can have hundreds of thousands more farmers leave the farms every year. They want to leave the farms if they can get jobs in industry. This is not only true of farmers, it is true in other occupations which have problems somewhat similar to farmers. So that to say, for example, that you have an unemployment now of 5.5 percent—and this corresponds roughly with your own measurements of capacity—overlooks what happens when you move into a period of real capacity utilization of labor. I would estimate that we could increase the number of hours of people working far more than 5 percent, perhaps much more than 10 percent if we had something of this kind. This is why both your presentation and putting the labor unemployment upside down, it seems to me, gives a limited picture, a photograph of the economy at a certain time, and does not give the proper picture of the economy, which is a motion picture, in which it does expand as demand increases.

Mr. KLEIN. Well, I would certainly agree about the elasticity of the labor force. We find it to be an awful problem in our forecasting models, just to say what the labor force is going to be, because the housewife, student, elderly person give us a great deal of cyclical movement, which is very difficult to predict.

Now, I am not so sure whether we really are trying to get any kind of capacity estimates that would tell us about overtime shifts and longer working week and such other measures, but we do want to take account of this elastic element in the labor force just by means of counting heads rather than by changing the length of the working week. Now, one property of our measure is that if we divide output by our rate of utilization measure, we get some small movements in capacity output. We do not always have a rising capacity. The explanation for not having a continuously rising capacity is that the labor force in fact is cyclical. It fluctuates a bit. Those measures of capacity utilization which rely entirely on stock of capital measures and capital output ratios would produce an estimate of capacity output

that always rises, as long as there is positive net investment which we have had for the whole period since the war and it seems that we are going to have for a long time in the future.

I would say that one of the advantages of our measure compared with some of the others is that it does simulate those types of movements in capacity output that are associated with cyclical fluctuations in the labor force. And I would agree that there is such an expansive element and contractive element in the labor force.

Well, I think I have nothing more in the way of positive statements to say about our particular method of measuring capacity.

I would be glad to answer any questions which you may have.

(The complete prepared statement of Lawrence R. Klein is as follows:)

THE MEASUREMENT OF INDUSTRIAL CAPACITY

(By Lawrence R. Klein, Wharton School of Finance and Commerce, University of Pennsylvania)

WHY MEASURE CAPACITY?

The rate of unemployment, the length of the working work, vacancy statistics, business cycle standings, and other series in our economic annals give a variety of measurements on the level of efficiency and utilization of full potentialities in our economy. Do we need a separate measure on capacity utilization? Efficiency is a many-sided thing, and we need to look at it from several points of view. The rate of unemployment is probably our best and most familiar measure of efficiency, yet it has limitations. We should not hesitate to improve upon this measure by seeking a more comprehensive indicator of economic efficiency. It is important in appraising our growth potential to see how much slack there is in our economy.

Unemployment, even if it could be measured more precisely than it in fact is, gives only a partial view of efficiency. It shows the extent to which manpower is being fully utilized. The kind of measure we are now aiming for is one that shows the extent to which all resources are being fully utilized. Capacity utilization, unlike the unemployment rate, is an output measure. It shows the extent to which an output potential is being realized through the use of all factors of production. The unemployment rate, in contrast, is an input measure, showing the extent to which an input potential is being realized. The capacity measure in terms of output should take into account the possibilities of substitution among production factors and the mutual compatibility of different input amounts of the several factors of production. In terms of the economist's concept of a production function, full capacity output is the highest output achievable with combinations of existing input factors. Presumably, if no incompatibility were to develop, this would be the point on the production function surface associated with full utilization inputs of productive factors. The full input of the labor factor would be the total labor force (allowing for purely frictional unemployment), and the full input of the capital factor would be the total stock of capital.

In fact the measures of capacity utilization that we have been able to develop have been highly correlated with the rate of unemployment, but the correlation has been much less than perfect; therefore we are led to seek this supplementary measure of economic efficiency.

Economic theorists, particularly those concerned with explaining the business cycle, have found it useful and important to include such a variable as capacity or its rate of utilization in their analysis of fluctuations. In order to give empirical content to these theories, it is very important to measure capacity. The explanation of investment behavior, either as an objective in itself or as a component of a well-rounded theory of the business cycle, relies heavily on capacity measures. The explanation of production as a factor input-output flow process would also need capacity measures because we lack direct estimates of utilized captial. Labor, materials, and in some cases, land can be distinguished in measurement between utilized and unutilized amounts.

WHAT DO WE MEAN BY CAPACITY?

Actual measurements of capacity are difficult to make because of lack of availability of some kinds of data, yet even if we had the series that we think we would need, a difficulty would remain in that we are not sure just what is meant by capacity.

A pragmatic definition could perhaps be given: Full capacity output is that level of aggregate production that would be realized if we were to employ the full labor force (except for a frictional level of unemployment) and use all available capital and land in a standard shift operation of facilities with normal stoppage for maintenance, repair, and vacation.

A purely physical measure would not be suitable since uneconomic "crash" programs are feasible for limited periods of time. By restricting the concept to normal shift operation with usual letdown time for vacation and maintenance we introduce elements of economic and social cost into the concept. Capacity is to be understood in this presentation as an economic concept and not a purely physical measure of production.

Apart from the qualifications introduced in the preceding definition, the capacity concept is viewed, as stated in the previous section, as a point associated with full utilization inputs of factors on the economist's production function. A more economic-theoretical concept of capacity output would be that output associated with the minimum point on the economist's cost curve. The cost curve relates total costs to total output, for a given set of input prices. We usually think of this curve as having, especially in the short run, a well defined U-shape. The minimum point on this U is regarded in the economic theory of a competitive society as a social norm. Each productive unit ought to be operating at this point of least cost, and each such output point might be called capacity output. Frictions, imperfections of the market, indivisibilities, and other obstacles may keep output from reaching the norm. The ratio of actual output to minimum cost output could be called the rate of utilization of capacity.

In any given production unit or small sector of the economy there may be no realistic limit to potential production if we put our efforts exclusively toward increasing activity in that branch, yet there are realistic economic limitations to such enlarged production, and that is where the cost concept plays an important role in our definition of capacity. Moreover, as we shall discuss later on, there is a question of combining different capacity outputs for the several sectors of the economy into a feasible set of total activity levels, and extensive programs in one sector to the neglect of others may be uneconomic in that it fails to harmonize with the rest of activity.

SOME MEASURES OF CAPACITY

Different techniques for measuring American capacity are being presented at these hearings. In the light of our objectives and concepts these methods can be appraised. The Econometric Research Unit of the Wharton School of the University of Pennsylvania regularly maintains an index of percentage utilization of capacity. In this section of the presentation, we shall compare this measure with some of the others being discussed here.

If cost functions or production functions were well established for each major sector of the economy, together with reliable data on labor force and capital stock for these individual sectors, we could attempt to measure capacity according to the preferred economic concepts described above. Lacking estimates of such functions on a comprehensive industry basis, we turn to other kinds of more practical measurement.

The McGraw-Hill Publishing Co.'s estimates are determined essentially by asking a sample of industrialists at what percent of capacity they are operating on specified dates and at what percent of capacity they would prefer to be operating. These estimates, determined for major industrial groups of the industry sectors in the Federal Reserve production index, have been averaged together in a national measure using the Federal Reserve index weights.

The National Industrial Conference Board measures the stock of fixed capital and output for each of several manufacturing industries. The ratio between these two variables fluctuates over the course of the business cycle and they select the value of this ratio for a benchmark period in which they judge that there was full utilization of capacity. The capital-output ratio for this period is also a capital-capacity output ratio, and they divide their moving capital series

by this benchmark value of the capital-capacity ratio. The benchmark figure is adjusted for declining trends in the capital-output ratio. This is done for each of several manufacturing industries, and a national figure is obtained by averaging the separate industry ratios.

The Federal Reserve Board collects statistics on capacity utilization directly from trade and Government sources on industries producing basic materials (steel, nonferrous metals, petroleum, textiles, and others). These are engineering type estimates and cover a small fraction of industrial production. There is no reason to question their reliability but their representativeness is limited.

A more recent measure developed at the Federal Reserve Board combines the McGraw-Hill series with data on the stock of fixed capital. Although a chart of the data has been made available we have not yet been able to determine the precise steps of calculation.

The Wharton School estimates are prepared differently. We plot large time charts for each of 30 components in the Federal Reserve index of production. The data are seasonally adjusted monthly values averaged into quarters of a year. We then establish series of peak values for each industry for the period since 1946. Peak values are picked out by inspection by determining points where values exceed the immediately preceding and adjacent values with special treatment of exceptional cases. When output is unchanged at a peak value for two successive quarters, the second quarter is selected as peak. When output is unchanged at a peak value for three successive quarters, the middle quarter is designated as peak. When output regains a peak following a decline of no more than one quarter in duration, the second of the two high values is selected as peak. Some minor peaks within postwar cycles have been eliminated from consideration, but no fixed rule has been set for these judgments.

When a series of peaks has been established for any given sector, straight line segments are drawn to connect successive peaks. This can be done numerically as well as graphically. Values of the series along the constructed straight line segments are termed capacity, and the ratio of actual production values to these capacity values for each quarter are computed as percentage utilization measures. The capacity point between any two peaks is determined by the connecting straight line segments, but values determined subsequent to the last peak in the series are computed differently. The last connecting segment is extrapolated with the same slope as the segment connecting the last two established peaks. If output rises above this extrapolation, the slope of the line is increased to bring its terminal point equal to the last output value, and capacity values determined since the last peak are revised accordingly.

Ratios established by this method for each sector are then averaged, using Federal Reserve index weights, to give a national industrial measure of capacity utilization.

This method is more straightforward in growing industries, which comprise the bulk of the 30 groupings used. In declining industries, a maximum attained within the period studied is selected and capacity is kept constant at this level.

Elementary properties of the Wharton School index

The measure of capacity output is in the same units as the production index. They are both on a 1957 base value of 100 for actual production and not a base value of 100 for capacity output. The ratio, representing degree of capacity utilization, is a pure number without specific units of measurement or base value.

Any single industry will have an operating ratio of 100 percent in peak quarters; but all industries do not peak simultaneously, and the ratio has never reached a value greater than 97 percent since 1946. It reached 97 only once—in the first quarter of 1947.

It has been our experience that small changes in individual industries, particularly when capacity values since the latest peak are revised as explained above, change the overall operating ratio by less than a full point. The overall index is not sensitive to isolated errors, and we have more faith in its relative accuracy than in the accuracy of any industry component.

Compared with other published measures of capacity, ours is usually higher when quoted in terms of the operating rate. This is because ours can potentially reach 100 percent, although it has never gone that high.

Comparison with other measures of capacity

Given the method of construction that we have used, it is not surprising that our measure of capacity utilization exceeds other available series. It should

be noted, however, that our series was lower than the values given by the National Industrial Conference Board in 1953 and 1955.

At the present time the McGraw-Hill series gives a value of approximately 83 percent as the rate of capacity utilization for yearend 1961. This is much lower than our fourth quarter figure of 93 percent, and discrepancies of this order of magnitude have been estimated since 1956. Prior to that time also, our measure gives higher values but only by a margin of 3 to 4 points.

The McGraw-Hill survey also asks respondents about their "preferred" rate of operation. This rate was formerly given as 90 percent; it rose to 94 percent in 1959–60, but now (we are told) this rate has fallen to 90 percent again. If we form the ratio between the McGraw-Hill operating and "preferred" rates, we come much closer to our own figures at comparable dates. At yearend 1960, we would still be above this ratio of operating and "preferred" rates by 6 points, but the figure of 94 percent as a "preferred" rate in 1959 and 1960 appears to be dubious. At yearend 1961, we again have a close comparison, for our rate is 93 percent, and the adjusted McGraw-Hill rate is 92.2 percent ($^{83}/_{90} \times 100$).

The reason for suggesting this adjustment to the McGraw-Hill series is that it may be unrealistic for all industries to reach 100 percent utilization simultaneously. Our measure, as an industrial average, never reaches 100 percent because all industries do not reach an output peak in the same quarter. It seems highly unlikely that all industries would reach 100 percent at the same time, for at such high rates of activity they would be bidding against each other for labor and other scarce resources, thus raising costs. Capacity is an economic concept, and outputs that appear to be capacity levels at existing factor costs will cease to be economical capacity levels if costs rise as a result of competitive bidding for resources by other sectors of the economy. It is, however, the belief of economists working in this field that "preferred" rates are, in fact, attainable. They are assumed to be mutually compatible output levels among all industries together.

It is not easy to compare our utilization rates with those of the National Industrial Conference Board since they have been published only for selected years and are computed at the point of highest output during the year. In each of the years for which data are available from the conference board (1953, 1955, 1956, 1957, 1959) our series on utilization rates, reached a peak value for some quarter. Therefore, our series has a peak value of 96 percent utilization for each year, but the conference board series is:

1953	103
1955	100
1956	95
1957	92
1959	96

It is hard to believe that the peak rate in 1957, a year of a strong business cycle high point, was so far below the levels of 1953 and 1955. The year 1957 was the terminal point of a capital goods boom, and it is unlikely that we would have experienced such a prolonged period of investment if there had been much excess capacity. Our rate measure was at a high point of 96 percent in the first quarter of 1957, giving us a peak value for that year. Its decline was soon followed by the series on capital expenditures. This pattern would seem to justify our figures more than those in alternative series for this date.

The series on capacity utilization developed by the Federal Reserve Board and given in a graph (chart 3) of the Annual Report of the Council of Economic Advisers (1962) is generally lower than our series. It has the same turning points over most of the period 1953–61, but its range of fluctuation is between approximately 94 and 74 percent, while ours is between 97 and 81 percent. It, too, has a downward trend in that the peaks of 1956, 1959, and 1960 are distinctly lower than those of 1953 and 1955. This is not true of our series.

IN DEFENSE OF THE WHARTON SCHOOL MEASURE

Our technique of measurement of capacity by means of trend lines through production peaks was not decided upon in an arbitrary or hasty manner. It is clearly a practical expedient, yet it has good justification.

It was first assumed that regularly published capacity data for selected industries from trade and Government sources were sound figures. Had such figures been available for a wider coverage of industry, we would have used these figures directly without designing new series.

In some leading cases, particularly steel, it was observed that the published industry data did approximate trend lines through peaks. In some industries, the trend lines followed the pattern of peaks but lay somewhat above them.

Our index has been criticized more for underrepresenting the period after the 1957–58 recession than for other periods, for it is argued that recovery to business cycle highs in 1959 or 1960 were weaker than in previous cycles. Our utilization rate reached 96 percent in 1959, fell during the steel strike, and rose again to 95 percent at the beginning of 1960. We are not far from the McGraw-Hill measure in the period since 1959 if preferred rates of 90 percent are used, as we suggest, to show a potentially attainable capacity level. In 1959, our peak rate of 96 percent agrees with the conference board peak rate estimate of 96 percent. The combined measure of the Federal Reserve Board is lower.

The high rates of capacity utilization suggested by our measure in 1959 and 1960 did not bring forth a high rate of fixed capital formation as might have been expected on the basis of past relationships, but this is partly due to the disrupting influence of the steel strike.

Another kind of consistency test of our measure in the present period can be made with an estimated production function used in our quarterly econometric model. In this system of statistical equations, we have a relationship between private real output, on the one hand, and man-hour employment and utilized capital on the other. We compute capacity output from this equation by inserting total full-time labor force (less 3 percent frictional unemployment) in place of man-hours worked and total stock of capital in place of utilized capital. The test is not completely independent since the relationship used is estimated by measuring utilized capital as the product of capital in existence and our value of rate of capacity utilization.[1]

We estimate the capacity level of private gross national product as $446 (1954 prices) averaged over the first three quarters of 1961 using labor force and capital stock values for this period. If we divide the actual series of private gross national product (1954 prices) by our measure of the rate of utilization, we get practically the same figure for full capacity output averaged over these quarters. Therefore, this extrapolation of a relation fitted to earlier data (terminating in 1958) gives us consistent estimates of capacity output and its rate of utilization in the present period.

It should also be pointed out that our measure of utilization rates, divided into actual series of real output, gives an estimated series of capacity output that has a clear upward trend but that does not always give positive quarter-to-quarter increments. As long as there is positive net investment, the stock of capital grows, and methods of measurement that divide benchmark (or trend declining) capital-output ratios into the time series of capital stock will give ever-increasing capacity estimates from quarter to quarter. In the short run, there are distinct fluctuations in the labor force, and it is not unreasonable to expect capacity output to show mild and short fluctuations. This is the kind of movement we find by dividing our utilization rates into a series of real private output. Both manpower and capital limitations ought to be considered; this is a reason for preferring our method to one that places primary reliance on capital stock measures.

A PROGRAM FOR FUTURE RESEARCH

It is encouraging to see a wide diversity of thought and activity devoted to the problem of capacity measurement. In the discussions on this subject during the last year many useful suggestions have arisen. It appears that a stronger research program focused on this problem would now be in a position to make some significant improvements in our measurement procedures.

(a) Extension of engineering-type estimates

The series included in the Federal Reserve index of capacity for major industrial materials could be expanded to other parts of the economy. In the first place, other sectors in the industrial production complex could possibly be induced to report capacity and utilization rates on the same basis as do com-

[1] We should also point out that the output series used in this relationship refers to the whole private economy, while our measure of capacity rate refers only to the industrial sector.

panies in steel, petroleum, paperboard, flour milling, electricity, and other industries. It is even possible that extensive library research could uncover some of these series already in existence. Related statistics on house vacancies, unoccupied hotel rooms, idle freight cars, and other surrogates would help expand the measure to wider sectors of economic activity. A research program of this kind should seek to achieve more unformity of definition and concept.

(*b*) *Estimation of cost curves*

A somewhat more speculative type of research endeavor, but by no means impossible, is to attempt to establish the economist's concept of cost curve, for each of the several industrial sectors of the economy. Points of minimum average cost, if they exist, could then be estimated as capacity output points for these industries. Such research requires a delicate application of the methods of modern econometrics. An estimate that has already been made for electric power stations compares well enough with separate engineering estimates of capacity output to justify further inquiry of this type.

(*c*) *Capacity at business-cycle peaks*

In order to improve upon the estimates obtained by our methods at the Wharton School, we can follow up suggestions that have been made to us by other workers in this field. Intensive studies can be made for each of the 30 industrial component sectors in our measure to see by how much the trend line of capacity could be raised above peaks instead of passing through peaks. This would involve a sifting of whatever related data we could find about production potential in these individual industries.

Instead of interpolating linearly between successive peaks, we could interpolate along a path determined by the individual industry series on gross capital formation. While this may bring some slight improvement to the short run movements of our series, experimental calculations have not indicated that any substantial differences would be obtained in this way.

If separate business cycle peaks could be assessed for their "strength" we might have a basis for adjusting our trend lines to make them pass above those peaks that are deemed to be relatively weak. Eventually this might be done on a selective basis for separate industries, but initially some composite measure of business cycle strength generally, such as a diffusion index of the National Bureau of Economic Research, may be used to make an overall adjustment to our composite measure. If such measures showed that the recovery peak in 1959–60, for example, were weaker by a given percentage than the preceding peak or some benchmark peak, we could accordingly raise the trend line of capacity above this peak value.

(*d*) *The aggregation of capacity*

The methods of measurement we have mentioned in this discussion have all arrived at a final national figure by starting from individual industry components. How should the individual industry series be combined into a national average figure in such a way that a mutually consistent set of outputs are used in the final figure? The present practice is simply to form a weighted average of the individual capacity estimates or operating ratio estimates, using as weights the figures employed by the Federal Reserve Board in their computation of the composite index of industrial production. Another method that has been suggested is to use weights that are proportional to capacity outputs.

A technique that pays special attention to consistency of the individual capacity components in the national average figure is to require that the outputs selected satisfy a linear input-output system of interindustry product flows. Methods of meeting the input-output restrictions have been discussed elsewhere, and some trial calculations have shown it to be feasible in application.[2] Research would be required to establish desirable bills of final demand at levels of capacity operation, manpower availability, and accelerator or capital-output coefficients for each industrial sector.

It is possible that more complex methods of aggregation that use interindustry input-output restrictions will not give appreciably different results from simple averaging, but a careful research effort to answer this question should nevertheless be made.

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[2] L. R. Klein, "Some Theoretical Issues in the Measurement of Capacity," Econometrica (Apr. 1960).

TABLE 1.—*Percentage utilization of industrial capacity, Econometric Research Unit, Wharton School of Finance and Commerce*

1946:		1952:		1958:	
i	88	i	91	i	82
ii	89	ii	88	ii	81
iii	92	iii	90	iii	85
iv	95	iv	95	iv	88
1947:		1953:		1959:	
i	97	i	96	i	90
ii	95	ii	96	ii	96
iii	94	iii	95	iii	92
iv	96	iv	90	iv	91
1948:		1954:		1960:	
i	94	i	86	i	95
ii	94	ii	86	ii	93
iii	93	iii	86	iii	92
iv	91	iv	87	iv	88
1949:		1955:		1961:	
i	86	i	91	i	85
ii	82	ii	94	ii	90
iii	82	iii	95	iii	92
iv	81	iv	96	iv	93
1950:		1956:		1962:	
i	83	i	95	i	94 [p]
ii	89	ii	95		
iii	94	iii	94		
iv	94	iv	96		
1951:		1957:			
i	94	i	96		
ii	94	ii	95		
iii	90	iii	94		
iv	90	iv	89		

INDUSTRY COMPONENTS AND WEIGHTS

1. Primary metal, 7.845.
2. Fabricated metal products, 5.501.
3. Nonelectrical machinery, 9.053.
4. Electrical machinery, 6.485.
5. Motor vehicles and parts, 5.115.
6. Aircraft and other equipment, 5.582.
7. Instruments and related products, 1.685.
8. Clay, glass, and stone products, 2.963.
9. Lumber and products, 1.675.
10. Furniture and fixtures, 1.502.
11. Miscellaneous manufactures, 1.502.
12. Textile mill products, 2.821.
13. Apparel products, 3.491.
14. Leather and products, 1.116.
15. Paper and products, 3.319.
16. Printing and publishing, 4.730.
17. Chemicals and products, 7.206.
18. Petroleum products, 1.959.
19. Rubber and plastic products, 1.939.
20. Food manufactures, 8.434.
21. Beverages, 1.583.
22. Tobacco products, 0.781.
23. Coal, 1.319.
24. Crude oil, 4.395.
25. Gas and gas liquids, 0.659.
26. Oil and gas drilling, 0.782.
27. Metal mining, 0.710.
28. Stone and earth minerals, 0.812.
29. Electric utilities, 3.816.
30. Gas utilities, 1.218.

[p] Preliminary.

Senator PROXMIRE. Go ahead, Senator Douglas. I am calling on you as chairman.

Senator DOUGLAS. No, no; you go ahead, please.

Senator PROXMIRE. I prefer to have Senator Douglas proceed.

Senator DOUGLAS. No, please proceed.

Senator PROXMIRE. I would like to say this has been very useful testimony to me. I think that I did hold you up and lead you into byways. I thought you handled it very well, but I feel that at the end of your statement, you have several constructive suggestions as to how this situation can be improved.

No. 1, extension of engineering-type estimates;

No. 2, the aggregation of capacity.

Now, frankly, I missed this in your testimony right now and I think this is so important. I wonder if you could briefly summarize this?

Mr. KLEIN. Yes. Well, we know that certain industries have traditionally produced capacity estimates. I think they are rather good estimates. I was sorry to see the steel industry hold back on the release of its publications recently.

Senator PROXMIRE. You think they were accurate and helpful?

Mr. KLEIN. Yes. I think if we were as well provided with statistics in other industries on capacity operations as we are there, we would be in a very strong position. Not only in steel, but I think the electrical industry, petroleum refining, textiles—all of the major materials industries—where there are indexes of long standing they have done very well with them.

Senator PROXMIRE. Here is another reason why I am wondering about your particular estimates here, because steel, as we know, has been operating at capacity. It fluctuates a good deal but was operating at close to 50 percent of capacity recently. Now it may be up to 75 or 80 perhaps, but it is far below the capacity you estimate. Automobiles have been operating at a very low level of capacity. When I say near 50 percent of capacity for steel, I am talking about a couple of years ago.

Mr. KLEIN. You see, one of the motivations——

Senator PROXMIRE. According to their own capacity indexes. This is the bellwether of industry.

Mr. KLEIN. The steel capacity output as the industry has measured it has come very close to trend of peaks in their production.

Now, you see, steel, after the 1959 strike, went to, something more than 100 percent rate of capacity. That is one of our observations, at a peak point of output, very near 100 percent. I think in the steel industry, one of our 30 component industries, essentially, we have not been led into drawing a line through the peaks that represent a substantial underutilization. When the steel industry has peaked, it has had very nearly full capacity operations.

There have been many points in the postwar period, sometimes following a strike, sometimes just as a result of the general business situation, when steel operations have gone fully to 100 percent.

In some other industries, the trend lines have not come quite so close to our peaks as has steel, but I think this is a fairly good industry for these measurements. Now, I think that there is a possibility that we could extend such measurements to other industries in the economy.

We could have reporting, much as reporting has been done in these major materials industries, to give us their rates of operation, and in addition, I think we could collate a number of related series that we have not looked at very carefully in this connection—I would say the series on idle freight cars, the series on vacant houses, the series on the number of hotel rooms vacant, and go right through the economy—through the service industries, through the communications and transportation industries. I think we could build up an estimate that might cover something like 25 percent of our industrial output. The major materials now, as they are regularly reported on a capacity basis, probably constitute something less than 15 percent of total output. I think we could do much more about extending these series by getting new reporting in other industries, discovering some fairly obscure series, or bringing in series that do not seem on the surface to be directly related to this problem, but in fact are.

Now, in one particular study that I undertook, I actually tried to estimate a cost function as an economist sees it for the electrical power industry. I determined the minimum point on this cost curve and compared it in terms of actual operation with the engineering estimates of capacity and actual operation, and I found that minimum average costs came very close as a percent of actual—no, actual operations as a percent of minimum average cost came very close to the engineering estimates of percent of capacity utilization in the sample of electrical stations that I drew.

Senator PROXMIRE. I want to make sure I understand—minimum average cost?

Mr. KLEIN. Yes.

Senator PROXMIRE. Would that be the concept that McGraw-Hill has of 90 percent?

Mr. KLEIN. Well, it probably is. It is stated to businessmen as the point of maximizing their return.

Senator PROXMIRE. Well, I think it would be quite different. For example, if you have a situation where you minimize your cost say 90 percent operational capacity and your price for the particular product is 10, and your cost at that point goes down to 7, obviously, you can keep going until your costs come up to 10 to maximize your profits. Now, it may take more input, but nevertheless, this is a different concept, minimizing your costs or maximizing your profits?

Mr. KLEIN. That is right. It is a different concept, but minimizing the costs is the academic economist's norm. We say if we had a competitive society, which is our theoretical norm, all sectors of the economy would be at minimum average cost. If they had such.

Senator PROXMIRE. I am glad to hear this notion. You are talking about minimum average costs. That is what your measurement here is that you found correlated closely with your previous estimates of capacity?

Mr. KLEIN. With engineering estimates in the electrical field.

Senator PROXMIRE. In the electrical field?

Mr. KLEIN. Yes.

Senator PROXMIRE. Very good; that is very helpful.

Senator DOUGLAS. Dr. Klein, I am somewhat struck by this comment of yours of minimum average total unit costs. Why not minimum marginal unit total costs?

Mr. KLEIN. Well, the reason we choose minimum average costs, is that if the industries were in a competitive situation and if there was a long-run equilibrium established, it would be established at a minimum average cost and at the same point, we would have marginal costs equal to——

Senator DOUGLAS. As I recall, Professor Viner had an article on this subject in the Austrian Journal 30 years ago, so you agree that these two points are identical?

Mr. KLEIN. I do not say that minimum average costs and minimum marginal costs are at the same point, but I say in a competitive situation, the long-run equilibrium for all producing units would be to be producing at minimum average cost. There would be a long-run equilibrium, with zero profits where profits are understood to be some excess return over and above the normal reward of management.

Now, this is a fairly abstract concept and very theoretical. Yet I think it is rather basic if we want to choose the kind of measure that we think ought to be our concept of capacity.

Senator PROXMIRE. I should think that a crucial measure in determining what capacity is would be where your marginal cost exceeds your revenue or your price, whatever you want to call it. You would keep operating up until the time that you would—the last unit that you produced, your cost would exceed your price and then you stop.

Mr. KLEIN. Well, you see, textbook economic theory says that you continue——

Senator PROXMIRE. Not economic theory; I am talking about what a businessman does if he has enough sense to really analyze exactly what is happening to what he is seeing and what his prices and his costs are?

Mr. KLEIN. That is right; and in the textbooks, it is expected that profits are maximized at the point where marginal revenue equals marginal costs. But that would be for a noncompetitive society if that point is to be different from minimum average cost. Marginal revenue and price will be equal and also equal to——

Senator PROXMIRE. Oh, I see.

Mr. KLEIN. And also equal to minimum average cost in a competitive society.

Senator PROXMIRE. Then you are assuming something that seems really academic here, and that is that we have a purely competitive society.

Mr. KLEIN. I am saying we should define capacity as the kinds of operation we would have if we had a competitive society.

Senator DOUGLAS. And you are assuming complete—free entrance of new firms into industry if there are pure profits to existing firms.

Mr. KLEIN. Yes.

Senator PROXMIRE. So you have the situation as you have in the steel industry, with same price, great differences in profits, for instance. You have an entirely different situation in the real world than you have in this theoretical model?

Mr. KLEIN. That is true. The real world is different. I do not think it is different because of this great divergence between cost and price. It is because of the lack of market competition as we understand it in ordinary economic theory. Yet I still think that this is an ex-

tremely valuable concept if we want to know what a national goal for capacity is to be, what a good set of outputs would be and what a realizable set of outputs would be for all different parts of the economy together.

I think it is not very useful to talk about a set of numbers if they are not capable of being realized for all industries together. I think that minimum average cost points would have the property that it would be an attainable set of outputs for different industries.

Senator PROXMIRE. I yield to Senator Douglas for questions.

I want to thank you very much.

Senator DOUGLAS. Dr. Klein, your paper is characteristically brilliant. We face the fact, however, that even at peak periods, there is a tremendous amount of invested capital that lies idle. Now, this is true in your indexes of manufacturing, as I think you indicated, in the service industries there is probably more. Even at the season of busiest years, the percentage of hotel rooms over the country that is idle is really startling. Since investment is largely determined by hope, and since hopes tend to exceed ultimate reality, does not this tend to mean that you are building factories that will never be fully used, putting in additions to plant that will never be fully used, building houses too large for families, getting summer cottages for a few weeks during the year? Is this not philosophical, that people never cut their hopes to realities, but their hopes go out beyond? People plan something that will never be realized and this is the answer to capital investment?

Mr. KLEIN. Yes; and I think we ought to look at those idle bits of capital and decide whether we want to include them in our capacity measures. You see, you hinted at one time that there may be—and at a business cycle peak there may have been some overinvestment in some firms, there may have been idle capital lying about, and yet this may not be utilizable for high level operations. We may have excess capital building in some parts of our economy, but I am not sure we want to include all those bits of capital as potential producers of capacity output.

Senator DOUGLAS. But is it not better to have a safety margin for breakdowns, physical incapacities and so on?

Mr. KLEIN. Certainly.

Senator DOUGLAS. But it is a very nice question. Should or should not economic forecasting throw a little cold water on the natural expansive tendencies of mankind to overbuild?

Mr. KLEIN. Well, I do not want to give any impression that I think we are in a good position as far as the American economy of the moment is or that we should set our sights very low in terms of expansion. I am mainly interested that we aim for the right numbers, and I am not particularly worried at the moment about doing to much. I think we are going ahead too slowly and doing too little.

Senator DOUGLAS. Now, Dr. Klein, in just a few days, the Finance Committee, then the Senate, and ultimately the country will have to make a decision on a tax bill. Amongst the many issues involved there is the question of what needs most to be stimulated. Some will say that what is needed most is to stimulate investment of new capital in commercially productive enterprises; with the idea that this will lower costs and improve efficiency. There are others who say that the important thing is to build up total demand so that existing capacity

will be more fully used, and if and when this is done, that the investment process will take care of itself without any added stimulation coming from the tax structure. I suppose one's judgment on this will depend in part upon the percentage of idle capacity which you regard as most true. Do you think, say, that 17 percent of productive capacity in manufacturing is not utilized, I suppose you think the first thing to do is to build up total demand. If only 6 percent is not utilized, you will not stress that quite as much.

I wonder if you have any words of advice to offer to perplexed businesses as to which of these tax theories should be followed, because they ultimately really are economic factors.

Senator PROXMIRE. Before Dr. Klein answers that question, I want to add that it is my understanding, Dr. Klein, that you indicate that it might be wise to leave out of account, due to your 93 percent, capacity which is excessive and which has not been utilized in the past.

Mr. KLEIN. Yes; I would agree with that.

Well, of course, the full answer to Senator Douglas' question, I think, would take us beyond this technical problem you mention in capacity. I would say it seems to me the primary problem is to increase the level of capital formation, and in particular, to see if this postwar high point of our index, 96 percent utilization, could be increased to 97 or 98 percent.

I think changes in that index from 96 to 98 percent, though they seem very small, would be very crucial changes at a point of operation of our economy, where, to use our jargon, things get very nonlinear, and there might be a very strong impulse to invest at such high levels of operation.

Now, it is a bit strange that in the whole postwar period, we have never seen, except in 1947, we have never seen our index above 96 since we have measured it. Therefore, I think that these few points of slack that our measurement would seem to indicate are very important ones but we should not think of stopping at 96. If we reach it—we are at 94 now—that does not mean we are extremely close to the end, because a few percentage points' growth in this very high region of the index are much more difficult to come by than a few percentage points of growth when the index is lower. It seems to me that we must push toward a couple more points of capacity utilization and much higher levels of investment associated with it.

Senator DOUGLAS. How would you do that, Doctor?

Mr. KLEIN. Well, I would certainly agree with the proposals of tax stimulus of capital formation, and possibly some easing of the interpretation of depreciation figures in tax calculations.

Of course, the other thing that I think is extremely important is public investment. I think public investment can be extremely productive and add as much to our overall capacity as private investment, and maybe more if it is placed in the right spots.

Senator PROXMIRE. Will you yield at that point?

Senator DOUGLAS. Yes.

Senator PROXMIRE. I am really puzzled about this answer, Dr. Klein. It seems to me it almost reverses what you previously maintained. If you want to go to 97 or 98 percent, this present rate of capital formation will not get you there; is that not true? You are saying we should do our best to get a full utilization of the capital

formation we have. Obviously, if you had public policies which create more capital and operations and demand stays reasonably constant, then you are not going to go closer to full utilization, you are going to fall farther from it. In other words, you will get to 91–92, instead of 97–98; is that not true? Or am I completely wrong?

Mr. KLEIN. I would say if we had a vigorous full-employment policy——

Senator PROXMIRE. Oh, yes. My problem is we might determine policies that would stimulate demand in some cases. If you stimulate demand, then with a given stock of capital, then you might move in the direction of 97–98. But if you stimulate your capital formation more than you stimulate your demand, it seems to me that you can predict in the future that you are going to be farther away from full utilization than you were to begin with.

Mr. KLEIN. My answer was not geared to the aftermath. At the moment, I simply want to see full utilization, full activity, stimulated in this economy before we concern ourselves unduly with what happens right after. We always must look ahead, but at the moment our problem is to get up to full capacity. At the moment, our problem is to get a higher level of output. And if we could get the index up to a figure of 97 percent or 98 percent, this in itself will induce a lot of investment.

Now, whether that lays the ground for a letdown or not is a matter of future policy. Future policy must be a policy to maintain full employment.

Senator PROXMIRE. Future policy is a thing you fellows at Wharton and other great institutions have the time to consider objectively in the long term.

Look back at the 1954 Revenue Act, which provided great capital stimulation and which many feel has created a problem now. If we project a similar experience with another shot in the arm in the economy, perhaps we will get a stimulation of investment for 2 or 3 years with excess capacity following. Is this wise public policy, however, looking at it as you can do perhaps far better than we can do in Congress, as a long-term approach?

Mr. KLEIN. Well, the American economy, once it starts operating at a high level of activity, can turn out a terribly large amount of goods. Therefore, our policies must always be looking for ways of keeping full employment once we have reached that level instead of sliding back.

Now, that calls for a much broader range of policies than those we considered when we took up the question of how to get up to full capacity, how to get up to our higher level of utilization at the moment. Once we get up there, then we must maintain it. Well, this is a very broad question with a lot of scope for policy. I think our exports are too small; I think that our public investment for many projects in education and housing that would keep us occupied for a long time are underdone. I think that there are a number of areas of the economy where we can find new types of demand and new needs for production. But our first step is to get this economy up to full utilization.

Senator PROXMIRE. Let me ask you one other question, then. Mr. Greenwald of McGraw-Hill, in testifying here, said that after sur-

veying a number of businesses, they found that 90 percent of them would not be influenced in their investment policy by the administration proposed investment credit. He said that of the 10 percent who said they would be, they would project throughout the economy, on the basis of their response, some $300 million—only $300 million of additional investment, which of course was very disappointingly small for something which would provide more than $1 billion of windfall credit for American business. On that basis, I presume you were addressing your reply to a policy which might stimulate investment without particularly considering the merits or demerits of this particular proposal, is that correct?

Mr. KLEIN. That is right; and I think we are in a serious national situation, dragging along at a low rate of growth, low rate of employment, and I think we ought to try many policies that would bring us up to a high level rate. This would be one of them only.

Senator PROXMIRE. You do not think you have any evidence that might refute the testimony of Mr. Greenwald?

Mr. KLEIN. No; I do not. I do not have any evidence that would say or indicate what businessmen would invest if they had particular credits. I simply feel that this is a step in the right direction and should be one of several steps that we ought to take in order to stimulate the economy.

Senator PROXMIRE. Thank you, Mr. Klein.

Any more questions?

Senator DOUGLAS. No.

Senator PROXMIRE. Thank you also for a very excellent job. I appreciate it very much.

The committee will reconvene tomorrow, Wednesday May 23, at 10 o'clock to hear from Mr. Sanford Parker, chief economist of Fortune magazine, Mr. Roye Lowry for Statistical Users, and John D. Norton of the National Planning Association.

(Whereupon, at 12:15 p.m., the committee recessed, to resume at 10 a.m., Wednesday, May 23, 1962.)

MEASURES OF PRODUCTIVE CAPACITY

WEDNESDAY, MAY 23, 1962

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 recess, in room 6226, New Senate Office Building, Senator William Proxmire (chairman of the subcommittee) presiding.

Present: Senator Proxmire.

Also present: James W. Knowles, staff economist; John R. Stark, clerk; Hamilton D. Gewehr, staff member.

Senator PROXMIRE. The subcommittee will come to order.

It is my understanding that Mr. Sanford Parker is ill, and we are very pleased to have Dr. Morris Cohen, an associate editor and economist for Fortune magazine, who has a distinguished background.

Dr. Cohen, I see you have an MPA at Harvard.

Dr. COHEN. Yes, sir.

Senator PROXMIRE. Congratulations. I have an MPA from Harvard, too.

Dr. COHEN. I know, sir.

STATEMENT OF SANFORD S. PARKER, CHIEF ECONOMIST, AND MEMBER, BOARD OF EDITORS, FORTUNE MAGAZINE, PRESENTED BY DR. MORRIS COHEN, ASSOCIATE EDITOR AND ASSOCIATE ECONOMIST, FORTUNE MAGAZINE

Senator PROXMIRE. We are very pleased to have you. I understand you not only will read Mr. Parker's statement but will also answer questions.

Dr. COHEN. Yes, sir.

Senator PROXMIRE. All right, sir. You go right ahead.

Dr. COHEN. Fortune's work on capacity dates back nearly a dozen years, two highlights being a series of four articles each, first in 1954 and again in 1958. In both, as well as in a number of individual articles, or parts of articles, the focus was on the outlook for capital goods spending, and the approach to the measurement of capacity was in a sense pragmatic, along with other important influences upon outlays, such as cash flow, new technology, the role of competition, and so on.

The approach has been pragmatic in precisely the sense that capacity is itself an essentially economic rather than engineering conception, and, accordingly, somewhat fluid from one time or industry to another.

Only in continuous process industries is physical capacity per se measurable, and even in these the trade will say, for example, that

true oil refinery capacity depends on the gasoline-residual "crack" and the octane rating, or that paper capacity hinges on 7-day operations in some areas and 6-day operations in others.

In steel, where ingot capacity has been a measure of only one of several important areas of capital, the trade has discontinued capacity calculations, since the advent of oxygen lances (apart from converters) has rendered some open hearth capacity virtually noncompetitive; such capacity may be standby in a buyer's market, or useful (or at least usable, with investment in lances) in a seller's market, or perhaps in the end obsolescent even along with lanced furnaces.

Senator PROXMIRE. If I may interrupt at that point, Dr. Cohen, is it your understanding that was pretty much the exclusive reason for the discontinuation of capacity calculations?

It was my feeling that there was also a policy matter involved here, that there was a recognition on the part of many that, with steel operating at a low level of capacity, it mysteriously had a relatively high level of profits, there were other economic questions and policy questions, public questions, involved in this situation. Do you feel it was almost entirely a technical decision on their part?

Dr. COHEN. I think it was mainly a technical matter. No one is quite sure just how much of this capacity is actually going to be used except in an unusual situation. As I understand it, they are still reviewing this matter and it is perfectly possible sometime in the future they may once again publish a new and revised——

Senator PROXMIRE. This is the first time they have interrupted their capacity calculations?

Dr. COHEN. No; I believe it happened before.

Senator PROXMIRE. And the time before when it happened there was some feeling on the part of some that this was based on a policy decision related to their public relations or something of that kind, at least partly, rather than relating entirely to technical reasons. Is this correct or not?

Dr. COHEN. I do not know.

Senator PROXMIRE. All right, sir. Proceed with the statement.

Dr. COHEN. In industries which do not operate on a continuing process basis, capacity is an even more fluid conception, with the same physical capability subject to shrinkage, economically speaking, should the industry become more seasonal (and vice versa, of course), or if other surrounding institutional arrangements change; for example, a major increase in labor overtime charges or similar practices.

All such factors must be taken into consideration at any given time, and in some measure have been, for Fortune's purposes, in the form of special memorandums from experts, or copious reporting in various industries, quite apart from the voluminous statistical compilations with which this paper is primarily concerned.

At Fortune, much as in other places, perhaps more so because of deadlines rather than sheer reverence for the printed word, such illuminations of unadorned statistics, when not put in print, pass out of memory and into the files and down to the basement, until the next occasion presents itself, perhaps 4 years later again, as is the case now. Incidentally, Fortune intends to do shortly a new capital goods series.

That, of course, may be just as well, as in 4 years conditions frequently change, or data improve (or get revised), or the experts or the trades simply change judgments, and it needs be done all over

again. This is especially true if, as in all organizations, the personnel changes, too, and the details of even quite explicit but nonetheless quite complex calculations, accordingly, become dim in organizational memory, despite the survival of various guides, animate or inanimate

With this preliminary, several points can be made clear:

1. Today's statement must serve as a general outline of Fortune's work and will be more fully supplemented at a later date, and for the record.

2. This presentation will concern itself primarily with statistical methodologies, no more than touching upon examples of the relevance of institutional or technological considerations.

3. Fortune's approach to capacity is primarily geared to the measurement of capital requirements.

4. The concept of capital is gross, not depreciated, plant and equipment, on the proposition that the productivity of the capital in place (that is, new machines versus old) is precisely the question to be investigated, not assumed, and that whatever capital business deems good enough to keep in place is good enough to measure.

The relevance of these considerations will emerge, hopefully, as the complex Fortune approach is now detailed, but in passing it should, perhaps, first be said that on pragmatic considerations there is no preference here for the use of capital measurements instead of capacity judgments. On the contrary, in changing times, capacity may well be whatever the persons in relevant business positions judge it to be—provided, several things:

That all of them (or a probably good sample) answer; that all, at any one time, mean the same things by capacity and, finally, that all mean the same from one time to another. The human fallibility of the samplers and the sampled being what it is, Fortune prefers to supplement objective statistics of subjective judgments with subjective judgments of objective statistics.

Senator PROXMIRE. I like that sentence. Do you want to give us an example of how you supplement objective statistics of subjective judgments with subjective judgments of objective statistics?

Dr. COHEN. We do this in the paper, Senator.

Senator PROXMIRE. You do?

Dr. COHEN. Yes. It is full of it, as a matter of fact.

Senator PROXMIRE. All right. Go ahead.

Dr. COHEN. Two measures have been devised of the growth of the capital stock. The first employs the techniques pioneered by George Terborgh, research director of the Machinery and Allied Products Institute, whereby purchases of capital goods, properly deflated, have been cumulated over time, subtracting therefrom the retirements of said capital goods, inferred from Terborgh's "survival curves"; these curves are based on the "useful life" criteria of the Treasury's Bulletin F.

What is new in this work is the allocation of various types of capital goods to various purchasing industries, and the application of the aforementioned technique to these purchases by industries. This makes possible the calculation, for example, for the group of metal and product manufacturing industries, and the nonmetal and product manufacturing industries, two stocks of capital, subdivided into plant, into "capacity machinery" (defined as "metal-working" and "special

industry," respectively) and into "other machinery and equipment," some of which has been further subdivided into electrical machinery, instruments, materials handling, office and store machinery and air conditioning.

Some of this latter subgroup is directly related to capacity growth, to be sure, such as electrical machinery, but in part at least, some subgroups such as materials handling or office computers may also be supposed to be serving the purpose of substitution for labor.

The same general technique has been applied to a number of industries, notably the oil, gas, and electric power industries, whose capitals have been similarly broken down; to the subgroup of all remaining industries, of course, and to some of them individually, such as communications, trade, railroads, etc.

The second main technique consists in calculating the capital stock from the corporate books; that is the Statistics of Income, undated by FTC–SEC data. Starting with a proper reflation of the capital stock at the end of the war, capital expenditures were calculated by adding the depreciation in any year to the change in depreciated assets for the year; then these capital expenditures so calculated were added to the gross stock of plant and equipment at the start of the year, from which was subtracted the surviving gross stock at year-end, to estimate retirements. All this, one should add, of course, on a price-deflated basis.

This task was performed for the total of manufacturing industries, and for each major industry subgroup thereof available; it was also carried out for the energy industries, and for some among the "all other" such as communications and railroads, where the corporate data would comprise the bulk of the industry total.

Senator PROXMIRE. Could you give a very simple example of how this operates?

Dr. COHEN. You start with a reflation of the capital stock. For example, let's take a situation.

Senator PROXMIRE. Is this for the economy as a whole?

Dr. COHEN. No, it is done by manufacturing industries, for major industries subgroups. Let's take chemicals, for example.

Senator PROXMIRE. Make rough assumptions in round figures and give me an example of how this works out.

Dr. COHEN. We have to have depreciated assets. Let's say they were 1,000 at the end of period 1 and they were 1,200 at the end of period 2. These would be depreciated assets. Then we would have depreciation, let's say 100 during period 2. I am not sure it is going to work out, but I hope it does. Then we have the gross assets at the end of year 1, which might be 2,000 and 2,200 at the end of year 2.

We say that we take the change in depreciated assets, which would be 200, and then we have the depreciation of 100 which together would be 300, and these would be the capital expenditures. Then we have a change in the depreciated assets, gross, which would be 200 and this would leave 100 for retirements for the year.

Senator PROXMIRE. I see.

Dr. COHEN. We are calculating in effect capital expenditures and retirements through the corporate books.

Senator PROXMIRE. Very good.

Dr. COHEN. Which we are then going to compare with the method obtained from the Terborgh approach, which uses survival curves, and our answer in both approaches gives you about the same result, which we found very, very encouraging indeed.

Senator PROXMIRE. Thank you very much. That makes it much clearer. Please continue with the statement.

Dr. COHEN. Which also leads to further implications.

Thus, Fortune obtained, from two independent sources, measures of the volume of capital outlays, retirements, and the stock of capital for several subgroups of industries, metal and nonmetal manufacturing, oil, gas and electricity, etc.; the one being of course the survival curves of the Terborgh approach and the other being this approach to the corporate books, the example of which I just gave you on depreciated assets and so forth.

The specifically ingenious solution to the accounting problem of obtaining such measures from the corporate books was devised by Alan Greenspan, associated with Fortune as a consultant on this matter in 1958; the painfully painstaking solution to the problem of subdividing capital purchases by major industry group and then reaggregating the stock was performed by Todd May, then of Fortune's own staff.

The results of the comparison of these two independent sets of estimates will for the present be confined to the manufacturing industries. Despite minor differences in the estimates of expenditures for various years, the two techniques have the same aggregate outlays ($108 billion in 1957 prices) for the years 1947 to 1957.

They similarly yielded equal totals for the retirements of capital, over the period, with this interesting difference by years: Actual retirements (from the corporate books) were less than theoretical retirements (from the survival curves based on useful lives) in prosperous years; in recession years actual retirements exceeded and caught up with the theoretical ones.

With these two conditions met for expenditures and retirements, plainly the two methodologies yielded similar estimates for growth of capital stock (apart from minor differences in the starting point capitals for 1945).

Now it became possible to compare indexes of capital for specific industries (obtained from the corporate books) with various other measures, as for example, physical capacity, in a few cases; McGraw-Hill chain indexes based on responses of sampled executives; and finally, the "ratchets" for peak productions in various industries.

These "ratchets" were at that time a moving index of the 2-year production peaks as shown by Federal Reserve data for some 90 subindustries.

In the case of primary metals, physical capacity checked out closely with capital stock; the same was true of paper, once the capital stock was adjusted for a shift in forest ownership from the lumber to the paper industry. Capacity data were at best only partial for other industries (textiles, stone, clay, and glass) or nonexistent. Instead the capital index was compared with the "ratchet" index and the McGraw-Hill index for each industry.

In some, capital grew faster than peak outputs, in others similarly, in none, less. But McGraw-Hill, which grew similarly to physical

capacity in primary metals but much faster in paper, also grew much faster than peak outputs (as well as capital) in several industries, for example, in textiles and food.

For the former, in textiles, the physical data on capacity, albeit limited, moved more closely with capital; in food, a slow-growing complex of numerous subindustries, unlikely to develop excess capacity, peak outputs grew with capital but far less than McGraw-Hill's index. As might be expected, the latter appeared close to other measures in industries dominated by large companies likely to be in the sample, while substantially exceeding other measures in industries of numerous firms where the successful (i.e., and so larger) firms were likely to dominate the sample.

Yet in such lines as motor vehicles, also of large firms, McGraw-Hill's index nonetheless somewhat exceeded capital growth; whereas capital growth in no case exceeded capacity growth in industries for which physical data were available. Inasmuch as the growth of capacity machinery matched overall capital growth in each of the two main subgroups of manufacturing, and new machinery may be more efficient than old, it seemed reasonable that capacity growth might exceed capital growth in general. In particular, manufacturing has relied increasingly on outside power purchases, less on its own capital for power generation. On the other hand, it was plain that in many industries this capacity growth was exaggerated by McGraw-Hill.

With all this in mind, Fortune proceeded to calculate an index of capacity, whose growth would plainly exceed that of capital but be less than that of McGraw-Hill. Some further steps were involved here, the details of which will be omitted for the present, involving, for example, the exclusion of Government-owned AEC chemical plants from capacity indexes and the revaluation of Government-sold rubber plants in the industry capital, to take the example for one industry.

Going down the line, the capacity index for an industry was simple when based on physical data, such as metals or paper, and simple, too, when capital and McGraw-Hill agreed. In large-company industries we leaned closer to their capacity estimate than to the capitals; in industries of many firms, we leaned closer to the capital index (supplemented by ratchets and limited physical data) than to the estimated capacity index.

Summing up, the estimated capacity index for such industries about split the difference between capital and McGraw-Hill growth for metalworking, but leaned somewhat closer to capital for nonmetal working.

Senator PROXMIRE. I want to skip back a page. Why do you say that it was plain in many industries this capacity growth was exaggerated by McGraw-Hill? What industries specifically?

Dr. COHEN. Senator, I do not know. We can get that for you.

(The following was later received for the record:)

For three metalworking industries, nonelectrical machinery, fabricated metals and electrical machinery, McGraw-Hill capacity figures rise more sharply than did the figures developed by Fortune from corporate books. From 1950 to 1957 the McGraw-Hill's capacity figures rose by 77 percent for nonelectrical machinery. Fortune's corporate books' estimate was 39 percent; for fabricated metals, McGraw-Hill was 45 percent, Fortune, 31 percent; and for electrical machinery, McGraw-Hill was 92, Fortune, 48 percent. For all metalworking industries,

McGraw-Hill's capacity figures rose 74 percent from 1950 to 1957, while Fortune's estimates from corporate books rose by only 45 percent. In nonmetal-working industries the comparisons are as follows: for the paper industry, McGraw-Hill's capacity rose by 51 percent from 1950 to 1957, while Fortune's, corrected for the probable purchase of forests by the paper industry, rose like the trade's physical capacity figures, namely, by 34 percent; for textiles, from 1950 to 1955, the McGraw-Hill capacity rose by 18 percent, while the Fortune estimate advanced by 6 percent (incomparabilities made impossible any asset figures for 1957) : for food, from 1950 to 1957, McGraw-Hill rose by 18 percent, while the Fortune estimate went up by only 9 percent; for chemicals, the McGraw-Hill capacity gained 75 percent from 1950 to 1957, the Fortune estimate, 45 percent; for rubber, McGraw-Hill rose by 47 percent, while the Fortune figure went up 32 percent.

Senator PROXMIRE. You do concede that capacity growth might exceed capital growth in general? You say that?

Dr. COHEN. Yes, sir.

Senator PROXMIRE. And you say that that might be a tendency generally because the new machinery is more efficient than the old?

Dr. COHEN. Yes, sir.

Senator PROXMIRE. I would presume that it might also be true, and it might not be true, but I think perhaps it might be, that more efficient industrial organizations generally might also conceivably be a factor?

Dr. COHEN. Yes, but less measurable unfortunately.

Senator PROXMIRE. Less measurable. At any rate, you know of no evidence to corroborate reports that in many industries capacity growth was exaggerated?

Dr. COHEN. I mean from the evidence that we put together with regard to the approach through the corporate books, the exaggeration resulted from the particular kind of sample that McGraw-Hill has, namely, large companies. Such a tendency might exist in industries where large companies account for only a small part of the total, as, for example, in textiles.

As a matter of fact, we found this out, so it is not a question of exaggeration in the sense of reporting; it is a question of exaggeration in the sense of a particular structure in industry where many small companies have an important part in the industry, but these are not sampled by McGraw-Hill.

Senator PROXMIRE. Thank you.

Dr. COHEN. It is a technical exaggeration rather than an exaggeration of those reporting.

Senator PROXMIRE. Mr. Knowles mentioned it is a sampling problem, because in textiles, for example, they overlook the less efficient, less rapidly expanding industries or they are less likely to have the smaller ones included in their samples.

Dr. COHEN. Yes, precisely. I will continue with the statement.

The resultant, overall pragmatic capacity index for manufacturing in effect therefore leaned slightly toward the side of exaggerating capacity growth and yet, in comparison with capital growth, it showed for the period as a whole approximately a one-half percent per annum greater increase than was shown by the growth of capital itself.

This capital efficiency compares with Kendrick's finding of a 1 percent annual growth in efficiency over many prior decades. This comparison made sense in light of two further observations, one that the proportion of new plant to equipment had begun to rise in the postwar

period from what it was in the 1930's, for example, and second, the shift toward purchased power was proportionately sharper in earlier than recent decades (by when it had already gone far).

This work of course makes possible an updated capacity estimate, for the metal and nonmetal halves of manufacturing separately, as follows:

From each new year's capital outlays (deflated) are subtracted theoretical retirements, thus carrying forward the growth of the capital stock; and the index of stock is adjusted upward annually by the same half-percent annual factor for capital efficiency (which, incidentally, was the same for both manufacturing and nonmanufacturing).

For these indexes, of course, a utilization factor was also computed, based on actual Federal Reserve production indexes and also on 2-year production peaks, or ratchets. The 1958 work took general account of the then upcoming Federal Reserve revision (based on the 1954 Census), and so the general utilization index has been carried forward but unfortunately, not the ratchet index, which requires complete recalculation.

This recalculation will be performed in coming months, as it becomes relatively the more important as utilization indexes rise. The latter today stands at 98 for metal industries, versus a 1960 peak of 100.5, a 1957 peak of 106, on an index base 1957 equals 100. For nonmetals, the current level is 111, versus 109 in 1960, 101 in 1957, on the same base. Before turning to the latter, the point may be summarized that, on Fortune's calculations, capital growth in manufacturing from mid-1957 to mid-1962 has been about 8 percent, capital efficiency has added some 2½ percent, so capacity has grown in all, some 11 percent. Output has meanwhile grown 15½ percent (assuming a second-quarter Federal Reserve Board index of 118, overall).

Senator PROXMIRE. When you say it has grown some 11 percent from mid-1957, to what time?

Dr. COHEN. Through the second quarter of 1962.

Senator PROXMIRE. Through the what?

Dr. COHEN. Second quarter of 1962.

Senator PROXMIRE. Second quarter of 1962.

Dr. COHEN. Now, in fact.

Senator PROXMIRE. All right. Thank you.

Dr. COHEN (continuing). The continuing necessity to update these analyses every few years is pointed up by the case of nonmetals manufacturing today. A large portion of the industry capital is represented by chemical plants, whose output is fully reported by the Federal Reserve (based on data gathered from establishments producing chemicals, owned by whatever industry).

But the Manufacturing Chemists Association recently reported that in 1961 the chemicals industry spent $1.7 billion for new plants while other industries spent $1.4 billion for new chemical plants. To the extent that the latter industries comprised rubber, the petrochemicals of oil, or other nonmetals, their capital growth was, of course, included in the nonmetals stock; to the extent that steel mills erected oxygen plants—or that a New Jersey zinc went into titanium dioxide, or anhydrous ammonia (as is now planned)—the capital data for nonmetals are too low, those for other lines too high. Such matters require

investigation, estimation, and correction, in order to comprehend more accurately where capital demands exist and what they amount to.

For the nonmanufacturing industries, of course, time will not permit full description of the extent to which the same techniques were applied and what results they yielded. But three major comments will be worth making here, one for the energy industries, one for all the rest of the economy's capital stock and use thereof, and a final one having to do with total private capital stock and output.

In the energy industries, capital and capacity appeared to move hand in hand for gas utilities. In electric utilities, only one capacity measure is available, for generating capacity, and that has moved ahead faster than total utility capital and, to a lesser extent, ahead of the utility subdivision for generating capital. Thus efficiency shows up again here, but in 1958 Fortune was told that some of the efficiency by reason of use of larger generators was offset by the need to maintain larger reserve margins following the move toward larger units; today much of the industry has changed its view on the point, while some of its experts still maintain the old view.

In short, there is a question as to effective capacity, the kind of question that exists in all industries. The capital breakdowns did show, however, the need for catchup of investment in transmission and distribution, and investment in these areas has been high. The same points hold for petroleum.

Breakdowns showed latent strength in capital demand for marketing and transportation capacity, and experience has confirmed this. But the capital data were not conclusive as to the extent of crude production over capacity, and checks within the industry at the time turned up extraordinary disagreement on this point, too.

Those puzzles are particularly important because it has been in the energy complex that investment has been lagging for the current period behind Fortune's 1958 projections.

In the rest of the nonfarm economy, on the other hand, investment has been exceeding projection, even though the analytic work on capital has perforce been less thoroughgoing than for manufacturing and energy. This is partly because corporate books are either unavailable or provide inadequate coverage for agriculture, trades and services, nonprofit institutions, and so forth.

But breakdowns of the capital stock for this whole complex had shown areas of definite lag in capital growth, as compared with one or another measure of output for these areas, and so investment has been high. Since this whole group accounts for half of all private investment, it is plain, from the overall pragmatic standpoint, that capital analysis can be rewarding even when it does not provide precise measure of something called capacity.

The third point emerging from the overall analysis is the validation of the conception of using a fairly stable overall capital-output ratio for the private economy in this period. Though capacity has grown faster than capital in manufacturing, and possibly in energy, the growth of value of output in the latter had exceeded the overall growth of private output, and the energy group of industries employs an unusually high capital-output ratio.

This growth of energy output was furthermore analyzed into that sold directly to consumers and that sold to industry and commerce, and

the analysis made plain the reliance of other nonfarm producers upon the high investments by the energy industries to provide increasing efficiency in the use of industrial and commercial capital. No algebraic formulation, unfortunately, was feasible to demonstrate precisely the projectability of an overall capital-output ratio.

Indeed numerous and recurring problems are involved, having to do not alone with the energy industries and their capacities and growth, but in general, with the tendencies of demand to shift toward or away from high-capital versus low-capital industries (that is, steel versus electronics), and quite separate tendencies toward or away from the substitution for labor with capital (that is, the boom in computers and controls, and the lessening of boom in materials handling).

These problems may yet act as a qualification upon the use of overall capital-output ratios, and will now require fuller investigation. But pending that, and in the absence of plain reasons to the contrary, the overall ratio does seem useful in light of Fortune's studies.

There is particular significance to this finding now, for the overall index of utilization of private capital stocks is for the first time reaching this quarter the same high point it did in early 1955, at the advent of the great 1955–57 capital goods boom. The significance that Fortune places upon this finding has continually been pointed out in the Business Roundup, which anticipates an accelerating rise in capital expenditures in response to the capacity pressures implied by the ratio.

In point of fact, the Business Roundup of January 1961 laid considerable emphasis upon the fact that cumulative growth in output since 1957 had exceeded cumulative growth in capital, thereby placing a floor under investment, which would immediately rise with the advance of the economy, paving the way for a possible superboom in investment in 1962–63.

The current levels of GNP are running 1 to 2 percent higher than then projected in that 18-month forecast (which was widely regarded as overoptimistic at the time) and so the implication from the capital-output relationships of an upcoming superboom in investment holds today even more strongly than then.

The next 6 to 12 months, therefore, both as a result of actual economic experience and as a result of Fortune's own renewed analysis of capital and capacity, should shed a gread deal of light on the accuracy and usefulness of the methodologies herein described to measure capacity and the potentials for investment, and possibly on what, if anything, new is required to make them more accurate and useful.

Those of us at Fortune primarily concerned with these matters accordingly look ahead to this period with divided desire, and two hats: As economists, we'd like to think our work has been right, while as journalists we'd like to have something brand new to say.

In the best case for us, the methodology will prove itself in all essentials and yet (with the inevitable modifications) provide great new insights and challenges for the future. In the worst, it will somehow fail and in such a way as to defy any proper modification as a scientific hypothesis.

In that event, perhaps as offended constituents we will be down here again, without invitation, blaming such misfortune on the interventions of Government into economic processes, as the cause of a bear market in stocks and a paralysis of investment decisions that statistics prove would otherwise have been powerfully favorable.

Buried in the poor jest is a general caveat: capacity is an economic concept, therefore in degree a human one, embodying institutional as well as engineering or financial calculations, for the future as well as the present. No set of statistics can measure all of these factors, but can only assume about some of them, that is, that the humans who deal with capacity in turn understand the operations of their markets, and that the markets will always change a little from the way things went on before, but not disruptively. The statistics assume this, and, hopefully, all here assume the same. This completes Mr. Parker's statement.

Senator PROXMIRE. Thank you very much, Dr. Cohen. I want to ask you a few questions.

You selected mid-1957 to mid-1962 and you say that in this period capital growth has been aggregate of about 11 percent or a little over 2 percent a year, whereas the output has been 15½ percent.

Dr. COHEN. Yes.

Senator PROXMIRE. Why did you select mid-1957? Wasn't mid-1957 the peak of the investment boom?

Dr. COHEN. Yes; it was done on purpose. We know it was going from the last peak to the current. We wouldn't want to make the comparison from the trough, you see.

Senator PROXMIRE. You are assuming that mid-1962 is likely to be the peak?

Dr. COHEN. No, on the contrary, we are saying that over the past 5 years output has grown faster than capacity and therefore there are still pressures toward more capacity working.

Senator PROXMIRE. Pressures, yes, but we might also argue this is 1957, which is the peak of the boom. The investment boom in 1957 was when the 1954 revenue act and a lot of other things, if not played out, at least reached their greatest impact on the economy. Then one would expect and predict the output would be likely to gain more rapidly, I should think, than the investment subsequently.

What I am trying to say is this: Since 1955 to 1957 was a period of very heavy capital investment, a big expansion in our plant, which generally exceeded output, I presume, during this period at least.

Dr. COHEN. Yes.

Senator PROXMIRE. By quite a margin.

Dr. COHEN. Yes, sir.

Senator PROXMIRE. Then, would you not expect in the following 4 or 5 years that output would tend to catch up with capital growth?

Dr. COHEN. Oh, yes, and this is part of the process, but this very process, you see, has opened up a new era of expansion which hopefully might not be as hectic as the last one but which might be all-pervasive.

Senator PROXMIRE. I see. Unless we get some other figures we cannot tell whether or not this measure of 15 percent in output as compared with an 11 percent increase in capacity growth since 1957 is sufficient to exert enough pressure to provoke more investment, is that right?

Dr. COHEN. That is right. In other words, we are in this period right now and all that we can see so far, in terms of various surveys of capital spending, suggests that with each successive survey the investment sights have been raised in numerous lines and the latest McGraw-Hill survey shows—this is a very important thing, I think—in a number of industries that they already have plans for higher capital spending in the next few years than they are spending in 1962.

Senator PROXMIRE. Mr. Knowles has a question.

Mr. KNOWLES. I have a question on the comparison between 1957 and the present for the purpose you have of showing the pressures for another investment boom. In mid-1957 the demand had grown so much slower than capacity over the previous 2 or 3 years that industry, generally, had been for some time experiencing falling operating rates. This was sufficient, in fact, to slow down and then terminate the investment boom.

Therefore, in a very real sense a 15 percent increase in output versus 11 percent in capacity since 1957, if I do some arithmetic real fast here, would get you about to the point of pressure on capacity which you reached at the last time (1957) when the investment boom died—so I am a little bit perplexed.

If you had made this comparison with a time like early 1956 when the pressure was still sufficient to drive the investment boom upwards, that would be one thing, but I think you would have gotten a different result.

Dr. COHEN. We can make the calculation.

(The following was later received for the record:)

The requested calculation can be most conveniently made for the year 1956 relative to the second quarter of 1962. On this basis, overall manufacturing output rose 17 percent while capacity rose 14 percent. For metals manufacturing, the output advanced 11½ percent while capacity rose 19 percent; for nonmetals manufacturing, output went up by 21½ percent, while capacity increased by 11 percent.

Mr. KNOWLES. I would suggest this would be enlightening because a little quick arithmetic ends up with your data—if I do my arithmetic correctly—about agreeing with McGraw-Hill, and if this is the case you haven't got enough pressure even by their calculations to set off an investment boom now.

Dr. COHEN. I do want to say one thing, Mr. Knowles. This is manufacturing, which has one set of calculations. The other point, I think perhaps equally as important or maybe even more important, is the overall economy, particularly the nonindustrial part, which has been very, very strong, indeed, stronger than we had even thought in the earlier projections, and this is half of capital outlays, so that there is a tendency, I think, on the part of too many people to look at manufacturing, and particularly the durables manufacturing, as being the whole point of the capacity pressures.

Capacity is overall in terms of the whole economy and there are other parts where they are equally important, such as, for example, in gas and electric utilities. In the case of electrical utilities the surveys now show a rising trend for planned outlays for the next 4 years, which I think is extremely important, a point of view which they did not have a year ago, by the way, because we queried them quite closely—they have changed their minds in the last year—analyses arising out of projection of demand for the next 4 years.

For example, there are other things like this, but we could make a calculation for you in 1956.

Mr. KNOWLES. Your conclusion struck me, whereas it would not have done so if you had reached the conclusion that we are getting up to the point where a little further movement would move you into this pressure zone for a superinvestment boom about a year or two from now—out in 1963 or 1964 under the assumption that the present rise will keep going up and that capacity will keep on growing more slowly than output, thus eventually causing a squeeze.

I would have, I am afraid, very little ground to guarantee the accuracy of the figures I have put before you. But when you said it could occur as early as this year and based it on this kind of comparison it puzzled me because of the 1957 start.

Dr. COHEN. I want to make it clear, if I may, Jim, on this one point further. In point of fact, in terms of our current thinking, we tend to rely more heavily on the overall relationship between private output and capital stock than we do on manufacturing. We are in fact puzzled, as we say in our notes, at the nonmetals part, quite puzzled indeed, and this is a matter of some concern to us, something that obviously needs correcting which we are about to do, so therefore we tend to place less emphasis on the manufacturing part and somewhat more emphasis on the overall part which is what I discussed earlier.

Senator PROXMIRE. It seems to me when you break down your investment and start talking about the energy producing it gets extremely interesting. You say at the latter part of your statement:

> The capital breakdowns did show, however, the need for catchup of investment in transmission and distribution, and investment in these areas has been high. The same points held for petroleum.

Then a few paragraphs later you say:

> Those puzzles are particularly important because it has been in the energy complex that investment has been lagging for the current period behind Fortune's 1958 projections.

Is this possibly because the energy complex is so directly and intimately related to FPC regulations and we have had a very great difficulty, of course, in getting a firm policy in the FPC lately? This isn't political, but a new administration has 8 years ahead and we now have an FPC which is entirely appointed by one President and which seems to have definite plans for this particular industry.

Would this be a factor in affecting investment expectations?

Dr. COHEN. I think it would be and, as a matter of fact, in recent weeks there have been a number of comments to this effect, that apparently the FPC's actions lately have been more encouraging than earlier and it could have, I think, a very important influence and it may be having one right now in terms of those plans I was talking about earlier, particularly for the gas and electric industries.

Senator PROXMIRE. You say in other areas, however, that investment has exceeded your projections.

Dr. COHEN. This is the whole nonindustrial area.

Senator PROXMIRE. I see. Further, you say that the overall ratio does seem to be useful in light of Fortune's studies. Do you feel its principal usefulness is in the earlier prediction of forecasting?

Dr. COHEN. That is what we use it for, and I know there have been hearings by this committee in which the question has been raised by

whether or not this ratio has been changing and I read such testimony with interest, but for the time being we have gone along with the notion that we could use a stable ratio. However, it is not a closed question, by any means.

Senator PROXMIRE. Then you make a very interesting statement here where you say:

> In point of fact, the Business Roundup of January 1961, laid considerable emphasis upon the fact that cumulative growth in output since 1957 had exceeded cumulative growth in capital, thereby placing a floor under investment, which would immediately rise with the advance of the economy, paving the way for a possible superboom in investment in 1962–63.

Then on the basis of the latest evidence you still feel there is going to be a superboom. In the light of that, does this seem to be a propitious time for the Congress to pass a new tax law providing an investment credit, which sole purpose is to persuade business to increase its investment even further?

Dr. COHEN. Here I want to change hats and speak personally and not for anybody else. I think that is a very important question and there are a number of differences of opinion in our own place on that question.

Senator PROXMIRE. You are speaking now, you say, for yourself and not for Fortune?

Dr. COHEN. Yes, because this is a matter in which there is divided counsel in our own staff and also the whole editorial board.

Speaking personally, I would still be in favor of the Congress passing such legislation because I think we need this type of legislation and we need to encourage capital investment, particularly at this moment of time, in terms of the economy for next year and I think if we are going to do any erring, let's err on the side of this kind of action now rather than action which might be required next year of a different type.

Senator PROXMIRE. If you are about to move into a superboom why would this be a logical time to have a superincentive on top of a superboom and have a super-superboom. Super-superbooms are inclined to be inflationary and inclined, also, to result in instability in the economy generally and to be followed by a superrecession or a super-superrecession.

Dr. COHEN. I understand, Senator. I still think that we need this. The economy has behaved in a particular manner in the first quarter of this year in terms of where we sit today. There is still a certain amount of caution on the part of the business community. We speak of a certain crisis in confidence recently. There has been, as we all know, a certain amount of objection from the business community itself on this proposal, but I think in the end it would be effective and it would stimulate a lot of capital spending, which would be helpful, and I would take my chances on it getting out of control.

Senator PROXMIRE. One of the difficulties with this is that once you adopt this there may be, at least proponents say, a very definite incentive for increasing investment. That incentive, however, should perhaps begin to fade as business becomes adjusted to this and it becomes something that they have had over a period of time.

The initial incentive would be in 1962–63, therefore, the remainder of 1962 and all of 1963 should be carried forward by an investment ex-

pansion that should be substantial. This should be particularly emphasized by the unfortunate supercyclical effect of this particular credit inasmuch as it is based on being able to write off your credit against your profits, that is, when firms are not making money there would be much less incentive to making investments; when they are making money there is much more incentive for making investments. Therefore, you are going to have two effects: (1) You expect a superboom, an investment and this would tend to at least increase it; and (2) you would on top of that have a peculiar kind of tax incentive which is far more favorable in prosperous periods than in recession periods, so that you would get a heavy concentration in investment in 1962–63 and maybe the beginning of 1964 and then you would begin to get a sharp trailoff perhaps that would come at a bad time in the cycle when you could expect to have influences retarding investment.

Dr. COHEN. Well, if we postpone the investment credit this year, we may not see it for years. This is what worries me about the argument, and I recognize the power of the argument, Senator. I am willing to take my chances. These are all adjustments.

Senator PROXMIRE. Dr. Cohen, thank you very much. It is a very excellent paper.

Mr. Knowles has another question.

Mr. KNOWLES. A technical matter to clear up one thing. You say in your statement—

This comparison made sense in light of two further observations, one that the proportion of new plant to equipment had begun to rise in the postwar period from what it was in the 1930's.

What puzzles me is this rise in new plant. As far as I can get from a quick look at a series I have here—which is essentially the Terborgh series for the private economy—this would be true only since 1957 and even then they are so modest that I would doubt the accuracy of the conclusion.

It is a matter of $2 billion out of about $800 billion, and at that point I bow out.

Dr. COHEN. I think this was made in the context of the Department of Commerce article on plant versus equipment manufacturing.

Mr. KNOWLES. This is installations, or the capital stock itself? This is what bothers me.

Dr. COHEN. This is not the stock. This is the new purchases.

Mr. KNOWLES. It kind of puzzles me because from what I can see here the accumulative stock of equipment was rising faster until 1957 and then rose about even with the stock of plant, which makes the matter a little bit curious, at least since this is the overall private economy in the Terborgh series which I have here in front of me, so this makes the statement a little bit puzzling.

I would appreciate it if you would clarify it a little with some numbers for the record.

Dr. COHEN. I would be glad to.

(The information requested follows:)

Upon reexamination of the available materials, including the study prepared at the Department of Commerce (Survey of Current Business, November 1956), we find that the tendency in manufacturing was not toward more plant in the postwar period. However, in the context of the presentation, the evidence for the whole economy does suggest that the proportion of new plant to equipment in the postwar period rose from what it was in the 1930's. According to the

national income tables (in 1954 dollars), the proportion of nonresidential construction to total capital goods outlays ran at 35 percent in the years 1931–40, while from 1948 to 1957, the corresponding proportion was 49 percent. More important still is the discounting by Fortune of Kendrick's finding of a 1 percent efficiency factor obtained for the period 1899 to 1953. (See his "Productivity Trends in the United States," Princeton University Press, 1961, and Solomon Fabricant, "Basic Factors on Productivity Change," 1959, p. 5.) What impressed Fortune was the discontinuity which took place from 1929 to 1948, when gross physical output per weighted unit of tangible capital rose by 2 percent per year. It leveled off from 1948 to 1953, and actually fell from 1953 to 1957; all told it has actually been declining since 1948. Clearly, the 1 percent factor obtained from averaging the entire period 1889 to 1953 could not be used for projections in the 1960's.

Senator PROXMIRE. Thanks again, very much.

Dr. COHEN. Thank you.

Senator PROXMIRE. We are privileged to have both Mr. Roye Lowry, representing the Federal Statistics Users' Conference, and Mr. John Norton, who I understand is in the same capacity, although he is with the National Planning Association. I also understand Mr. Lowry will make the presentation and both you gentlemen are willing to answer questions.

Mr. LOWRY. Yes, sir.

STATEMENT OF ROYE L. LOWRY, EXECUTIVE SECRETARY, FEDERAL STATISTICS USERS' CONFERENCE; ACCOMPANIED BY JOHN D. NORTON, ASSISTANT DIRECTOR, PARM PROJECT, NATIONAL PLANNING ASSOCIATION

Senator PROXMIRE. All right, Mr. Lowry, why don't you go ahead and take the microphone?

Mr. LOWRY. Thank you, Mr. Chairman.

I am Roye Lowry, the executive secretary of the Federal Statistics Users' Conference.

The Federal Statistics Users' Conference is an organization of over 150 business, farm, labor, and nonprofit research organizations which use Federal statistics and are interested in their improvement.

The Conference is very grateful to have this opportunity to appear before you today. Although we would like to include in the record a paper which has been prepared for FSUC members by John D. Norton of the National Planning Association staff, ours is not primarily expert testimony. Rather, it is an expression of the views of users from all sectors of the economy who are seeking information to assist them in making decisions on a wide variety of matters.

It is quite easy to summarize users' views on capacity statistics: there is a broad interest in data directly or indirectly related to capacity or capacity utilization; almost anything that seems to be related to the subject is used; there is a general feeling that present data are inadequate; and users really aren't sure what needs to be done about it.

Members of FSUC's Committee on Long Range Improvements in Federal Statistics for some time have wanted to stir up discussion about capacity statistics among our members. FSUC asked Mr. Norton to prepare a paper to help stimulate this discussion. When this committee's hearings were announced it was obvious that we would have to obtain views of members more quickly if we were to be helpful

to the committee. We thereupon went to our members with a questionnaire designed to get some indication of the extent of interest in capacity statistics, the purposes for which such data are used, the degree of satisfaction with existing data, and what, if anything, should be done in the Federal Government's statistical program to improve information in this area.

From replies received it is clear that there is a broad interest in capacity data, and that there are many users in all sectors of the economy who find this kind of information valuable for their purposes.

Those who use or try to use capacity data are looking for information to be helpful for a wide variety of purposes. Among these are: Economic projections, estimated future capital requirements, forecasts of plant and equipment expenditures, forecasts of price behavior, forecasts of transportation requirements, location studies, and broad, unidentified economic analysis and market studies.

Most users try to find something in Federal statistics to help them. Federal Reserve data are most widely cited, but users also refer to a great number of other sources. Among these are: Bureau of Mines data on refinery capacity; Office of Business Economics estimates of plant and equipment expenditures; and Census of Manufactures data on production, shipments, and company statistics.

There were also a number of isolated references to other specific series and also references to unspecified Federal sources of production or shipments data. In short, users seeking capacity information will use anything they can get which seems likely to have some bearing on the problems with which they are dealing.

Another indication of the willingness to use a wide variety of materials is to be seen in the response from FSUC members that they accept data with either a "technological" or an "economic" concept of capacity. There are few purists who insist on either one or the other of these concepts. This is not because users are indifferent to these conceptual differences; rather, it is an example of making do with what is available.

Most FSUC members who use capacity data find the available information inadequate for their needs. Their principal complaints center on the lack of a consistent definition or concept of capacity, lack of coverage, and lack of detail in existing data.

By about 2 to 1, FSUC members feel that there is a need for a greater degree of Federal activity in this area. When pressed further, they are vague as to what they would like to have the Federal Government do and seem generally to feel that Federal activity should be rather limited.

If there is a hazy outline of a consensus it is this: the greatest contribution the Federal Government could make would be to work with private groups to develop some generally agreed concepts of what capacity is. Users do not appear to be committeed to any particular concept of capacity, but they would like to see the Federal Government, in cooperation with private groups, raise a standard to which wise men can repair.

Mr. Norton has prepared for us a very detailed paper looking at capacity statistics from a different point of view than the other presentations which have been made and suggesting the potential ability

to get some information from the Census of Manufactures. Mr. Norton has prepared this for the conference. It is not an official document of the National Planning Association. It is prepared for discussion among members of the conference, and it doesn't represent a conference position either. It is, I believe, a stimulating contribution to the general discussion, which is the purpose for which it was intended.

This was completed only a couple of days ago. Mr. Norton is with me and I am sure that he would be pleased to give you a summary of the paper and to answer any questions about the paper which you may care to ask.

Senator PROXMIRE. Yes, we would like very much, Mr. Norton, to have you give us a summary of this and I would appreciate it if you would do so, at least in part, on the basis of the points raised so well by Mr. Lowry.

Incidentally, Mr. Lowry, this is extremely useful to us. This is exactly the kind of approach and the kind of attitude which is most helpful to this committee, and your inquiry among the statistical users gives us the direction, even though we are both disappointed in the adequacy of capacity now. It does give us a direction which is very helpful.

I would like to ask Mr. Norton to bring these points into his summary, if he could say that the principal complaints are lack of a consistent definition or concept of capacity, that is, the extent to which such a definition can be developed perhaps; lack of coverage—any feeling you have on what may be done about this—and lack of detail.

Mr. NORTON. I would like to say again that I am here as an individual and the opinions expressed are my own, particularly are not those of the Office of Emergency Planning with whom the National Planning Association works under contract.

My paper is concerned primarily with the measurement of industrial capacity at the establishment level, that is, the point where most of our basic economic statistics originate. Therefore, it deals with problems which are different from those discussed previously in these hearings.

This is a long paper so I would like to concentrate on three points: First, to suggest that this is a time where the Government might do more in the way of direct collecting of capacity statistics than heretofore; second, to suggest that for the manufacturing sector the quinquennial census and the annual survey are the appropriate media; and, finally, to suggest that there are possibilities for analysis in depth by use of modern computer techniques which can greatly expand our knowledge of the capacity problem if the additional capacity questions suggested are incorporated in the census.

Senator PROXMIRE. Let me just interrupt for a minute to say that all of these, you feel, should be accomplished by the Federal Government, certainly the first two, and also the analysis and depth computer techniques you think are appropriate functions?

Mr. NORTON. Yes, sir. As I will point out later these involve statistical analysis of individual returns and these are confidential and could only be analyzed by the Census or Census agents in some other department of Government such as the Office of Emergency Planning where census work is done, but under supervision of members of the

staff of the Bureau of the Census. I might say, also, that as a user of statistics, my experience is somewhat different from other speakers in that I have been concerned in our present project and in previous projects with the statistical implementation of large, detailed mathematical models of the economy, so we are in this particular model forced to develop estimates of capacity for something like 250 industrial sectors into which the total economy is divided.

In this connection we have made a search for available capacity statistics and they are summarized in tables 1, 2, and 3, which appear in my statement.

You will note that there are 1,076 five-digit product classes in the Census of Manufactures and for 343 of these we have been able to find some capacity data. Two hundred and one of these are reported completely for the five-digit product class; the others are reported only in part. They have attempted to evaluate this in terms of a value of shipments of the industries so represented.

Unfortunately, there is a slight discrepancy in the basis on which tables 2 and 3 were prepared. It was convenient to use the four-digit summaries for the value of shipments for the corresponding industry groups. In this case we have included as available a capacity report for any four-digit industry or any part thereof. In table 3 we indicate that 32 percent of the value of shipments in 1958 are represented by recent capacity statistics. This undoubtedly exaggerates somewhat the availability, although it is greater than the 19 percent represented on the basis of complete coverage at the five-digit level in table 2.

Senator PROXMIRE. Do you feel that the important thing is to get complete coverage, or is the important thing to get sufficiently representative coverage or sample coverage in each industry so that you can make a judgment, or do you feel that it is difficult for various technical reasons to get an adequate sample?

I notice, for example, in this chart you have a number of industries in which the percent covered at the five-digit level is zero and percent covered zero also for four-digit industries.

Mr. NORTON. There is a sampling problem involved. There is no coverage on the apparel industry, for example.

Senator PROXMIRE. What I am getting at is, if you had maybe 20 percent covered in some of these industries which have no coverage at all would that be quite satisfactory? Would you be moving into a situation where you would have pretty much what you needed, or do you feel you have to get all of them close to 100 percent?

Mr. NORTON. I would feel that coverage would be desirable for all establishments included in the certainty sample of the annual survey of manufactures, which includes plants of 100 employees and over. I think very small samples below that level would be quite adequate for the purpose.

I should say that, although I am not speaking in this capacity, my experience and my immediate interest in this problem is connected with the problems of planning for the Government in the event of a possible nuclear attack. For this purpose it is, I think, essential that we have the capability in the Government for creating a simulated census of the surviving resources. For this purpose the National Resources Evaluation Center, which is maintained by the Office of Emergency Planning, has a file of something like 100,000

resource points representing agricultural, banking, manufacturing, mining, transportation, utility, and warehousing establishments. Since we cannot anticipate where postattack bottlenecks may occur, we should have some representation of the capacity of all industries represented in this file so that a computer estimation can be made quickly and the capacity represented by the surviving establishments can be determined according to the industries in which they operate.

Senator PROXMIRE. Has the Defense Department indicated any interest in this, or any sense of responsibility for it, or anything of the kind?

Mr. NORTON. To my knowledge, their concerns are what they have always been; that is, concerned with the capacity of the military end item industries and critical components and materials. The responsibility for industrial mobilization and planning as a whole has remained in the Executive office with OEP and insofar as I know, this general interest has not been manifested——

Senator PROXMIRE. There has been no discussion with Defense officials?

Mr. NORTON. I cannot say as an employee of a contractor just working for the Government.

I feel that we are with respect to capacity statistics very much in the position in which we were in the 1920's with respect to labor force and unemployment. Although we all recognize shortcomings in the present estimates of the labor force, I think that we are very much better off in all measures of economic performance because we have a direct measure of the labor force which was not available at that time. I feel that something can be done in the way of direct measurement now of capacities to provide us with a similar basis for our economic indicators.

In the absence of this, I think we are forced to utilize what impolitely might be called "Rube Goldberg statistical devices" to come up with estimates by indirect means. I have suggested in the final part of my paper that the annual survey of manufactures and the quinquennial census, provide the appropriate media for collecting this information.

I confess to some difficulties in understanding what the meaning is to questions of the McGraw-Hill type, when addressed to the General Electric Co., for example. What is the meaning of the capacity of the General Electric Co? Is there any one individual who assembles that kind of data companywide? I feel less difficulty about such question addressed to the establishment level.

The manager of the Bridgeport small appliances plant may very well be able to give a meaningful statement in terms of dollars in a given product mix for the maximum potential output of his particular plant. I also point out in my paper, that we have a demonstration of the feasibility of this approach, which occurred in 1952 when the Bureau of Labor Statistics attempted a survey of maximum potential employment for the metalworking industries. This is the most comprehensive and the most carefully carried out of all Government surveys to date, relating to capacity. Similar questions could be raised for maximum potential output at the plant level.

I feel that in order to get usable answers to capacity questions it is necessary to be very specific about the conditions to which they apply.

This forces us to choose two alternatives, either to make a very elaborate separate questionnaire, or to introduce capacity questions in a more general questionnaire in which these details are already spelled out.

This suggests that the Census of Manufactures does provide the kind of background to make the necessary interpretations for a reasonable estimate of capacity.

There is a further reason in my judgment why this is desirable. The economics of computer operations upset preconceptions of what is feasible in inquiries of this sort. Arithmetic has become very cheap. Once a return has been transcribed on to magnetic tape most of the cost consists of passing the tape through the machine. For example, it would now be feasible to obtain the mean and standard deviation of every published figure at little additional cost.

More to the point is that it would be possible to examine many cross-relationships, to compute simple and multiple regressions, and to perform tests of significance. For example, if this procedure were followed it would be possible to determine the available capacity of plants in terms of the ratio of book value to accumulated depreciation, which is a proxy for the average age of the capacity installed in the plant.

Another possible variation would be to get capacity for plants with a definite ratio of total cost of materials to value of shipments. Many such cross-relationships could be developed which would quickly expand our knowledge of the status of existing capacity and the prospects for investment in particular industries.

There is, however, one condition which is essential to obtaining this kind of analysis from the census. The information for which these cross-analyses are to be made must be present on the same tape. At the present Census of Manufactures for 1958 is available only on six separate sets of tapes. For our immediate purpose to compute input coefficients we have had to merge tapes at considerable extra cost.

In another census year it probably would be possible to make a cross-analysis at the time each return was examined as a whole. In the course of machine editing procedures on the tapes the extraction of information necessary for computation of single and multiple regression analyses and other sums of cross-products and statistical measures can be performed. For this purpose it is not necessary to have all the acceptable schedules present for all the establishments in an industry.

The product moments for the individual establishments can be accumulated for the acceptable part and revised schedules can be added later. I feel that we are really at the threshold of a major breakthrough in statistical analysis. So far the design of the Census of Manufactures reflects largely the age of the Hollerith machine and is not really reflective of the new capabilities of modern computers. I feel that we must reexamine our concepts of statistical integration. With this possibility in mind we might consider the possibility of bringing more information together on the same schedule, and not making so many separate inquiries of the same establishment in different questionnaires circulated at different times.

Senator PROXMIRE. Mr. Norton, thank you very, very much. I think this is very helpful. This is the kind of information this com-

mittee perhaps can do something about when you point out that as to General Electric which you took as an example, the individual plant could give a far more statisfactory, more precise, and responsive reply on capacity than if you asked some top corporation official who would have to, of course, make an economic rather than an engineering estimate, and the census could make quite a contribution on the basis of your own expert testimony here this morning.

I want to make sure that I understand what you are talking about on capacity and its usefulness in the various definitions you have here. You say:

> Capacity is strictly a relationship between throughput and facility during a specified time interval.

You go on to say:

> A facility may have such a capacity even though none of the requisite input items is actually available.

The availability only becomes relevant when demand develops, and so on.

You emphasize emphatically that what you are talking about largely is a technological or engineering concept. When you get over to the economic aspect of it, however, you don't dismiss it. You indicate it is useful, but that the subjectiveness, apparently of this concept, makes its utility unsatisfactory, at least for your purposes and what you say here is that the measurement problems implicit in this definition—this is your definition of economic capacity, relating it to preferred operating rate—are greater than those expected with physical capacity.

> These difficulties preclude its use at present, except as an internal management tool. Practical application of the economist's definition on a broad front seems remote.

Well, in addition to its usefulness as a management tool, isn't it useful in terms of public policy also perhaps in giving us some notion of, for instance, investment expectations, also in terms of the stage of the business cycle, and so forth? Isn't it useful in that sense, also?

Mr. NORTON. I find the concepts all very helpful and I would say that they help us to interpret the significance of capacity based on an engineering technological definition. There is a somewhat different problem in my judgment connected with the problem of the aggregation of capacity which Professor Klein particularly stressed yesterday. I am concerned about using these estimates in large mathematical models and for this purpose we want to test a given capacity against given stipulations of final demand.

The problem of the balance among industries is handled explicitly from the demand side. I feel that models of the type we are developing can be used to aggregate capacities over groups of industries and over the economy as a whole, and I believe this approach will be attempted by Professor Klein in the model which he is working on under the auspices of the Social Science Research Council. We will, speaking now for the National Planning Association, probably make proposals to the Office of Emergency Planning for a computation of aggregate capacity indexes using the model which is being designed for them, but I think it is premature to say much about that prospect at this time.

Senator PROXMIRE. On the basis of your very extensive and detailed report here in your study and your thought about this thing do you foresee any practical difficulties for the census, any substantial objections, legitimate objections, on the part of respondents to the census that might stand in the way of this comprehensive survey that you are suggesting?

Mr. NORTON. Well, I am afraid it is probably too late for the 1963 census and I would anticipate strong objections from the Census at this time for inclusion in the census in the full detail which I have described. There are, of course, difficulties with any new type of questionnaire. The Census probably would be reluctant to introduce it without a good many pilot studies and, certainly, indoctrination of business respondents on the nature of the question.

I do think that the experience of the Bureau of Labor Statistics in their one-time survey of the counterpart maximum potential employment suggests that it is feasible, and I don't see that there should be much difference in estimating maximum potential employment and maximum potential output in dollar terms, for physical units are not appropriate, given the specifications of the conditions under which the question is to be answered, such as provided by the census return as it now stands.

Senator PROXMIRE. Mr. Knowles tells me that this is a 5-year situation and could be in 1963 or 1968 so that the 1963 factor doesn't have to be too much concern to us.

One other question. Do you feel that the concept of capacity can be sufficiently simplified in the questions so that the people who employ more than 100 persons, which I take it is where you would have comprehensive coverage, would be in a position to give an accurate answer?

Mr. NORTON. I believe that is true.

Senator PROXMIRE. All right, sir. I want to thank you very, very much and also I want to thank Mr. Lowry and Dr. Cohen. This has been a very educational morning for me. I have learned a lot and I think that the material that we have for the record has been very helpful to the committee and constructive. I hope, on the basis of these suggestions and with the response we will get tomorrow from Mr. Bowman we may make some specific progress. If you want to make an additional comment, go right ahead.

Mr. NORTON. My assistant has just handed a comment to me which is pertinent to one of your earlier questions, Senator. He notes that in the available statistics on capacity something like 30 different definitions of physical capacity are being used in both private and Government reporting media.

Senator PROXMIRE. Thirty different definitions for physical capacity are used?

Mr. NORTON. Yes, sir.

Senator PROXMIRE. That indicates a pretty enormous problem for us before we can actually get the statistics in usable form from these tens of thousands of respondents and process them and so forth. Thank you very, very much. Thank you, gentlemen.

The committee will resume tomorrow morning at 10 o'clock when we will hear from Mr. Frank deLeeuw and from Mr. Raymond T. Bowman.

(Mr. Norton's statement, prepared for the Federal Statistics Users' Conference, follows:)

CAPACITY STATISTICS: PROBLEMS AND POTENTIAL, BY JOHN DEWITT NORTON, ASSISTANT DIRECTOR, PARM PROJECT, NATIONAL PLANNING ASSOCIATION, MAY 23, 1962

Introduction.
I. The concept of capacity.
II. The measurement of capacity.
III. The reporting of capacity.
IV. Census potential.
Appendix A: 1958 Census of Manufactures—departmental list.
Appendix B: Maximum potential employment forms.

This paper has been prepared at the request of the Federal Statistics Users' Conference. Although based largely on work performed by the National Planning Association under contract CDM-SR-59-39 with the Office of Emergency Planning, the opinions are the sole responsibility of the author. The contents have not been evaluated, nor do they necessarily reflect the policy of either the National Planning Association or the Office of Emergency Planning.

INTRODUCTION

This paper is concerned primarily with the measurement of industrial capacity at the establishment level; that is, at the point where most of our basic economic statistics originate. Thus, it deals with problems fundamentally different from those involved in efforts to impute capacity at the level either of the company or of industry aggregates such as the McGraw-Hill, Wharton School, or NICB series. The labor and ingenuity which such roundabout measurements represent should not be belittled. Nevertheless, I believe that the development of Government statistical reporting has progressed to a stage at which direct reporting of capacity at the establishment level is both feasible and expedient.

For purposes of business decision making and Government policy formulation, there is widespread concern with the improvement of measures of economic performance. The past 30 years have been marked by an extraordinary development in the variety, reliability, and frequency of such statistical series. There remains, however, a conspicuous gap: statistics on the capacity and utilization of industrial plant and equipment. In our economy, rapid expansion is dependent on a higher and more continuous utilization of the capacity of the investment goods industries. The presumed overexpansion of the middle fifties, subsequent underutilization, and postponement of further expansion, is a piece of economic history which underlies the need for adequate and timely information on capacity.

With respect to capacity and utilization statistics we seem now to be in much the same position we were in with respect to labor force and employment statistics in the twenties. Meanwhile, circumstances have changed. White collars replace blue collars in the work force. The proportion of direct production workers declines. Personal income is the most steadily rising component on the economic horizon. As automation is applied more extensively, measures of capacity

utilization could become a most telltale indicator of general economic performance.

The professional preoccupation which underlies this paper, however, represents a different requirement for capacity statistics. For several years I have been engaged in the development of procedures and data to be used in planning for economic recovery in the event of a nuclear attack.

Capacity has always been a key concept in mobilization planning. The possibility of massive destruction to home-based resources makes the advance measurement of capacity a necessary condition of effective preparedness in the cold war. Under postattack conditions, prompt identification of industrial bottlenecks, and the rapid preparation of detailed schedules for the decontamination, restoration or construction of the required facilities will be crucial. Prior to attack the bottleneck industries cannot be identified in adequate detail by any probability calculus because of the diversity of possible attack patterns. Preparedness thus requires advance knowledge of the capacities of all industries, by establishments, by geographic location. Only on the basis of periodic preattack reports on the status of capacity will it be possible to estimate quickly the surviving capability of the economy.

This paper describes one approach to capacity measuresments and outlines a program which would provide the statistics required for this purpose. If preattack planning is taken seriously, a major breakthrough in the field of capacity statistics could result.

Unfortunately, this goal cannot be achieved without imposing another statistical chore on an already burdened business community. Nevertheless, compilation of the required data need not go uncompensated. The additional understanding of the peacetime economy which a new program of capacity statistics could bring can, I believe, be justified on its immediate advantage to decisionmakers in business and government.

This paper is written in the hope that the indicated feasibility and usefulness of capacity measurement at the establishment level will generate support for an extended and better integrated peacetime program.

I. THE CONCEPT OF CAPACITY

At the outset distinguish the capacity to store, from the capacity to process, as illustrated by the capacity of a tank and the capacity of a pump. We will be concerned here primarily with process capacity.

Let us define capacity (C), generally and in the abstract, as the maximum of the ration of the flow of goods and services (s) to the processing facility (f) per unit of time (t):

$$(1) \qquad Cf = \text{maximum } \frac{s}{t}$$

(Formulas will be used here chiefly for mnemonic convenience.) We will now consider the concept of a maximum and each of the terms which enter into this definition. Many difficulties will come to light which must be taken into account in any practical definition of capacity.

1. *Maximum.*—First consider the simplest case. A constant force is applied in the operation of a small pump. Performance is indicated

by the throughput per unit of time. By varying the application of force, the maximum throughput of the pump could be determined. As the force is increased experimentally, the throughput would increase until the pressure thereby created in the chambers of the pump caused a breakdown. The maximum rate of throughput is obviously some rate of operation short of the point of actual breakdown which would allow a margin for safety. This may be called the pump's rated capacity and is a matter of engineering judgment.

2. *Flow of services.*—It is convenient to distinguish the flow itself and the items on which the flow is composed. The term "throughput" will be used to avoid any premature commitment as to the flow in or out of the process.

The throughput of our illustrative pump could be continuous, as it might be in raising water from a deep well; it could be a batch operation, as when used to empty a single tank; or it could be interruptable, as when used to meet an irregular demand.

The throughput could be measured with reference to the output—a tank filled; or to the input—a tank emptied. If no leadtime is involved or the quantity is not diminished in the process, the throughput per unit of time is the same measured either way. If the loss is a constant amount, the throughput can be expressed in input or output equivalents by application of the appropriate factor. This equivalent basis of measurement is also applicable when the throughput in fact transforms an input item to a different output item.

An output flow may consist of a single, relatively homogeneous item. But it is likely to be a composite, a product mix. The mix may be in fixed proportions or it may be variable. On the input side there is always a mix. In some cases there may be a dominant input item, as crude oil into petroleum products. The associated inputs, however, may not always be invariant to changes in the composition of output.

3. *Facility.*—The name of this term is chosen for its generality. It may refer to an isolated machine or piece of equipment, or it may refer to the whole complex of processing equipment in a single establishment, or even to some company or industry aggregate thereof.

A facility may be single purpose: devoted to processing a dominant input or a single output item. It may be general purpose; capable of processing a variety of different inputs or outputs.

A facility may be a single stage or multiple stage. The latter refers to a sequence of processes with identifiable outputs at each stage. A facility may also comprise two or more processes which are carried on simultaneously, as the joint operation of a motor and a pump.

4. *Time.*—A facility which is available for 100 percent of its service life is exceptional. In general it must be shut down for repairs and maintenance for some portion of the calendar time. Similarly, a facility may be shut down part of the time because prevailing custom or conditions preclude full utilization of the available time. Capacities may thus be quoted either on the basis of calendar time, or available time, or time utilized.

5. *Independent capacity.*—The inputs to a productive process do not appear as such in the general definition (1) given above. Capacity is thus by definition independent of the availability of inputs whether materials, supplies, containers, energy, or manpower. Capac-

ity is strictly a relationship between throughput and facility during a specified time interval. A facility may have such a capacity even though none of the requisite input items is actually available. The availability of input items becomes relevant only with reference to the satisfaction of demand. Shortages of input items, as well as capacity, may make some demands infeasible. Infeasibility and capacity, however, are separate concepts. The interjection of supply considerations, or feasibility questions, in the definition of capacity not only confounds measurement at the level of greatest disaggregation, but may complicate or defeat efforts to aggregate capacity at higher levels.

6. *Balanced capacity.*—Consider the case in which output consists of the flow of a homogeneous commodity. Processes producing this flow which operate either simultaneously or in sequence may be matched in the sense that the maximum throughput of no one component process is greater in equivalent terms than any other. Approximately balanced capacity so defined is more frequently found in continuous process or highly automated industries. The capacity of a balanced combination, like a single process, may be determined from engineering considerations. A rated capacity may indeed be designed into it.

Now consider the case of a facility which turns out multiple items, each of which utilizes two processes but at different rates. If the outputs always appear in fixed proportions, balanced capacity may be designated into the facility. But if the output occurs in variable proportions, the possibility of a balanced process-mix becomes uncertain. No doubt, on the assumption of a satisfactory composite product, queueing theory could prescribe an appropriate combination of processes.

7. *Bottlenecks.*—Multiple process facilities which are completely balanced are also exceptional. Built-in excess capacity may be encountered in the coupling of any two machines. The output of the combination is limited to the output of the bottleneck machine. The capacity of any multiple process facility, whether at the shop, department, or establishment level, is limited to the capacity of the bottleneck component. One useful rule for determining capacity is: Look for the bottlenecks.

8. *Status of facilities.*—In appraising the capacity of any collection of similar facilities, it is appropriate to differentiate capacity in use, standby capacity, and shutdown capacity. The distinction between the latter two is perhaps a matter of degree, but at the extremes capacity may be earmarked for use in state contingencies or may await salvage.

The serviceability, age distribution, and condition are pertinent in determining the status of facilities. A facility may represent best current practice, or it may be obsolescent or obsolete. Age may presumably be determined from records. Condition may be new, operational, repairable, or at least salvageable. Status that takes account of all relevant factors may not be objectively determinable.

9. *Preferred operating rate.*—Objection may be taken to the definition of capacity introduced initially. It could be called an engineer's definition. Economists, though recognizing the difficulties of statistical implementation, are likely to suggest a definition in terms of an

optimum operating rate such as the minimum point on the short-run average cost curve:

$$C_t \equiv O_t \equiv \text{minimum } \frac{i_t}{r_t}, \tag{2}$$

where (c) is capacity, (O) the optimum rate of operation, (i) the cost of inputs on current account, (r) receipts, and the subscript (t) refers to the time interval.

The measurement problems implicit in this definition are greater than those connected with physical capacity (l). These difficulties preclude its use at present except as an internal management tool. Practical application of the economist's definition on a broad front seems remote. I am afraid that the identification of capacity with the optimum rate of operation implicit in the economist's definition tends to keep matters confused. The practice of the McGraw-Hill survey which distinguishes sharply between capacity and the preferred rate of operation is to be commended.[1] The preferred rate as used there may be interpreted as a relaxed, if somewhat more ambiguous, optimum rate.

10. *Economist's definitions.*—Although the economist's definition cannot be successfully implemented at present, it contributes to the interpretation and suggests reservations concerning the physical capacity definition which needed to be kept in mind. In this context two variations on the previous definition may be considered.

Definition (2) has certain theoretical shortcomings. Since in some industries shortrun average costs in the neighborhood of the minimum may be virtually constant over a considerable range of output, the definition does not really indicate an optimum rate.[2] This is shown in figure 1.

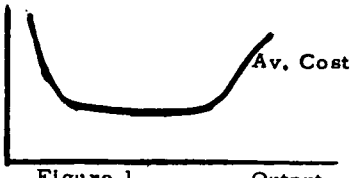

Figure 1

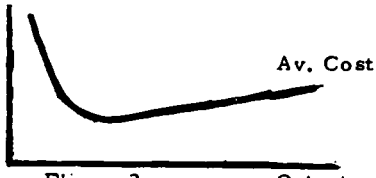

Figure 2

Moreover, industries differ markedly in the rate at which costs increase once the point of minimum average cost has been passed. A manufacturer with a sharply rising curve, as in figure 1, cannot be expected to operate appreciably beyond the turning point. A manufacturer whose costs rise only gradually, as in figure 2, may find it expedient to absorb the extra costs and operate beyond the minimum point temporarily, or even for extended periods, if he does not anticipate a permanent increase in demand. His effective capacity is therefore greater than his optimum rate of operation. De Leeuw has recently suggested a revised definition which takes these difficulties into account:

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[1] Business Plans for New Plants and Equipment 1961–64, 14th Annual Survey Department of Economics, McGraw-Hill Publishing Co., New York, 1961.

[2] cf. (1) Lawrence R. Klein, "The Measurement of Capacity," Cowles Foundation Discussion Paper No. 49. (2) Joel Dean, "Managerial Economics," New York, 1951, p. 304.

(3) $$Ct \equiv Ot + aOt,$$

where (a) is a factor determined by "the level of output at which short run marginal costs are "X" percent above minimum short run average total costs." [3]

This contrasts with what may be called the trigger point definition which is intended to indicate the level of output at which the expansion of capacity is called for.

(4) $$Ct \equiv Ot - bOt,$$

where (b) is a factor reflecting reserve desired to meet fluctuations in demand.

These definitions help to clarify important issues. However, the attempt to crowd them all under the capacity concepts tends to create confusion and so blunt the effort which could be made to get on with the measurement of physical capacity.

11. *Explicit definition.*—The discussion so far has been very general. The definition of physical capacity (1) proposed is implicit in the sense that the terms have not been applied to specific situations. Enough complications have been introduced, however, to indicate that no single, all purpose definition of physical capacity seems possible. Explicit definitions have to be tailored to the conditions which pertain to particular products or establishment groups.

II. THE MEASUREMENT OF CAPACITY

Measurement (is) the assignment of numerals to objects or events according to rule—any rule.[4]

Capacity is not directly observable. Its measurement depends on an appropriate set of rules. The uncertainty and ambiguity which abounds with respect to capacity may be traced to the lack of an accepted set of rules. This is a not unfamiliar situation. The income of an enterprise is also not observable. Like capacity, income is an intellectual construct. But unlike capacity, the rules involved are so widely accepted that they are taken for granted. It was not always so. Not only the Internal Revenue Service, but the entire accounting profession as well, exist to assure the reasonable comparability of income measurements. Doubtless the concept of income would not play such a crucial role in private and public decisions if the applicable rules did not exist and were not observed.

1. *Objectives.*—In designing rules for the measurement of capacity, the first consideration is the purpose they are to serve. Capacity estimates are useful chiefly for four reasons:

To assist in the assessment of economic performance.

To indicate approximately at what point in the expansion of output additional capacity may be required.

To provide a base for testing the feasibility of demand projections.

To assist in isolating a major factor in productivity changes.

Moreover, each of these may be a matter of concern with respect to a machine, a process, a department, an establishment, a company,

[3] Frank De Leeuw, "The Concept of Capacity," 1961 Proceedings of the Business and Economic Statistics Section, American Statistical Association, pp. 320–329.

[4] S. S. Stevens in "Measurement: Definitions and Theories," edited by C. West Churchman and Philburn Ratoosh, New York, 1959.

an industry, or the economy as a whole. Note that while the same estimate may be used for any one of these purposes, the refinement and accuracy of the estimate required depends on the level at which it is to be applied.

In general, the relationships involved are quite simple. One index of economic performance is the capacity utilization ratio.

$$P_f = \frac{s}{C}, \tag{4}$$

where (P_f) is the performance of the facility and (s) and (C) are defined as in expression (1). Investment may be called for when demand (d) is greater than or equal to capacity.

$$D \geq C. \tag{5}$$

Projected demand will be feasible if less than or equal to capacity.

$$D \leq C. \tag{6}$$

As in the previous discussion these symbols take on more explicit definitions in the specific contexts in which they are used. As noted earlier, expressions (5) and (6) may need an additional term to denote decision points either above or below stated capacity. However, physical capacity implies a limit or bottleneck, so these qualifications apply more to economist's definitions and to the interpretations of physical capacity which their definitions suggest.

In part, productivity is a function of capacity utilization. In productivity analysis it is important to differentiate the effects of this factor from other factors such as training of employees; vintage of technology, depreciation and maintenance of equipment; and labor, capital and energy per unit of output.

2. *Standards.*—The adoption of a classification scheme, the designation of the appropriate respondent, the development of the requisite procedures for estimation, are all steps designed to assure the comparability of capacity statistics. The definition, elaboration and acceptance of standards is the essence of the problem of capacity measurement. Free choice in these matters would yield results which would not add up. Replies to questionnaires could be so bewildering as to be virtually useless, except to the individual respondent.

This is not to suggest, however, that standards are to be applied uniformly to all establishments in all industries. The applicable standards must discriminate among situations which are substantially different. Indeed, it is precisely the failure to discriminate, to attempt to treat by identical means situations inherently different, that leads to ridiculous, or at least discredited results. This undoubtedly means that, in practice, the respondent on his side must tolerate answers which seem to him extremely crude, and the economist on his side must be ready to support an approach which seems unusually detailed.

3. *Classification.*—The starting point on the road to comparability of capacity statistics is classification. With respect to the stream of goods and services (s), adequate classification schemes exist in the Census 5-digit product class or 7-digit product codes. However, the outputs of only a minor portion of the codes, even at these disaggregated levels, are sufficiently homogeneous to be stated in quantity

terms. Strictly speaking, engineering estimates of capacity are restricted to cases in which measurements can be made in physical units. In the past, capacity statistics have tended to be available only for industries in which such measurements are possible. All other outputs involve product-mix and dollar valuation problems.

The use of deflators and other rules for converting to constant dollars do not need separate discussion here. But several comments on product-mix can be made. Where the mix is of fixed proportions, the problems washes out; the composite serves as well as a homogeneous product. For some purposes, a dominant input item, such as crude oil into petroleum refining, may be taken as an adequate indication of the flow. This approach can be generalized to all cases in which the input mix is substantially invariant to changes in the composition of output. It will often be true, particularly at the 5- and 7-digit level of classification, that output expressed in constant dollars will provide a sufficiently good approximation. The case for treating the flow, expressed in constant dollars, as practically homogeneous becomes increasingly stronger with the level of disaggregation attained.

The situation with respect to the classification of facilities is much less satisfactory. The Standard Industrial Classification is a classification for establishments by primary product. The Census of Manufactures includes a rudimentary list of departments within establishments, chiefly metalworking (see app. A, p. 114). Classification for tools and equipment exist in the Standard Commodity Classification and the Federal Supply Catalog. The former seems to have been little used and the latter is elaborated only for items which enter into Government procurement.

A simple classification of facilities in one dimension, by product, is insufficient. It must be supplemented by a second dimension, comprising major process or department. Departments are defined by the kinds of tools and equipment which they contain. Establishments processing the same primary product may not be alike in the departments they contain, and departments of the same name in different establishments making the same primary product may not be alike in the tools and equipment employed. Unfortunately, the process analysis approach to capacity at the equipment item level proliferates too much detail to make it a practical means of capacity estimation at present. But a qualitative classification of departments, and an approximate measure of their importance by the number of workers employed, seems feasible.

Another basis of classification, age of facility, often merits consideration. In some cases, facilities identical except for age, may have significantly different capacities. This may merely reflect increasing downtime for maintenance and repairs with age, or it may involve diminished capital productivity, over and above the attainable by normal maintenance and repair, during the service life of the facility.

Regardless of the adequacy either of one or of all of these classification schemes, there is a difficulty common to all of them: A basis is often lacking for summarizing the availability of facilities which is independent of the objective of the inquiry itself, namely, the capacity of the facility. Capacity may be the only practical unit in which to measure a collection of a given category of establishments. That is,

facilities are often so dissimilar that they cannot be meaningfully totaled in units of themselves.

One possible common basis for the measurement of facilities needs to be mentioned here. The stock of facilities (or capital) may, indeed, be measured in terms of original cost in constant dollars, less depreciation. This provides a basis for the aggregation of capacity over establishments and even industry groups. Although it involves serious shortcomings of its own, it also provides a valuable, corroborative approach to the problem of capacity measurement. A discussion of the collection of data for this purpose is given in section III of this paper.

One might suppose that time would pose no classificatory problems; unfortunately not so. Capacities are often quoted in revolutions per minute, kilowatt-hours, tons per year, etc. This diversity suggests the problem of the classification of time. Flow is often neither continuous or instantaneous. Output is usually intermittent with cycle of varying duration. The rule here is that it is expedient to quote the flow in units of time which are greater than the productive cycles involved: The output of aircraft carriers is not stated per second. The importance of this point is that it may frequently be easier to measure capacity flow for a short interval than a long one. Nevertheless, ordinarily it will be desirable to express capacities with respect to a common unit of time, such as a year, which accommodates most production cycles.

Often, then, capacity for the common time unit will be some multiple of the output during the measured interval. Two questions of classification need to be raised. The available time may be straight calendar time, or it may be time assigned to one or more shifts. The available time may be gross, or net, depending on whether an allowance has been made for necessary downtime for repairs and maintenance. The relevant downtime, incidentally, is the downtime over the service life of the facility. The options in its treatment are germane to the classification of time. Downtime may be taken either as a constant, or as an increasing function of age or flow.

4. *Respondent.*—Different people, to reiterate a truism, may see, interpret, and report the same event differently. No two officials of the same establishment, therefore, may be expected to furnish exactly the same measurements of an identical facility. Furthermore, their biases if not their bases of measurement may have become institutionalized. Controllers, production managers, and engineers may find different answers to the same questionnaire. Also, the answers may depend on the opportunity for measurement afforded by their respective positions. Each of these specialists, furthermore, may give different answers depending on whether he is operating at the company, establishment, or department level.

5. *Procedures.*—Even in the simple case of determining the output of an assembly line an explicit procedure is called for. In this example no more may be called for than counting and recording the daily totals in a journal. But the procedure is based upon rules, specifically in this case in the matter of rejects.

Capacity measurement is necessarily a more complex procedure involving, not an actual count, but a statement with respect often to entirely hypothetical circumstances.

In making physical measurements, it is generally convenient to use an instrument that is somewhat more precise than the precision required in the answer. A company official, similarly, in answering a questionnaire on capacity may use internal company information which is perhaps an order of magnitude more detailed than the answers he is called upon to give. He will be asked to state the maximum potential output (or equivalent) for a given facility under given conditions. The facility at sometime in the past may have operated at such a maximum. In this event he has merely to report the observed rate. It may be that the facility is one to which a rated capacity has been assigned through application of engineering judgment. This could be reported. But the maximum may be an altogether hypothetical state. The capacity will then have to be determined either by intuition or calculation. Intuition need not be lightly dismissed. If the respondent has had the opportunity to observe the facility at varied rates of operation over an extended range, he may be able to provide an estimate as good as any produced by more elaborate calculations.

In most cases calculations according to explicit rules will be necessary. The simplest case is that of a single product of a facility which must operate at 100 percent of capacity or not at all. In this instance all that is needed is an appropriate allowance for downtime. Another easy case is one which there is a conspicuous bottleneck, of which the maximum throughput is known. More generally, it will be necessary to deal with the case of multiple products and multiple-purpose facilities.

For such calculations it will be necessary to know the individual capacities of all component facilities. For many machines the only measure of capacity will be the availability of the machine itself. Under the circumstances, it will then be necessary to know the time required to process a unit of each output item. The calculation as a whole will call for a study of the process time required on each output item on the preferred and alternative equipment at all stages of processing for all end-items. An optimum machine-loading analysis would then be required based on the available facilities and their alternative uses. For this purpose it would be necessary, further, to specify a standard composition of output, defined in terms of standard lot sizes. Such an analysis, of course, suggests the framework a respondent might use to determine his answer, not the terms in which the capacity itself is to be reported.

6. *Accuracy.*—Many inherent difficulties in the measurement of capacity have been brought to light in the foregoing discussion. The practicality of the endeavor depends on the degree of accuracy sought. It must be recognized that gross approximations are involved at best. Whatever the degree of approximation, the estimates should be capable of withstanding challenge. Except for reasons of national security, the results of capacity surveys should be published. Only through the scrutiny of all concerned can necessary improvements be assured.

The degree of approximation to be sought depends on the kind of decision and the level of application. Investment decisions call for more precise measures than indexes of performance. Applications

at the level of national policy may tolerate greater approximation than at industry or establishment levels. At present it is hardly feasible to quantify these remarks by attempting to assign the corresponding ranges of acceptable margins of error. Difficult as the measurement of capacity itself may be, the measurement of error involved would be a higher order problem. However, it is futile to consider the specification of accuracy as a prior condition which must be satisfied before measurement can begin. On the contrary, it is only by undertaking actual measurements of capacity that sufficient experience can be gained to interpret and evaluate the accuracy of the results.

Although the verification of economic statistics in general calls for recourse to data more detailed than that under scrutiny, some direct checks at the same level are feasible. For example, a subsample of the reporting facilities may be resurveyed with scrupulous attention to the classifications, procedures, and professional type of respondent making the original return. The difference between the original and the resurveyed estimates would provide some indication of the confidence to be placed in the results of the original survey.

Another approach to verification is to duplicate the estimates by alternative methods. One available alternative is the capital stock-output ratio techniques to be discussed in section III of this paper. An alternative basis for measurement is sometimes regarded as a mistake because it may result in conflicting estimates and thereby promote uncertainty as to the validity of either. But this is surely a defeatist attitude based upon an uncritical, uninformed, and essentially static view of economic statistics. Discrepancies in related statistical series can, upon analysis, contribute both to the understanding of the underlying processes and to the improvement of the statistics themselves. Information theory, indeed, suggests that redundancy is the key to accuracy.

III. THE REPORTING OF CAPACITY

Experience gained from capacity surveys has often bred caution. A proponent in 1939 had turned complete skeptic in 1950, concluding "Capacity to produce is meaningful but is not measurable."[5] Nevertheless, a perhaps unexpectedly large amount of capacity data is collected and published. The introduction of appropriate safeguards should make it possible to extend the coverage.

1. *Recent coverage.*—The National Planning Association as a part of its work for the Office of Emergency Planning has made a search of available capacity statistics from both Government and private sources. For manufacturing industries it is convenient to consider the extent of the coverage with reference to the number of standard industrial classification-census five-digit product classes, of which there are 1,076. Capacity estimates have been reported for 201 of these product classes within the past 4 years. In addition, fragmentary information is available for an additional 142 product classes. The details are given in table 1.

[5] Cf. Edward Hincks, "The Capacity To Produce," Dec. 8, 1939 (processed), and a paper of the same title given at the December 1950 meeting of the American Statistical Association.

The distribution by major industry (two-digit) group of the 201 product classes for which capacity data is available is given in table 2. The relative importance of the product classes covered is shown in table 3, where the value of shipments of each four-digit industry for which any capacity data are available is indicated. Because of difference in the level of classification tables 2 and 3 are not strictly comparable. The 32 percent availability figure shown on both is a coincidence. With respect to the value of shipments, 32 percent is an obvious overstatement of the actual availability of data.

Note in table 2 that data for 102 of these product classes were not published by the Government agency or private organization responsible. Presumably it is available on request to anyone with sufficient diligence to go after it. Occasional instances have turned up in which capacity data have been collected by an agency but never tabulated. A larger body of capacity data—not included in these tables—is collected by the Defense Department and Industry Evaluation Board (Department of Commerce) which is not accessible because of a security classification. These surveys involve military end items and critical components and presumably are identified only at the seven-digit product level or by Federal stock numbers. The results of other capacity surveys have been withheld by the Business and Defense Services Administration (largely survival items, and not necessarily carrying a security classification) and by the Census (sawmills) because of poor response, or defects in survey design, and so forth.

Capacity data are collected by Government agencies for a variety of administrative purposes or for the information of the industry concerned and the public. Historical accident has a part in these responsibilities. For example, the Attorney General publishes an annual report on the synthetic rubber industry, including the latest reported capacity. The Federal Trade Commission reports capacity of antibiotics laboratories; Tariff Commission, sheet glass and mosaic tile; Tennessee Valley Authority, fertilizer; Internal Revenue Service, distilleries; Atomic Energy Commission, uranium ore milling.

TABLE 1.—*Coverage of capacity data in manufacturing by number of product classes* [1]

Number of 5-digit standard industrial classification-census product classes	1,076
Number for which capacity has recently been reported by Government agencies or private organizations, or both	343
Reported at the 5-digit level	201
Collected by Government agencies	158
Published	63
Unpublished	95
Collected by private organizations	43
Published	36
Unpublished	7

[1] Compiled by John A. Waring, Apr. 13, 1962.

Reported only at more detailed (6–8 digit), or incompletely with respect to industry or product coverage	142
Collected by Government agencies	123
Published	20
Unpublished	103
Collected by private organizations	29
Published	20
Unpublished	9
Number of 5-digit standard industrial classification-census product classes concerning which no capacity information is available at any level of detail	733
Percent for which some capacity information is available	32
Percent available at 5-digit level	19
Percent for which nothing is available	68

TABLE 2.—*Coverage of capacity data in manufacturing by major industry group (2-digit standard industrial classification), by number of product classes* [1]

[5-digit complete coverage only]

Industry group	Number of product classes						Percent covered at 5-digit level
	Total	No data	Capacity data collected by—				
			Government agency		Private organizations		
			Published	Unpublished	Published	Unpublished	
20 Food	120	70	13	30	2	5	42
21 Tobacco	4	2				2	50
22 Textiles	79	46	33				42
23 Apparel	69	69					0
24 Lumber and wood products	37	32		2	3		14
25 Furniture and fixtures	32	32					0
26 Paper and products	47	28		4	15		40
27 Printing and publishing	51	42		9			18
28 Chemicals	83	59	6	13	5		29
29 Petroleum [2]	17	(2)	(2)	(2)	(2)	(2)	(2)
30 Rubber and plastics	24	24					0
31 Leather and products	21	21					0
32 Stone, clay, and glass products	49	40	1	6	2		23
33 Primary metals	71	47	7	8	9		34
34 Fabricated metal products	70	70					0
35 Machinery, ex-electrical	110	106		4			4
36 Electrical machinery	81	66		15			19
37 Transportation equipment	42	40	1	1			5
38 Instruments, etc	26	24		2			8
39 Miscellaneous manufactures	43	40	2	1			7
Total	1,076	858	63	95	36	7	[3] 19

[1] Compiled by John A. Waring, Apr. 13, 1962.
[2] Petroleum refinery capacity (4-digit) and principal product capacity (7-digit) are available.
[3] Excluding petroleum.

TABLE 3.—*Coverage of capacity data in manufacturing by major industry group, by corresponding value of shipments in 1959* [1]

[4-digit industries]

Industry group	Value of shipments (millions of dollars)						Percent covered
	Total	No data	Capacity data collected by—				
			Government agencies		Private organizations		
			Published	Unpublished	Published	Unpublished	
20 Food	56,582	27,047	4,049	17,433	5,560	2,493	52
21 Tobacco	3,821	1,212				2,609	68
22 Textiles	13,368	5,744	7,421		203		57
23 Apparel	12,695	12,695					0
24 Lumber and wood products	8,209	4,255	625		3,329		48
25 Furniture and fixtures	5,658	5,658					0
26 Paper and products	14,119	8,154			5,965		42
27 Printing and publishing	13,357	9,604			3,753		28
28 Chemicals	26,209	13,908	10,216	151	1,934		47
29 Petroleum	15,566	1,056	14,510				93
30 Rubber and plastics	7,046	6,958	32		56		1
31 Leather and products	4,168	1,939				2,229	53
32 Stone, clay, and glass products	9,145	7,209	1,506	47	383		21
33 Primary metals	34,336	13,448	5,242		15,646		61
34 Fabricated metal	19,677	19,340	337				2
35 Machinery	23,084	22,444			640		3
36 Electrical machinery	21,480	21,031			449		2
37 Transportation equipment	31,531	31,059	472				1
38 Instruments, etc	4,958	4,958					0
39 Miscellaneous manufactures	7,442	7,442					0
Total	332,451	225,161	44,410	17,631	37,918	7,331	32

[1] Compiled by John A. Waring, Mar. 21, 1962.

NOTE.—In case capacity data is collected by both Government and private organizations, only the collection by Government is reflected above.

Apart from such special situations, most capacity data are collected by the Department of Agriculture, the Bureau of Mines, the Business and Defense Services Administration, and the regulatory agencies. In general, capacity data are not collected as a part of a systematic, periodic, and comprehensive coverage of the industries over which the agencies have cognizance. Capacity information tends to be collected in one-time surveys, irregularly, and in a piecemeal fashion.

The National Planning Association, in a forthcoming report to the Office of Emergency Planning will list all the available capacity data for a comprehensive list of mining, manufacturing, utility, and transportation industries. This will show the latest reported capacity figure, the corresponding production or shipments in 1957, and index numbers based on that year. Where capacity data is available at a more disaggregated level, this will be shown. The table will also give estimates of capacity for mid-1957 and January 1962 for all industry groups for which reported capacity data are not available. These estimates are based on an extrapolation of recent peak production as indicated in the FRB index, or on extrapolations of the maximum potential employment estimates (discussed below).

2. *Questionnaires.*—All establishments in all industries were queried on capacity in the Biennial Census of Manufactures for 1921 and 1923. The question was worded as follows:

> What is your estimate of the percentage of your output compared with your possible output if you had such a demand as to require full running time?[6]

The chief statistician for manufactures, La Verre Beales, described the response and explained why the question was not repeated again:

> Many manufacturers failed to answer the question at all, and the replies made by others indicated that they failed to understand the import of the question. The purpose was to ascertain the percent which the actual output formed of the maximum possible output which could have been produced with the equipment in place; but apparently many manufacturers interpreted the question to refer to the maximum possible output which could have been produced with such additional equipment as could have been installed in the space available. It became necessary therefore to do a great deal of estimating in order to assemble the statistics; and since the function of the Bureau of the Census is to compile and publish reliable and trustworthy statistics, not estimates of doubtful authenticity, the inquiry was dropped.[7]

Hopefully, we have learned something about the principles of questionnaire design during the intervening 40 years.

The most extensive use of capacity surveys to date occurred during World War II. So far as the questionnaires are concerned the effort is completely documented.[8] It must be remembered that these inquiries for the most part originated with industry specialists who could phrase questions and obtain answers satisfactory for their immediate purposes. For example, OPM form 3 (Mar. 12, 1941) simply asked for yearly capacity for the production of structural shapes and plates as of December 31, 1940 without definition or qualification with respect to either capacity or products. However, the catalog of WPB forms shows that questions became more specific and the assumptions to be followed in making estimates more explicit as the management of the war economy progressed.

The variety of approaches is suggested by the following list of salient points which may be covered in a capacity survey, together with examples or comments on some of the treatments used.[9] Capacity information was usually sought not in special surveys, but as a part of more comprehensive reports giving production for an immediate past period and often planned production for future periods.

Production: Occasionally, total production including production for use in the plant is distinguished explicitly from production for sale. The exclusion of rejects is sometimes mentioned. For some industries direct product, byproduct, or coproduct characteristics may be asked for, as well as lists of related products.

Product specifications: Grade, size, unit weight, volume, tolerance, purity, et cetera, are indicated as appropriate.

Product-mix: "As at present"; "normal"; "ideal balance"; "maximum for all sizes and types you are best fitted to manufacture currently or at the same time you are manufacturing all the other types shown"; are among the vague usages under this heading. In contrast are carefully particularized instructions: "As during a stated past period"; "in proportion to current order

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[6] Hincks (1939), op. cit.
[7] Ibid.
[8] U.S. Civilian Production Administration, "Catalog of War Production Board Report and Application Forms, as of Nov. 2, 1945," 10 vols.
[9] Quotation from U.S. Civilian Production Administration, op. cit.

backlog." Often multiple capacities are requested under the assumption that output is restricted to each product in turn; or separately for each product "maintaining same ratio of all products requiring same facilities."

Units of measure: "In units commonly employed for your own records, that is, prices, tons, 9 in equivalent, and so forth, but convert to short tons and submit that figure also." Units of standard size containers are sometimes specified. The output of machines, assemblies, and components was usually stated in terms of the number of items produced.

Operating schedule: Capacity may be requested for both present conditions and full shift utilization. Output for workweeks of specified number of hours may be requested. "Assume three 8-hour shifts or two 10-hour shifts, 6 days a week, 4.3 weeks per month (indicate choice)"; "give practical maximum hours"; "if maximum output is based on less than 168 hours per week, state factors which limit." Interestingly, one group of forms provided for estimates of maximum output with "operation of limiting or bottleneck departments 24 hours per day, 7 days per week—with time out only for necessary repairs, maintenance, and setups."

Down time: Allowance for maintenance and repairs is frequently included explicitly in the assumptions. Mention of setup and make-ready time is rare. A superficial search did not reveal any explicit treatment of the related problem of batch sizes.

Make-or-buy and subcontracting: Assumptions as to the composition of input are generally lacking. At a time when the practice of subcontracting was unusually widespread and officially encouraged, omission of any explicit assumptions is surprising. In a few instances information on available excess capacity by departments was collected in an apparent search for additional possibilities for subcontracting.

Equipment status: "Include equipment active or inactive during the past year, but exclude obsolete equipment."

Availability of equipment: Commonly the presently available equipment is to be assumed as the basis of estimate. Supplemental estimates based upon equipment "contracted for or definitely decided upon" were requested occasionally. In one case, capacity was to be estimated "with added equipment to balance production lines," but there a list of required equipment was also requested.

Equipment inventory: In some industries the conventional approach to capacity measurement is by a count of equipment. This may involve elaborate specification and differentiation of equipment, as in textile industry reports.

Availability of materials: Unlimited availability is commonly to be assumed.

Availability of manpower: Although unlimited availability is the most frequent assumption, estimates on the basis of both present and unlimited availability may be asked for.

Not all of the WPB inquiries, of course, mentioned all of the points listed. The catalog does serve as a guide to the way in which respondents in particular industries have been questioned on capacity. In at least one instance reference to a trade association was made for

a conventional definition of capacity (WPB 3174, Sept. 11, 1945). It is notable that all of the cases included involved the measurement of actual or potential output in physical units. It does not appear a difficult extension to translate output so defined into constant dollars values. More serious difficulties may arise in cases in which output is measured only in monetary terms.

3. *The maximum potential employment survey.*—This experiment was undertaken by the Bureau of Labor Statistics in January 1952. It originated in the need of the National Production Authority for estimates of unused capacity in certain critical industries during the Korean war. It was financed by the Air Force as part of a research project on the application of interindustry economics to industrial mobilization planning. The metalworking industries were covered, including major groups 34–37, and minor parts of 25 and 33. The survey is notable for several reasons:

The use of a dominant input—man-hours—as the basis for measuring capacity.

The first attempt since the Census of Manufactures of 1923 to obtain a consistent set of capacity estimates over an extensive group of industries.

Circulated and processed by regular procedures as a supplement to an established report form—BLS 790 Employment, Payroll and Hours.

Followup by a systematic quality check.

Full documentation.[10]

The use of man-hour input as a basis for estimating capacity can be justified on the assumption of a functional relationship between employment (measured in man-hours) and output. This is not likely to be affected by productivity changes in the very short run. A distinction must be made, of course, between shifts in the productivity curve through time and movement along any given curve toward the point of the maximum employment in a particular plant. The relationship is proportional only in the simplest case. Nevertheless, proportionality may be a reasonably good approximation. A similar assumption is implicit in the use of employment as a proxy for output in some subseries of the FRB Production Index.[11]

Respondents were asked to base their estimates on the following assumptions:

(1) Product-mix as of the time of measurement.
(2) Same proportion of subcontracted components and purchased parts.
(3) Workers available for expanded operations.
(4) Materials available for expanded operations.
(5) Orders available for expanded operations.
(6) Only present plant to be used.
(7) Only present equipment to be used.

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[10] Samuel Weiss and Seymour L. Wolfbein, "A New Approach to Capacity Measurement," a paper presented at the annual meeting of the American Statistical Association, Chicago, Dec. 27, 1952.
U.S. Bureau of Labor Statistics, "Employment and Shift Operations in Selected Metal Working Industries, January 1952," issued April 1952.
Fritz Kafka, "Quality Check of the Reporting of Maximum Employment in Metal Working Industries," U.S. Bureau of Labor Statistics, September 1952.

[11] "Industrial Production—1959 Revision." Board of Governors of the Federal Reserve System, 1960, p. 22.

The BLS 790 is a mail questionnaire. Returns were received from a subsample of 5,670 establishments, representing 62 percent of the included industries. The quality check sample consisted of 139 establishments in four metropolitan areas, stratified by major industry groups.

The estimates reported in the original mail survey were found generally reliable. Man-hours and, to a still larger degree, employment figures for the first shift were especially good as were all estimates of large establishments. Biases were found to follow a definite pattern; namely, second- and third-shift operations were frequently not considered by the respondents and the scheduled weekly hours were slightly understated. The presence of a pattern enables the user of the original survey results to make appropriate adjustments.

Maximum first-shift man-hours in the quality check were revised upward less than 7 percent. All shift operations were revised about 30 percent.

There is a noticeable reluctance on the part of the respondents to assume multishift operations. The reluctance to assume additional shifts was clearly shown in the quality check.

Among the assumptions to be made, unlimited availability of labor admittedly caused the greatest resistance, followed by the assumption of unlimited availability of materials.

About two-thirds of the respondents based their estimates of potential maximum man-hours on experience. Thus, experience is the most important crutch used in the process of estimating maximum employment. * * *

As for productivity at the level of maximum employment, most establishments expected unchanged or reduced productivity. Generally, if the man-hours of January 1952 were doubled, respondents expect the output to be 1.9 times as large as in January 1952. If this expectation is realistic, an adjustment for productivity changes would not be of major importance.[12]

4. *The special case of steel.*—The announcement by the American Iron and Steel Institute that it was dropping its familiar series of operating rates related to capacity put the subject of capacity statistics into the headlines a little over a year ago. Coming at a time when there was increasing recognition that capacity utilization was potentially as important an indicator of economic performance as unemployment, this decision appeared regressive. Given in explanation of the action is the following statement:

The institute said the decision stemmed from suggestions both from within and outside the steel industry. It is believed that percentages of capacity operated have become unrealistic as a measure of economic activity in the steel industry, due to changing production techniques, better steels, and new products.

Recent technological developments that increase production from existing facilities, including the use of oxygen and improved quality of raw materials, have introduced new, yet to be defined, relationships between production and physical capacity of iron and steel-making facilities.[13]

This episode reflects a number of genuine problems inherent in the concept and measurement of capacity. The capacity series had been maintained by the institute annually since the turn of the century. It was derived from production records for individual furnaces. Ingot capacity as reported was based on the maximum output ever attained during any month by each furnace. The capacity figures reported for individual furnaces were continued in the series at a constant level until exceeded, or as long as the furnace and auxiliary facilities were maintained in the condition of the record period. In totaling the ingot capacity for the industry no distinction was made as to type of furnace or the chemical composition or physical properties of the steel produced. Moreover, the capacity base was not

[12] Weiss and Wolfbein, ibid.
[13] American Iron and Steel Institute, news release, Dec. 14, 1960.

adjusted immediately as new furnace records were reported, but only as of the first of each year. At a time when steel processes and steel output were a great deal more homogeneous than they are today, this procedure may have provided a reasonable approximation.

It is not surprising that as the basis for the measurement of steel industry performance, the capacity series became increasingly unsatisfactory. The widening gap between output and capacity appears to have become embarrassing. As of January 1, 1960, reported annual capacity of the U.S. steel industry was 148.6 million ingot tons. Unofficial estimates put current capacity at 160 million tons.[14] The largest output of steel in any year was 117 tons in 1955. During the last 4 years output has not exceeded 100 million tons. Since the reported series was based on maximum recorded output rather than on rated capacity, it is interesting to speculate whether the procedure followed may not have systematically understated the capacity available.

The steel industry now finds itself in the midst of a technological revolution. The modification of an open hearth furnace by the introduction of an oxygen lance has drastically shortened the time required per heat.

> Some open hearths that could turn out only 25 to 30 tons an hour are producing 125 to 150 tons an hour with oxygen. Gains vary from plant to plant because of dissimilar operating conditions.[15]

The cost of modification is small relative to the cost of reproducing the original furnace, or replacing it with a basic oxygen furnace—the current preferred technology. Consumption of gaseous oxygen in the steel industry has increased from 13 to 44 billion cubic feet per year since 1958.[16] As of January 1, 1960, 85 percent of the reported steel ingot capacity was in open hearth furnaces.[17] The process of modification appears to have only begun.

Suddenly, in the face of a large nominal excess of physical capacity, the industry must also find itself with a large proportion of high cost capacity. Other relationships in the industry have been upset. In the past, steel furnace capacity has been the chief process bottleneck in the sequence from blast furnaces to finished product. Now, in any given plant converting to oxygen, the charging facilities and soaking pits limit the extent to which modification is immediately practical. Moreover, the procedure of getting material into and out of the furnace is itself undergoing substantial innovation.

Under conditions of less rapid technological advance, there may have been no competitive advantage in withholding information about the potential output of particular furnaces. Under present circumstances it would be surprising if the companies did not regard this as proprietary information. Nevertheless, both as a basis for an indicator of industry performance and to provide a means of estimating postattack capability, a steel ingot capacity series is needed.

An alternative approach is readily suggested by analogy with available loom-hour or spindle-hour measures used in the textile industry, or the kilowatt-hour basis used in electric power generation. Also pertinent is the less familiar "inch-hour" measure sometimes used in a part of the paper industry.

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[14] Steel—The Metal Working Weekly, Apr. 16, 1962, p. 85.
[15] Steel, ibid., p. 87.
[16] Steel, ibid., p. 85.
[17] "American Iron and Steel Institute, Annual Statistical Report, 1960," New York, 1961, p. 53.

Reports are made for each paperboard machine as to number of hours operated, and the hours are weighted by the "trim" (width of the machine). There are several advantages of this "inch-hour" method. Since the report is in terms of *hours* of operation, the estimates of operation to capacity are unaffected by such matters as changes in basis weight, or even a shift of the machine from paperboard grades to paper grades.[18]

Cubic-foot-hours of furnace capacity are actually what is made available for ingot production. The output of a particular furnace and its associated equipment may depend, among other things, on the composition of the charge and the chemical and physical properties desired in the product. Different steels produced in the same furnace may require heats of different durations, as may the same steel produced in different furnaces.

There is thus no unique relationship between available cubic-foot-hours and ingot production. After allowance for necessary downtime and including time for charge and discharge in the duration of each heat, the maximum potential production of a furnace could only be determined with respect to a steel ingot of standard composition or to a specified product-mix. However, for most purposes, reference to output in capacity-utilization ratios may not be necessary. The ratio could well be expressed in terms of cubic-foot-hours available and utilized. To improve the utility of such measures, it would be desirable to differentiate open hearth furnaces by type of modification.

It is likely that the suggested measure would not be guarded as proprietary information to the extent that an output measure might be at present. In fact, an equivalent measure, rated capacity per heat, has been reported for each furnace, but apparently never tabulated for the industry as a whole, in the Iron & Steel Works Directory, published by the American Iron & Steel Institute. The most recent issue is dated 1960. Tons per heat is a direct function of the content of the hearth in cubic feet, qualified to some extent by the composition of the charge.

A measure equivalent to cubic-foot-hours would be ton-hours. For an individual furnace this might be expressed as:

$$(7) \qquad C_t \equiv (w)\,(t - dt)$$

where (C_t) is the capacity of the furnace, (w) is the output in ingot tons per heat, (t) is calendar time in hours, and (d) is the proportion of calendar time required for downtime for furnace relining, and other maintenance and repairs. The adoption of standard allowances for downtime by type of furnace would simplify the estimation of capacity on this basis from the information published in the directory.

5. *The stock of capital approach.*—A method of capacity estimation has been advanced which avoids nearly all of the difficulties heretofore discussed.[19] It is based entirely on financial records. The key concept in this approach is the capital-output ratio. Capital is taken as the cost of acquisition of structures and equipment, expressed in base year prices, less accumulated depreciation similarly deflated.

[18] Robert S. Schultz 3d, "Paper Capacity and Operating Rates," American Statistical Association, 1961, Proceedings of the Business and Economic Statistics Section, p. 332. (See supplemental statements herein, p. 148.)

[19] Daniel Creamer, "Estimates of Capacity and Capacity Utilization in Manufacturing," "Pt. III: Capacity Estimates Based on Accounting Data," prepared for the Commission of Money and Credit, September 1960.
Daniel Creamer, "Capacity Expansion and Capacity in Postwar Manufacturing," Studies in Business Economics, No. 72, New York: National Industrial Conference Board, 1961.

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Output is taken as gross operating receipts corrected for changes in inventories, also expressed in base year prices. The capital output ratio for a year of peak operation is assumed to represent the full utilization of capacity.

The limitations of this approach are aptly summarized by Pincus:

> The reliability of this method depends on the choice of the benchmark year, the accuracy of the capital stock figures, and on the validity of the assumption (implied) that capital-output ratios remain constant. The capital stock estimates are particularly subject to question when based on accounting book values. Accounting methods do not generally reflect accurately changes in the productivity of capital, and furthermore, these methods themselves are subject to change over time. Life expectancy curves may, of course, also be subject to error. Finally, historical series encounter problems of price deflation, particularly for capital stock pricing.[20]

There are additional limitations inherent in "Statistics of Income," the source of data on capital, depreciation, and also receipts. This information is reported by company rather than by establishment. Consequently, industry grouping at best can be carried out only at a highly aggregated level, often no more detailed than the two-digit classification.

Nevertheless, this method affords an important supplement to, and check on, the methods previously discussed. These are not reliable enough to make it expedient to neglect any independent means of appraisal. The usefulness of the capital-output approach, moreover, could be greatly enhanced by putting it on a more secure and explicit footing.

In a special supplement to the 1959 Annual Survey of Manufactures, the Bureau of the Census collected information on depreciable or depletable assets, including gross book value, accumulated depreciation and depletion, and depreciation and depletion charged in the current year. These questions could become the basis for a new historical series of major importance if incorporated in the shuttle form on the annual survey for the 1963–67 quinquennial.

IV. CENSUS POTENTIAL

The technical basis now exists for obtaining reliable capacity estimates for mining, manufacturing, and utility industries. The need for such statistics exists both for the measurement of economic performance in peacetime and for the implementation of planning and training procedures for postattack recovery. This section will suggest how the task might be accomplished, with specific attention to manufacturing.

1. *The Census of Manufactures.*—It has been shown here that before the capacity of an establishment can be estimated reliably many particulars concerning both its current operations and the ways operations would be changed under conditions of maximum output must be specified. The question cannot be asked or answered meaningfully in a simple two-line questionnaire. The whole context of operating schedule, product-mix, departmental structure, and stock of capital has to be spelled out in detail. This implies either a long and complicated questionnaire designed especially to elicit facts about capacity, or embodying capacity questions in an existing survey which

[20] J. A. Pincus, "U.S. Productive Capacity Available for Increasing Defense and Foreign Aid Procurement—RM–2843–PR," September 1961. The RAND Corp.

has already established the factual context required. The latter course is almost certainly preferable.

The existing reports which meet these requirements, obviously, are the quinquennial Census of Manufactures and the Annual Survey of Manufactures. The annual survey, in particular, has the further advantage of being collected on a 5-year shuttle form which presents in one place establishment data for the base year and for each subsequent year as reported. To some extent it thus provides implicit consistency checks. Neither the quinquennial or the annual surveys are now particularized in all respects necessary to describe the context of capacity estimates. Suggestions for additional questions are discussed below.

Against such a detailed background quantified in terms of the respondent's own operations, it becomes practical to ask for capacity estimates. On the principle that redundancy promotes accuracy, three measures related to capacity could be collected:

(1) Maximum potential employment.
(2) Maximum potential output.
(3) Maximum throughput of bottleneck departments or processes (selected industries only).

An estimate of the independent capacity of each establishment would be appropriate. This implies the unlimited availability of inputs of materials, and of production workers, supervising, technical, and professional personnel. Estimates might appropriately be made as of the end of the calendar year for which the report is made. The appropriate plant and equipment base to be assumed is what is in place as of that date. On this point supplemental assumptions might also be considered. Pilot surveys might be undertaken to determine the significance and reporting feasibility of introducing more refined assumptions with respect to the equipment base (*a*) by excluding equipment in place but idle throughout the calendar year; and (*b*) by excluding equipment fully depreciated (on a normal, not an accelerated basis).

2. *Specifications, employment and hours.*—Information is needed to determine the operating time to which is to be attributed both the actual production of the report year and the estimated maximum. Production worker and man-hour data are now collected by the census respectively for a representative week and in total for each quarter. These questions could be paralleled by questions on employment by shift and the number of scheduled hours on each shift. A simple extension of the form could provide for maximum potential employment by shift and scheduled hours under such conditions. The treatment of these questions in the BLS form 790C–1 might provide a model.

Maximum potential employment estimates do not require explicit specification of the total hours of plant operation during the year. Estimates of maximum potential production do require this datum to be pinned down. The following questions are suggested, to be answered both for the actual report year and for the estimate of maximum potential employment given previously:

(*a*) Number of hours plant was (is to be) shut down for Sundays, holidays, and vacations.

(*b*) Number of hours not counted in (*a*) plant was (is to be) shut down for maintenance and repairs.

(*c*) Number of hours normally scheduled plant was shut down for strikes, lockouts, or other work stoppages involved in labor disputes (zero for maximum potential).

(*d*) Number of hours during year plant was (is to be) in operation (not counting maintenance and repair shifts outside of regular operation).

(*e*) Number of hours not utilized in production not accounted for above. (Number hours in year—(a)—(b)—(c)—(d) =time not utilized in production.)

3. *Specifications, Departmental structure.*—The standard industrial classification scheme often results in establishments of three essentially different types being classified in the same industry group:

(*a*) Plants assembling a final product.

(*b*) Plants manufacturing components and parts identified with a final product (for example, motor vehicle parts) if sold to other establishments.

(*c*) Integrated plants manufacturing components and parts as well as assembling them into final products.

Clearly, capacity means something different in each case. Also, there are industrial processes which are the primary business of certain independent establishments but which exist as captive departments embedded within an establishment otherwise classified. Some final products (for example, barbed wire) may be the output of special departments appended to a major producer of basic or intermediate products but which may also appear as the primary product of a distinct industry group.

To provide comparable capacity estimates for aggregates of establishments, the existing standard industrial classification needs to be supplemented by a classification of departments (or major process configurations) within establishments. This has already been provided and is used in the census for metalworking industries. (See appendix.) The same procedure could be extended to food processing, textiles, apparel, woodworking industries, paper, printing, chemicals, rubber, and petroleum refining.

The problem of a suitable measure of the relative importance of departments within an establishment is more difficult. Although the spread of automation makes it increasingly less reliable, the number of employees, or the proportion of the total work force still is for many industries a useful approximation. For others, it may be necessary to adopt a measure based on capital value.

4. *Specifications, production.*—The total production, and the corresponding capacity, which is to be determined is that of a group of establishments having similar characteristics. The development of a supplementary departmental classification would make it possible to assign establishments to more nearly homogeneous groups.

The total production of an establishment, as well as its counterpart capacity, may be measured—according to what is appropriate to the industry group of interest—as output; as an input of a dominant item (such as crude petroleum into refineries); or as the intermediate output of a bottleneck process (such as steel ingots). Wherever throughput is sufficiently homogenous to be measured in physical quantities, it

would be appropriate to determine in such terms. However, a common physical measure for a diversified production flow may not be justified when the components differ markedly in unit value and the composition is subject to major changes. For multiproduct establishments, total production will usually need to be stated in dollar terms. For such establishments capacity may be stated alternatively in terms of the product mix of the base year (quinquennial census), or of the report year. The first option gives comparable capacity figures for each year of the quinquennial. The second provides for comparability of capacity and production in each year. The collection of both measures might be desirable.

5. *Specifications stock of capital.*—Information on expenditures for plant and equipment are already regularly collected in the census. A supplement to the 1957 annual survey collected data on depreciation and book value of depreciable assets. This inquiry might well be usefully made a regular part of the quinquennial and annual surveys.

Better integration of these data with studies of capacity and investments would be possible if the subject were covered more systematically. Data on both book value and accumulated depreciation are needed separately for buildings, equipment, and reserves. The amounts under each of these headings at the beginning and end of the report year, together with changes specifically attributable to sales, retirements, and additions both new and used, would be useful.

6. *Capacity analysis.*—There is a further advantage to be gained by incorporating capacity questions in the census of manufactures and annual survey.

We are on the threshold of a major breakthrough in the application of statistical analysis. To date the scope and published format of the census has been little influenced by the introduction of high speed electronic computers. It has been handled essentially as a data processing and tabulation job. The possibilities of treating each establishment return as a separate observation have received little attention.

The economics of computer operations upset preconceptions of what is feasible. Arithmetic has become very cheap. Once a return has been transcribed onto magnetic tape, most of the cost consists in passing the tape through the machine. For example, it would be feasible to obtain the mean and standards deviation of every published figure at little additional cost. More to the point, it is possible to examine many cross-relationships, to compute simple and multiple regressions, and perform tests of significance. Thus it is practical to explore in depth relations and distributions which lie behind the principal published totals. Interconnections and developments now concealed in the published aggregates can be uncovered. This wealth of detailed information could be revealed without violating the disclosure rules because individual returns cannot be reconstructed from the computed statistical measures.

One reservation must be mentioned. This information-in-depth can be obtained only if all the items to be considered for any given establishments are present on the same record. If information from several surveys has to be merged, then costs go up as the multiple of the number of records to be combined. There is now a significant premium to be gained from collecting and processing as much as pos-

sible of the information to be obtained from a single respondent in one integrated operation.[21]

Taken in isolation each of the capacity measures suggested here is relatively crude. As such they have conspicuous shortcomings and may be of limited usefulness. However, in the context of the intensive statistical analysis suggested, these restrictions would be much less serious.

Many cross-relationships could easily be computed. Maximum potential employment could be tested against maximum potential production. Capital output ratios could be compared with capacity output ratios. Establishments could be segregated by the ratio of accumulated depreciation to book value of depreciable assets (a proxy for average age of assets), and the percent of the total capacity of particular industries found in various ranges of the ratio could be determined. Similarly, cross-relationships involving man-hour productivity and capacity could be explored.

The addition of capacity questions could make the census a more balanced instrumentality for economic analysis and a more useful base for projections. Such intensive quantitative analysis is characteristic of the computer age. Analyses in depth would permit a higher utilization of the potential capacity of the census itself to provide information needed by both business and government.

Appendix A

1958 Census of Manufactures

Departments included in metal and metalworking inquiries

Coke oven.
Blast furnace.
Steel department (furnaces) (throughout pouring stage).
Rolling and finishing mills.
Foundry (iron or steel).
Foundry (nonferrous, except die castings).
Forging (presses hammers, upsetters) (exclude manufacturing of nuts, bolts, etc.).
Other manufacturing or fabricating departments (nuts, bolts, steel containers, etc.).
Service or auxiliary departments.
Electroplating.
Galvanizing and other hot dip coating.
Heat treating or annealing of metals for production purposes.
Automatic screw machine department.
Machine shop.
Tool and die shop.
Plate or structional fabrication.
Stamping, blanking and forming.
Painting, lacquering, and enameling.
Pattern shop (foundry patterns only—metal, wood, etc.).
Die casting (nonferrous metals only).
Plastics molding.
Assembly of product.
Shipping department (including packing and crating).
All other operations such as maintenance and warehousing.

Source: "1958 Census of Manufactures and Minerals, Special Inquiry Manual," U.S. Department of Commerce, Bureau of the Census, Industry Division, June 1959.

[21] Efforts to apply this approach to the 1958 Census of Manufactures are handicapped by the fact that the data now exists (in magnetic tape form) only in six separate sets of tapes. Relating materials consumed, for example, to value of shipments requires the merging of two sets of records. The statistical analysis suggested here should be integrated with the machine editing process and conducted when the return is examined as a whole and before it is split for convenience in tabulation.

APPENDIX B

MISCELLANEOUS EXHIBITS

BLS 790C-1
Report of January 1952

Budget Bureau No. 44-R878.4
Approval expires March 31, 1952

SUPPLEMENT TO THE REPORT ON EMPLOYMENT, PAYROLL, AND HOURS

U. S. DEPARTMENT OF LABOR
Bureau of Labor Statistics
Washington 25, D. C.

(CHANGE MAILING ADDRESS IF INCORRECT—INCLUDE POSTAL ZONE NUMBER)

Return the white copy of this form to the above address with your regular January report on Employment, Payroll, and Hours. The green copy is for your files.

The information requested on this form is vital to national defense and is required under authority of the Defense Production Act. The individual company information reported on this form is for use in defense mobilization activities. Persons who have access to individual company information are subject to penalties for unauthorized disclosure.

1-4						
Qtr.	State	Report No.	Tab.			

BEFORE ENTERING DATA PLEASE SEE EXPLANATIONS ON BACK OF YOUR GREEN FILE COPY

EMPLOYMENT IN PAY PERIOD ENDING NEAREST JANUARY 15, 1952
(These are the same figures requested on the Employment, Payroll, and Hours report.)

1. a). ALL EMPLOYEES.—Enter the total number of persons who worked during or received pay for any part of the pay period (preferably 1 week) ending nearest January 15, regardless of type of work performed. . . . . .

b) PRODUCTION AND RELATED WORKERS.—Enter the number of production and related workers included in the figure entered above. . . . . .

PRODUCTION AND RELATED WORKER EMPLOYMENT AND SCHEDULED HOURS BY SHIFT CURRENT AND MAXIMUM	1st Shift (day)	2d Shift (evening)	3d Shift (night)	4th Shift (_____)
2. a) Enter the number scheduled to work on each shift most days of the week ending nearest the 15th of January. .				
b) Enter the maximum number that could be employed effectively on each shift with present equipment . .				
c) Enter the length of the workweek in hours (example 44) scheduled for most production workers for the workweek ending nearest the 15th of January				
d) Enter the maximum workweek in hours (example 48) that could be scheduled for most production workers at the level you have indicated in (b) above.				

TOTAL MAN-HOURS WORKED BY PRODUCTION AND RELATED WORKERS DURING FOURTH QUARTER 1951

3. Enter the total number of production and related worker plant man-hours for the entire fourth calendar quarter (October, November, and December, or comparable 13-week period). . . . . (Omit fractions)
(See explanations on back of green copy for definition of plant man-hours.)

4. LOCATION OF ESTABLISHMENT COVERED IN THIS REPORT
(May differ from above mailing address)

Street and number _____ City _____ County _____ State _____

5. COMMENTS.—Enter in this space comments which will explain or clarify entries above.

(Signature of person making report) (Position)

EXPLANATIONS FOR ENTERING DATA ON FORM BLS 790C-1

Item 1a. ALL EMPLOYEES—Transcribe the number of employees from the January line of your regular monthly report on Employment, Payroll, and Hours.

Item 1b. PRODUCTION AND RELATED WORKERS—Transcribe the number of production and related workers from the January line of your regular monthly report on Employment, Payroll, and Hours.

Item 2a. CURRENT EMPLOYMENT BY SHIFTS—For ONE WEEK, ending nearest the 15th of January, enter the number of production and related workers scheduled to work on each shift a majority of days of the week. Or, if you prefer, distribute by shift the total number of production and related workers shown in Item 1b.

Item 2b. MAXIMUM POTENTIAL EMPLOYMENT—Estimate the maximum number of production and related workers that could be employed effectively on each shift. In making this estimate, assume the same product-mix as in mid-January, that is, that the same items would be produced in the same proportions of total production and approximately the same proportion of subcontracted components will be purchased. Also assume workers, materials, and orders to be available for expanded operations, but only present plant and equipment to be used.

If 7-day operation of the plant is assumed, include the number of additional workers that would be required.

If a fourth shift is worked or could be worked, enter a name for it in the space provided.

Item 2c. SCHEDULED HOURS BY SHIFT—The number of hours scheduled per week for most production workers on each shift should include overtime hours actually worked but exclude overtime hours paid for but not worked. For example, if the normal workweek is 40 hours and most production workers were scheduled to work an additional 4 hours overtime and to be paid for 6, enter 44 rather than 40 or 46.

Item 2d. MAXIMUM SCHEDULED HOURS—In determining the number of hours that could be scheduled per week on each shift for most production and related workers at the maximum employment level you have indicated in 2b, make the same assumptions with regard to product-mix, materials, orders, etc., as in 2b.

ANSWERS TO ITEMS 2a, 2b, 2c, and 2d IMPLY DEGREE OF PLANT UTILIZATION. IF YOU FEEL THEY DO NOT DO SO IN YOUR CASE, PLEASE EXPLAIN UNDER "COMMENTS."

Item 3. MAN-HOURS OF PRODUCTION AND RELATED WORKERS DURING FOURTH QUARTER 1951—"Plant man-hours" is designed to measure the over-all activity of the plant during the quarter covered by the report. The requested figure consists of all man-hours worked or paid for except hours paid for vacations, holidays, or sick leave when the employee was not at the plant. Include actual overtime hours, not straight-time equivalent hours. If employee elected to work during the vacation period, include only actual hours worked by such employee.

For establishments that make a "Report of Plant Operations" on Form NPAF-1, this entry should be the same as entered in Section II of NPAF-1. If different please indicate reason under "comments," Item 5.

Plant man-hours of production and related workers during the fourth quarter of 1951 will not necessarily be consistent with the number of man-hours reported on the Employment, Payroll, and Hours report for the months of October, November, and December since the latter will include paid sick leave, holiday, and vacation man-hours.

BLS 2230

Budget Bureau No. 44-5206
Approval Expires 6-30-52

UNITED STATES DEPARTMENT OF LABOR
Bureau of Labor Statistics
Washington 25, D.C.

C O N F I D E N T I A L

FIELD QUALITY CHECK OF BLS 790C-1, JANUARY 1952

Instructions To The Interviewer.

This questionnaire is designed for the use of authorized field personnel when interviewing plant officials of companies who submitted returns on form BLS 790C-1.

The purpose of the personal interviews is to gather information on the assumptions and methods that were used by reporting companies in answering Items 2b and 2d, and to determine the meaning and usefulness of maximum-employment estimated in estimating maximum output.

It is important to hold the interviews with plant officials on the policy making level that are well informed on the production problems of the plant, since the questions raised can only be answered by management's informed opinions. It is desirable that the person who filled out BLS 790C-1 be present at the interview.

Please list under "Remarks" (Question 12) all relevant statements of the respondents which are not recorded under No.1 to 11. Add your own evaluation of the respondents and refer to the extent of their being informed, cooperative, etc.

You are being supplied with a copy of the respondent's BLS form 790C-1 for October 1951 and January 1952 and form NPAF-1 for October 1951. Please have these copies with you at the interview.

Persons who have access to individual company information are subject to penalties for unauthorized disclosure.

Name of Interviewer: _____

Date of Interview: _____

---

1. Plant Identification

Plant Name _____

Plant Address _____

Parent Company _____

Official Who Signed BLS 790C-1 _____
(Name) (Position)

Officials Interviewed:

Name _____ Position _____

Name _____ Position _____

2. Product Mix (INTERVIEWER: Please show the respondent form BLS 790 C-1)

(a) What product mix did you assume in answering 2b and 2d?

Description of Product	(Check one) Percent of: Sales ( ), Production ( ), Shipment ( ) Other ( )

(b) Does this product mix differ materially from the 1951 product mix?
Yes ( ) No ( ) If yes, give reasons _____

3. Assumptions Made in Estimating Maximum Employment

(a) Subcontracting and purchased parts.
How does the proportion which you assumed in answering 2b and 2d compare with the January proportion? (e.g. same proportion of total output)

(b) INTERVIEWER: Answers should be qualitative (e.g. unlimited, adequate) not quantitative.

In answering 2b and 2d, what assumptions did you make as to the availability of:

(1) materials _____

(2) orders _____

(3) labor _____

(4) supervisory, executive, and engineering personnel _____

(c) (1) In answering 2b and 2d, did you assume any changes in your present plant and equipment? Yes ( ) No ( )

(2) If answer to 3,c,1 is yes: Please specify _____

4. Method of Estimation

(a) What was the basis for your estimate? (Example: recent experience, a count of work stations) _____

_____

(b) On the instruction sheet you were asked to "Estimate the maximum number of production and related workers that could be employed effectively on each shift." How did you interpret the phrase "employed effectively?" _____

_____

(c) Did you assume seven-day operation of all or any parts of the plant?

_____

(d) What has been the peak employment reached in your plant since 1940?

_____ When? _____

5. In making maximum exployment estimates, did you assume changes in
the plant lay-out? Yes ( ) No ( )
equipment operation speeds? Yes ( ) No ( )

6. Occupational Structure

(a) At maximum employment, would you expect the occupational pattern to be essentially the same as in January? Yes ( ) No ( ) No opinion ( )

(b) If answer to (a) is No: What substantial changes would be made in supervision, set-up, maintenance, material handling, etc.?

_____

_____

7. Productivity

(a) With employment raised to the estimated maximum level, what change would you expect in output per man-hour compared with mid-January?

_____

_____

(b) How would output per man-hour on the second and third shifts compare with that on the first? _____

_____

8. Nature of Bottlenecks

At maximum employment, what would be the limitations on second and third shift operations?

(a) Capacity of certain production equipment? Yes ( ) No ( )

If Yes, what equipment, and for what products _____

_____

(b) Downtime for maintenance and tool set-up? Yes ( ) No ( )

(c) Capacity of servicing facilities? (e.g. water) Yes ( ) No ( )

(d) Lay-out of plant? Yes ( ) No ( )

(e) Storage space? Yes ( ) No ( )

(f) Transportation of workers? Yes ( ) No ( )

(g) Other (please list) _____

_____

9. After our discussion today, are there any changes that you think ought to be made in your maximum employment estimates? Yes ( ) No ( )

10.

If answer to 9 is Yes:	1st shift:	2nd shift:	3rd shift:
What is the revised answer to question 2b.....			
What is the revised answer to question 2d.....			

11. Your estimate of maximum employment indicates a possible increase in man-hours of _____ percent over January. (INTERVIEWER: Check with question 10) What percent increase in volume of output would you expect with this increase in employment? _____ percent.

12. Remarks _____

_____

_____

_____

_____

_____

_____

(Whereupon, at 11:45 a.m., the hearing in the above-entitled matter was recessed, to be reconvened at 10 a.m. on the following day.)

MEASURES OF PRODUCTIVE CAPACITY

THURSDAY, MAY 24, 1962

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 recess, in room 6226, New Senate Office Building, Senator William Proxmire (chairman of the subcommittee) presiding.

Present: Senator Proxmire and Representative Widnall.

Also present: James W. Knowles, staff economist; John R. Stark, clerk; Hamilton G. Gewehr, staff member.

Senator PROXMIRE. The subcommittee will come to order.

Our first witness is Mr. Frank de Leeuw, economist, Division of Research and Statistics, Federal Reserve System.

Mr. de Leeuw, I understand you will testify on the methods used by the Federal Reserve and what they show in capacity and so forth. Go right ahead. Happy to have you with us.

STATEMENT OF FRANK DE LEEUW, ECONOMIST, DIVISION OF RESEARCH AND STATISTICS, FEDERAL RESERVE SYSTEM

Mr. DE LEEUW. Thank you.

The demand for capacity figures has been brisk in recent years, but the supply continues to be small and of uncertain quality. There is no doubt that we know much less about capacity than we know about output, prices, or employment. The primary problems of capacity measurement, therefore, are how to make judicious use of the limited supply of capacity figures available, and how to increase the supply.

The paragraphs below will deal with these topics, first by reviewing two currently available capacity measures, and secondly by mentioning two steps which might add to the current store of information.

By way of introduction, however, it may be useful to comment on the meaning of the term "capacity," and on the reasons for the current brisk demand for capacity figures.

THE MEANING OF "CAPACITY"

Almost all of the many implicit and explicit definitions of capacity have in common the notion of the quantity of output (per unit of time) which a given stock of plant and equipment can produce. They agree, that is to say, that capacity refers to a quantity of output, and that it is associated with a given stock of plant and equipment. Where they differ is in the interpretation of the words "can produce."

A full discussion of how this area of difference might be narrowed is beyond the scope of this statement. Suffice it to say that one common approach is to interpret "can produce" as "can produce given 'normal' downtime, operating speed, number of shifts per day, et cetera." Normal, in turn, refers to typical establishment or industry practice in recent years.

A second approach is to define "can produce" as referring to the cost of a unit of output—for example, "can produce at lowest average total cost," or "can produce at less than some 'high' marginal cost." The so-called engineering definition of capacity interprets "can produce" as "can produce regardless of cost," which really means "can produce at less than what the 'engineer' regards as prohibitive marginal cost."

The first or "normal" approach is probably the most feasible for most industries, but some variety of the cost approach seems more relevant to the uses of capacity figures. For such materials as steel ingots, petroleum products, and electricity—highly capital intensive and normally produced under continuous operation—the various approaches probably would yield only a narrow range of estimates. For such final products as apparel or furniture, or for service industries, the various approaches might lead to an extremely wide range of estimates.

An additional definitional problem is the problem of aggregation. A furniture establishment may be able to produce 500 desks per week or 500 tables per week, but both in the same week; its total capacity is less than the sum of its individual product capacities. Furthermore, it can produce 500 desks or 500 tables only if the necessary lumber is available, and the total capacity of all furniture establishments in the country, say, may exceed the total capacity of the sawmills which supply them with lumber.

For the whole economy, as this example suggests, the sum of individual product capacities must greatly exceed the level of output actually feasible. The effects of high capacity utilization therefore begins to show up long before the economy reaches the sum of its product capacities.

Where possible, it would seem desirable to eliminate some of the aggregation problems before adding up individual product capacities. Otherwise, total capacity might reflect a degree of duplication which would change from year to year, and hence increase the difficulty of interpreting an aggregate measure.

One way to eliminate duplication is to define establishment capacity in terms of a "normal" product mix. Another possibility is to measure an industry's capacity at what is often its bottleneck stage—for example, the ingot stage in steel manufacturing, or the generating stage in the electric utility industry.

As for aggregation problems which these or other techniques do not solve, it is important to keep in mind that they exist, that they often reinforce the effects of changes in aggregate capacity utilization, but that they complicate somewhat the meaning of any aggregate capacity figure.

THE USES OF CAPACITY MEASURES

Interest in capacity at the Research Division of the Federal Reserve Board centers on its influence on prices, costs, and fixed investment, all

in relation to general economic conditions. There are other sources of demand for capacity figures also—for example, the requirements of defense planning—but they will not be discussed here.

Price and cost pressures are one important set of variable which appear to respond to changes in the degree of capacity utilization. Whether a particular level of aggregate demand and set of credit conditions is inflationary depends to an important extent on the degree of capacity utilization. The influence of capacity utilization shows up not only in the price level, but also in profits and profit margins. Particularly important in analyzing price pressures is capacity utilization in materials-producing industries, to be discussed below.

Another direction in which capacity utilization appears to exert a major influence is in the demand for new plant and equipment. There has been extensive discussion and testing of this relationship in recent years, and one of the capacity measures to be outlined below was developed in order to examine this relationship for manufacturing. The underlying hypothesis in all this work is that as output approaches capacity and expectations of further rises in output are strong, more and more firms find it cheaper to increase output by adding new plant and equipment than by using existing plant and equipment more intensively.

In both the investment relationship and the price-cost relationship, capacity utilization serves as an indication of shortrun cost conditions. High capacity utilization is taken to indicate that the cost of an additional unit of output—the marginal cost—is high relative to average cost at the most efficient operating rate; this high marginal cost in turn is assumed to influence prices and the demand for capital goods.

TWO MEASURES OF CAPACITY

Capacity and output indexes for major materials

To facilitate analysis of capacity developments, especially in relation to costs and prices, the Federal Reserve Board staff has developed indexes showing monthly output series and annual capacity levels for 17 manufactured materials, among them steel, aluminum, cotton, and petroleum.[1] The coverage of the basic materials area is fairly broad, although building materials are represented only by cement, and industrial chemicals are underrepresented. The total index is shown in the first of the attached charts.

The capacity figures underlying the indexes are drawn from Government and trade association surveys. They are physical quantities of potential output referring for the most part to continuous—or nearly continuous—operation processes. They probably suffer less from the definitional dilemmas referred to earlier than most capacity measures; "normal" capacity and a high-cost definition of capacity probably correspond fairly closely for a machine designed to be operated continuously.

Nevertheless, there are measurement problems in this area, and they are resolved in various ways by the organizations which compile the underlying figures. Thus, the reported annual capacity figures for

[1] A complete list of included materials follows: iron, steel, aluminum, copper, coke, cement, cotton yarn, synthetic fibers, pulp, paper, paperboard, petroleum, synthetic rubber, sulfuric acid, ammonia, chlorine, and benzene.

steel incorporate a substantial allowance for repair time and typically exclude "obsolete" capacity. The annual capacity figures for synthetic fibers are based on 51 operating weeks per year for each mill, while the woodpulp capacity figures are based on working-day assumptions which vary among mills depending on the "normal" practice prevailing in each. The problem of high-cost capacity is important for aluminum and for some other materials.

For some materials, capacity figures have been adjusted or partly estimated by the Board's staff. Petroleum refining capacity has been defined as excluding shutdown capacity, which has averaged about 3 or 4 percent of the total in recent years. Coke capacity has been defined to include all slot-type ovens (including a substantial proportion over 25 years old), but includes only those beehive ovens which are described by the Bureau of Mines as "in operating condition." The cotton yarn capacity estimates assume three-shift operations for spindles in cotton-growing States, and two-shift operations for spindles in other States. The cotton capacity index also includes allowances for indicated changes in the amount of cotton consumed per spindle-hour, calculated by comparing cotton consumption in bales to cotton-system spindle-hours active. The weights used for combining the various output and capacity indexes are based on value added data, and are directly related to the weights in the Board's index of industrial production.

The principal limitation of the major materials indexes does not lie in the area of technical measurement problems. The principal limitation is simply the low coverage of the indexes. While basic manufactured materials are covered adequately, the total is only a small fraction of the entire industrial sector. Physical capacity data are simply not available for most industries. The area covered is probably of strategic importance in gaging price pressures and bottleneck developments, but may not serve well as an indicator of a broader total.

Turning to the first chart, the dashed capacity lines for 1960 and 1961 are based on "high" and "low" assumptions about iron and steel capacity; the discontinuance of the American Iron and Steel Institute's annual capacity survey has removed one of the most important sources of data for the indexes. The utilization rate shown in the bottom panel is based on an intermediate assumption about iron and steel capacity in the last 2 years. Apart from strikes, the range of capacity utilization indicated in the chart runs from 96 percent in the first two quarters of 1951 to 67 percent in the second quarter of 1958. Capacity utilization in the first quarter of this year is estimated at 82 percent, about equal to the rate in early 1959, but well below the rate in earlier periods of expansion.

The second chart relates capacity utilization for major materials to materials prices. The top panel of the chart shows materials prices in relation to prices of finished industrial products at wholesale; the chart makes clear that materials prices fluctuate more than, and often lead, finished goods prices. The bottom panel of the chart is a scatter diagram relating prices to capacity—specifically, plotting materials prices relative to finished industrial prices on one axis, and major materials capacity utilization (from chart 1) on the other. Finished goods prices are here taken to represent the general level of prices and costs, so that the chart relates capacity utilization to the margin of materials prices above general prices and costs.

CHART 1

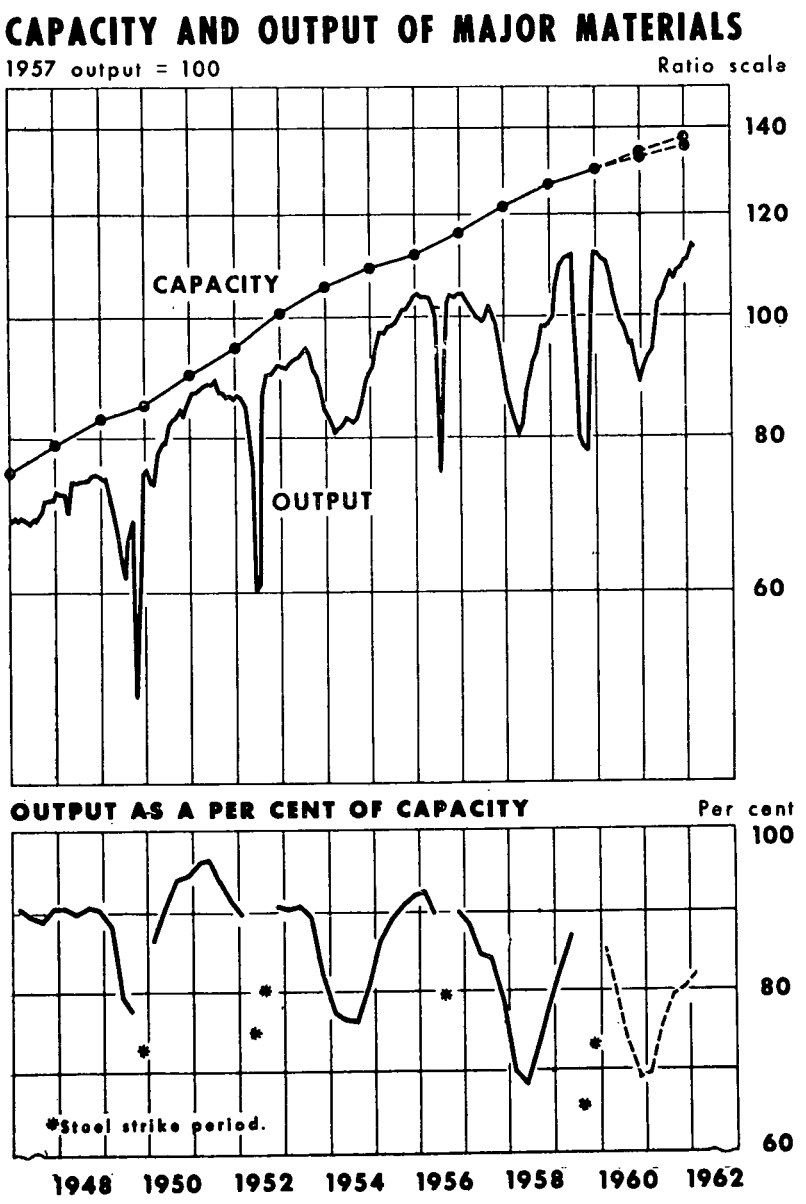
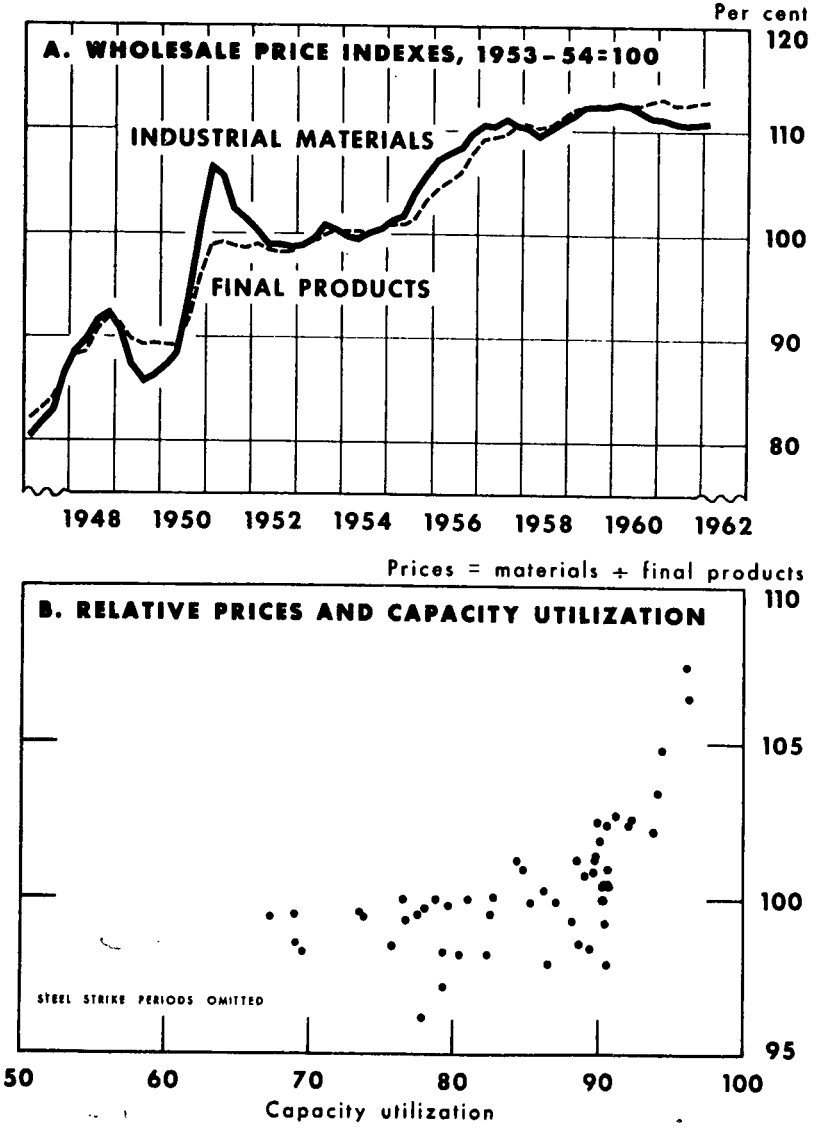

CAPACITY AND OUTPUT OF MAJOR MATERIALS
1957 output = 100
Ratio scale
140
120
100
80
60
CAPACITY
OUTPUT
OUTPUT AS A PER CENT OF CAPACITY
Per cent
100
80
60
*Steel strike period.
1948
1950
1952
1954
1956
1958
1960
1962

CHART 2

PRICES AND CAPACITY UTILIZATION



The suggestion of the chart is that as materials output climbs above 90 percent of capacity, in other words, as you move to the right along the horizontal axis past 90 percent, materials prices begin to rise relative to the general level of prices and costs. This rise, in turn, feeds back to the general level of prices as materials costs go up; but the feedback is not depicted in the chart. Below 90 percent, the slope of the relationship in the chart is much less steep than above 90 percent. The current utilization rate of 82 percent, therefore, implies that on this score inflationary pressures are less of an immediate threat than in much of the earlier post-war period.

An index of manufacturing capacity [2]

A crude series representing manufacturing capacity has been developed as part of a study of the determinants of quarterly capital spending by manufacturers. Since the series is to be related to the Federal Reserve Board index of manufacturing production, it has been calculated so as to be conceptually as close to that index as possible.

Three sets of figures were used to estimate manufacturing capacity. The first was the Commerce Department's estimates of manufacturers' fixed capital stock in 1954 dollars. The second was the McGraw-Hill index of manufacturing capacity, based on an annual mail survey including a question as to the percentage increase in the physical volume of capacity during the past year. Both of these series were assumed to have a gradually shifting relationship to the desired capacity measure, on the grounds that many of their differences from the desired measures—differences in weighting, in sampling bias, in treatment of capital retirements, in implied treatment of quality changes—would have effects which develop gradually over time. Both of these series showed a steady upward trend, with the McGraw-Hill series growing at about 2½ percent per year more than the Commerce series.

The third ingredient of the capacity measure was based on answers to another McGraw-Hill question: "How much of your capacity were you operating at the end of 19—?" The Federal Reserve output index divided by the aggregate "rate of operations" is a third capacity measure available beginning only with January 1955. Since this measure is directly tied to the output index, its bias relative to the desired measure should not change greatly over time. However, it is probably subject to more short-term random influences than the other two series. For one thing, the response rate is lower to this than to other McGraw-Hill questions, and the index varies significantly, depending on whether "end of year" in the question is taken to refer to December, to the last week of December, to an average of December and January, to a seasonally adjusted or to an unadjusted output rate.

In view of these different sources of bias, the desired capacity measure was estimated by assuming that the ratio of the third measure above to each of the other two measures depended on time and a random disturbance. The judgment that the sources of the bias in

[2] This section is taken largely from "The Demand for Capital Goods by Manufacturers," by Frank de Leeuw, to appear in Econometrica (forthcoming).

the three measures are sufficiently different enables one to get a less biased estimate by combining them.[3] The final measure grew at about 1½ percent per year less than the McGraw-Hill capacity index, and at about 1 percent per year more than the Commerce stock series.

Needless to say, these estimates are many steps removed from actual figures on the capacity of particular capital goods. The capital stock series serves as a capacity measure only under the assumption that capacity bears a stable relation to capital stock, an assumption to which available evidence does not give must support. The two survey figures, which are the other sources for this measure, are very difficult to appraise, because of unknown sampling errors and lack of precision in the underlying questions.

The final capacity series and the output index are shown in charter 3. The "rate of operations," or output-capacity ratio, in the bottom panel of the chart ranges from 96 percent in the second quarter of 1953 to 74 percent in the second quarter of 1958, with a 1947–61 average of 86 percent. It was higher during the 1952–53 Korean war period than at any other time.

The rate in the first quarter of this year, 85 percent, is roughly the same as the average rate in the first half of 1959, and again well below rates in the earlier postwar upswings. In its current showing, then, the utilization rate for all manufacturing gives the same impression as that for major materials shown in chart 1. Historically, the two have shown some divergencies, most of which seem explainable in terms of different demand forces affecting materials and final production.

The final chart compares the capacity utilization estimates for all manufacturing to manufacturers' purchase of new plant and equipment. The turning points in capacity utilization show a decided lead over those in the plant and equipment series, but capacity utilization clearly does not account for all of the movements in the plant and equipment expenditures series.

TABLE 1.—*Major materials output as a percent of capacity (quarterly, seasonally adjusted)*

Year	I	II	III	IV	Year	I	II	III	IV
1947	91	89	89	90	1955	86	89	91	92
1948	90	90	91	90	1956	92	90	80	90
1949	88	79	78	73	1957	89	85	84	79
1950	87	91	94	94	1958	69	67	73	78
1951	96	96	94	91	1959	83	87	66	74
1952	90	75	80	91	1960 [1]	85	80	74	69
1953	90	91	90	83	1961 [1]	69	76	79	80
1954	78	77	77	81	1962 [1]	82			

[1] Estimated on the assumption of 1½ percent increases in iron and steel capacity during 1960 and during 1961.

[3] Specifically, the following two equations, converted to logarithms, were fitted to seven observations starting with the beginning of 1955:

$$y_{3t} \div y_{1t} = a_1 b_1{}^t u_t,$$

and

$$y_{3t} \div y_{2t} = a_2 b_2{}^t v_t.$$

The Commerce series was y_1, the McGraw-Hill capacity index y_2, the indexes based on the McGraw-Hill rate-of-operations figures y_3, u and v random disturbances, and a's and b's regression coefficients. From estimates of the a's and b's, two values of y_3 (one from each equation) were calculated for all years, and an average of these two was taken as the final capacity measure.

TABLE 2.—*Manufacturing output as a percent of capacity (quarterly, seasonally adjusted, 1947–62)*

Year	I	II	III	IV	Year	I	II	III	IV
1947	91	90	88	89	1955	87	90	91	92
1948	88	88	87	85	1956	90	89	87	89
1949	81	77	78	77	1957	88	86	85	80
1950	80	86	92	93	1958	74	73	77	79
1951	94	93	89	88	1959	82	88	84	83
1952	89	88	89	95	1960	87	86	84	80
1953	96	96	94	87	1961	77	82	84	85
1954	83	83	82	84	1962 [1]	85	------	------	------

[1] Preliminary.

CHART 3

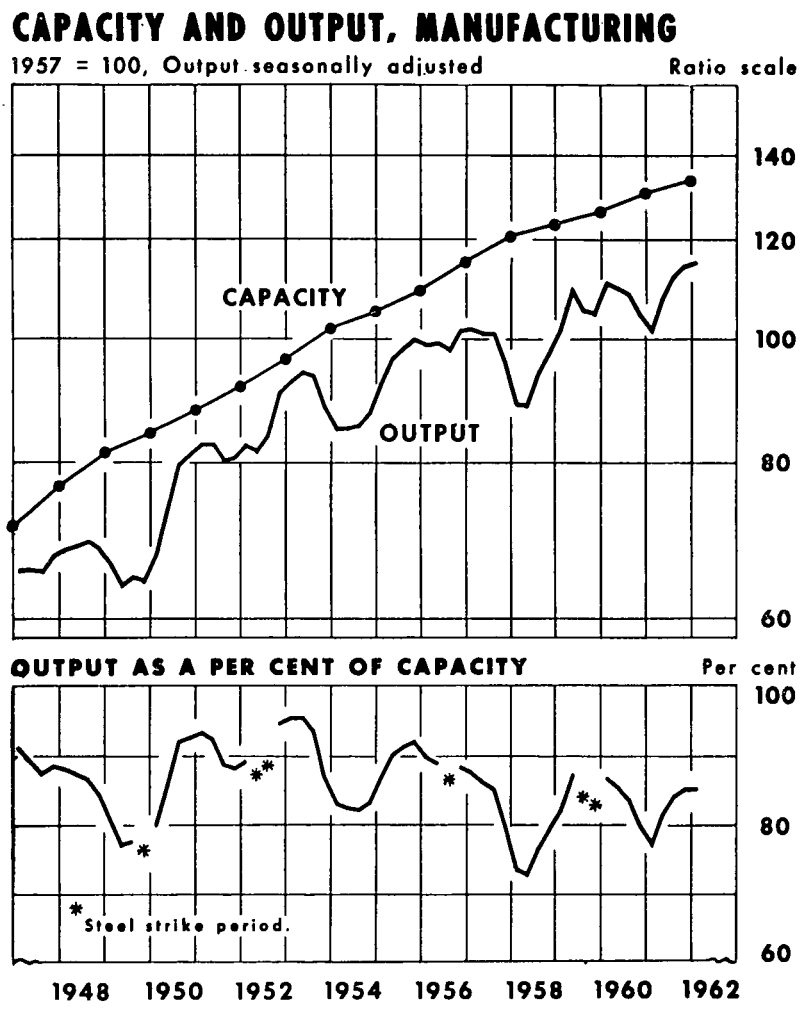
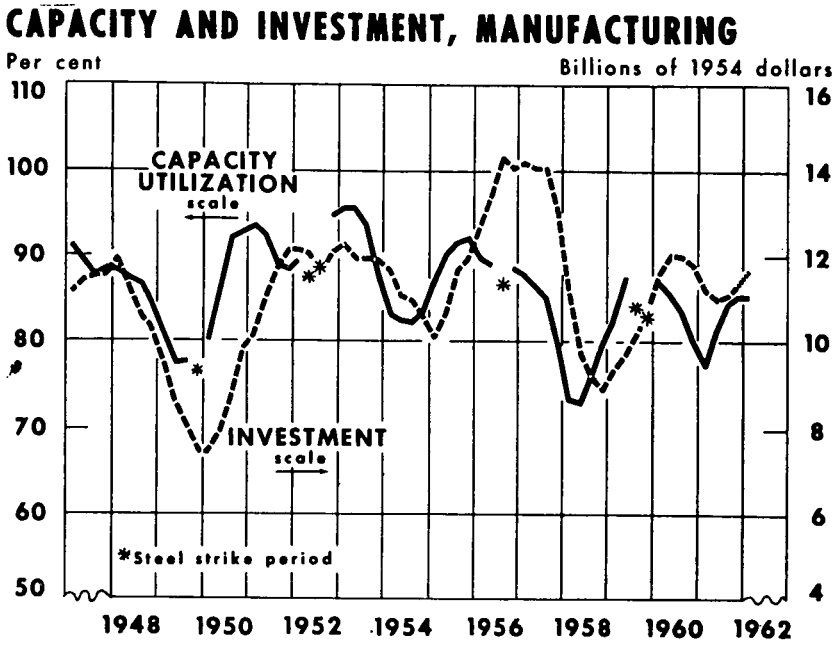


CHART 4



POSSIBILITIES FOR IMPROVEMENT

Of the two capacity measures described in the two foregoing sections, one is extremely crude, and one has severely limited coverage. Both, as the chart suggests, are of some use for current economic analysis, but current economic analysis could profitably use far more capacity information. In concluding this statement, therefore, it seems appropriate to offer two suggestions for adding to our knowledge of capacity.

First, a proposal that a capacity question be considered for inclusion in one of the periodic Government surveys of business firms—for example, the quarterly plant and equipment survey of Commerce-SEC, or the annual survey of manufacturers. Officials or establishments might be asked to compare their actual output during a year (or quarter) with their potential output. "Potential output" might be defined as the output that could have been turned out using end-of-year or end-of-quarter stock of plant and equipment, and assuming normal product-mix, normal number of shifts and days per week, normal repair time, and no shortages of men or materials.

The question might list 8 or 10 choices—for example, "30 to 40 percent," "40 to 50 percent," and so on—and ask respondents to choose the most appropriate range. Quarterly or annual replies to such a question from a broad sample of firms would add immensely to our knowledge of capacity. The sample might be drawn initially from industrial firms and perhaps eventually from other sectors of the economy as well.

Pioneering work in this kind of inquiry has been done by the McGraw-Hill staff, whose survey question on rate of operations is

similar to the question proposed above. The National Institute of Economic and Social Research in England has also experimented along these lines. The work of these two groups would seem to demonstrate that firms can supply information on capacity utilization, however complex the underlying concepts may be.

One advantage of including a capacity question in one of the Government-sponsored surveys would be that the samples in these surveys are larger and more stratified than in any private survey of business firms. The body of related information which is collected in the Government-sponsored surveys might make possible some valuable editing checks on the plausibility of the replies to the capacity question. And having capacity utilization and other information available on a firm-by-firm basis might also make possible some valuable cross-sectional studies of business behavior, as it has in the case of the McGraw-Hill data.

There are, to be sure, objections to the proposal. A question on potential output would be more speculative, less concrete, than most questions in current business surveys. In this respect, it resembles questions on anticipated sales or expenditures; the latter type of question asks for estimates about the future, the former for estimates about what might have been feasible in the recent past. At long intervals, firms might be asked to specify their "normal" assumptions as to shifts per day, downtime, and so forth, but over short periods, we might know nothing about changes in these "normal" assumptions.

In spite of these objections, however, it seems likely that the replies to the proposed question would be useful. We have good reasons for supposing that capacity influences prices, costs, and fixed investment. The more or less haphazard collection of capacity measures we now have tends to confirm these suppositions, but is not reliable or extensive enough to provide a firm basis for judging current developments. An attempt at a better measure seems a logical step to take.

In conclusion, a more specific suggestion; namely, that the American Iron & Steel Institute resume its annual capacity survey. The measurement of steel ingot capacity has its perplexing problems, but the benefits for general economic analysis of having the institute's best estimate seem to me far greater than the possible dangers of misinterpretation.

Senator PROXMIRE. Mr. de Leeuw, I want to thank you very much. Once again, this is a very interesting and helpful presentation.

You discuss the meaning of capacity, and I presume that your first definition, with normal operating speed, number of shifts, et cetera, is the one that you advert to later on, when you are talking about your charts, and so forth. Is that the concept that is used by the Federal Reserve?

Mr. DE LEEUW. In the first and second charts, based on the materials figures, they are what you would call engineering estimates for the most part. In other words, capacity is taken as the output which the plant manager or the engineer regards as feasible, without running into prohibitive costs. And then, sort of appended to these engineering estimates, are certain normal assumptions as to downtime.

In the third and fourth charts, relating to all manufacturing, I think you could say that the normal concept is being used. The measurement

is so indirect that it is hard to say exactly what the underlying definition is.

Senator PROXMIRE. Now, you say:

Apart from strikes, the range of capacity utilization indicated in the chart runs from 96 percent in the first two quarters of 1951 to 67 percent in the second quarter of 1958,

and then you go on to discuss—

Capacity utilization in the first quarter of this year is estimated at 82 percent.

Then you are talking about the same kind of capacity that McGraw-Hill was, when they were before us?

Mr. DE LEEUW. Yes, I think so, roughly.

Senator PROXMIRE. And the Wharton index, which is a capacity measurement based more on an economic concept, that is, the notion of maximizing profits, would be quite different, and for the reason that theirs is higher than McGraw-Hill, I understand, it would be higher than yours, at least at the present time, for this reason. Is that correct?

Mr. DE LEEUW. I think that basically the reason theirs is higher than the others is that capacity can never exceed actually attained output, under their definition. So, as you say, this would probably be closer to a "most efficient" definition of capacity than the engineering or McGraw-Hill definitions.

I think theirs is high currently, though, partly because they define capacity as equal to the attained peak in each successive cycle. And if you look at chart 1, for example, you will see that successive output peaks, as we measure capacity, have represented lower and lower utilization, since at least 1953.

Senator PROXMIRE. Will you spell out a little bit more? In your statement you say:

While basic manufactured materials are covered adequately, the total is only a small fraction of the entire industrial sector.

And you say:

The area covered is probably of strategic importance in gaging price pressures and bottleneck developments, but may not serve well as an indicator of a broader total.

What do you mean by that? What utility would additional coverage provide?

Mr. DE LEEUW. Well, especially in using a measure of this type for estimating demand for plant and equipment, I think you need a broader total. I think this measure is of particular use in price and cost developments, but that a broader total is needed for plant and equipment developments. The broader total might also be of use in analyzing price developments.

Senator PROXMIRE. In plant and equipment developments in what way? Estimating, forecasting, investment?

Mr. DE LEEUW. Yes, in discussing the outlook for investment expenditures.

Senator PROXMIRE. Has there been demand directed to the Federal Reserve for more coverage with this in mind by business groups or others?

Mr. DE LEEUW. There has been interest in whether we could come up with a broader measure, yes.

Senator PROXMIRE. Yesterday there was an expression of some concern by the statistical users on the inadequacy of capacity figures, capacity data, and while the Federal Reserve Board was not singled out at all, it was the feeling in general that the Government statistics were inadequate, and they said they were about the same quality level as unemployment statistics in 1920.

Mr. DE LEEUW. Yes. I would also say our experience has been that any figures we have come up with have been grabbed up very eagerly; there has been quite a bit of demand.

Senator PROXMIRE. Would the addition of greater coverage in any way, in any significant or substantial way, increase the burden on the Federal Reserve? Would it not be a much more costly operation? Would this not be a fact?

Mr. DE LEEUW. Yes. The Federal Reserve does not do any surveying of business firms itself, now.

Senator PROXMIRE. You simply use the data that is gathered?

Mr. DE LEEUW. That is right. And the proposal that I discussed a few minutes ago was that the capacity question be incorporated in one of the already existing Government surveys of business firms; and Federal Reserve does not have any such survey. The Federal Reserve does not survey business firms.

Senator PROXMIRE. There would be no significant increase in cost, as far as the Federal Reserve is concerned?

Mr. DE LEEUW. I am not sure I understood the question.

Senator PROXMIRE. Well, later I am going to ask Mr. Bowman about the effect on the Census and on other agencies that would have to gather the information and would have to do more work, perhaps; but I wanted to be sure of my assumption that the Federal Reserve Board had a greater coverage, instead of—30 groups now, is it?—you have 60 groups covered.

Mr. DE LEEUW. Well, we have 17 materials.

Senator PROXMIRE. Seventeen materials, well, I have heard 30 groupings. But say you had that doubled or tripled or quadrupled, increased very greatly. The burden on the Federal Reserve would not increase greatly. You would not have to acquire additional economists or analysts?

Mr. DE LEEUW. I think it would not be significant.

Senator PROXMIRE. I felt that would be true, but you can never be sure. Later in your statement you say:

> Finished goods prices are here taken to represent the general level of prices and costs, so that the chart relates capacity utilization to the margin of materials prices above general prices and costs.

How reliable and consistent do you think this is? Do you have any experience that would indicate whether or not this is fairly correct and precise?

Mr. DE LEEUW. Well, if you look at chart 2, you can see in the bottom panel that there is by no means a perfect relationship. There is quite a scatter around any kind of average line you could draw through the points. In that sense, there are certainly many other influences on prices.

Now, maybe your question refers to the accuracy of price figures.

Senator PROXMIRE. What I am getting at is this: You know, there is a great dispute in the country and great disputes between some Members of the Congress and the Federal Reserve Board, on their monetary policy. And there is a feeling on the part of some people that the Fed is supersensitive to inflation, and feels that if we grow too rapidly, we are going to have inflationary pressures that will drive prices up quite sharply.

I presume that they rely to a considerable extent on this kind of analysis in their feeling that if we get above 90 percent of capacity operation, the effect is inflationary.

My question is: How comprehensive and how reliable is this kind of analysis here in judging the effect of greater utilization of capacity on the general price level?

Mr. DE LEEUW. Well, I obviously cannot speak for the reliance the Board might place upon it.

Senator PROXMIRE. I know; but I presume they do consider this as data which relates to their judgment.

Mr. DE LEEUW. I think all I can say is that it is one piece of evidence that seems significant.

Senator PROXMIRE. Is there any other specific, objective, tangible evidence which the Federal Reserve Board considers, statistical evidence that they consider, in arriving at this judgment on the effect of capacity utilization on prices?

Mr. DE LEEUW. Well, I really would hesitate to speak for what the Board considers or does not consider.

Senator PROXMIRE. To your knowledge, this would be one of the elements which is available for consideration. You know of no other specific evidence of this kind, at least?

Mr. DE LEEUW. Let me say that the research staff of the Federal Reserve Board considers a great many influences on prices and price developments.

Senator PROXMIRE. You see, the difficulty is that whenever you have good, hard, objective statistics, you cannot argue with them. They are honestly gathered. You can dispute their interpretation of them. You can indicate that you think they may not be appropriate or pertinent or that their significance is exaggerated or is irrelevant. But at least they are objective and specific.

And we can argue on theoretical grounds all we want to about the effect of growth on prices; but when you have these kinds of statistics, it seems to me they can go very far in their influence and be very effective.

You have at least one hard core in your argument which is very hard to dispute. And I am just trying to evaluate how significant this is, how reliable it is.

Also, I suppose a more constructive question might be: Would the addition of greater coverage significantly improve this?

You have indicated in your statement that you think this is quite reliable; but would there be significant improvement if you could get greater coverage?

Mr. DE LEEUW. I think I indicated that there are quite a few materials not covered; so that significant improvement might well result.

Senator PROXMIRE. Of the other materials that are covered, do you think they are a fairly representative sample?

Mr. DE LEEUW. Well, the main deficiencies in the sample are in the areas of building materials and chemicals: Metals, textiles, paper and pulp, petroleum, are pretty well covered.

Senator PROXMIRE. Just one other question.

You say—

First a proposal that a capacity question be considered for inclusion in one of the periodic Government surveys of business firms, for example, the quarterly plant and equipment survey or the annual survey of manufacturers.

Now, we had a very interesting and constructive suggestion by Mr. Norton yesterday of a different kind, and I wanted to make sure that I understand this clearly.

You are suggesting an operating rate as the relationship. Mr. Norton was suggesting that two figures be given, one, the capacity, the actual capacity, and the other, the production.

And on the basis of these facts, which the census would gather, then perhaps the Federal Reserve or perhaps the private agencies or others can compute the rate of capacity operation.

Is this your understanding, too?

Mr. DE LEEUW. Yes; I think that is one difference between the two proposals.

Senator PROXMIRE. You see, the feeling is that perhaps Mr. Norton's suggestion might give us somewhat more objective and accurate statistics to work with than if we asked the agencies to make the computation of the operating rate, which McGraw-Hill does.

Mr. DE LEEUW. Yes; I think Mr. Norton's suggestion is for a much more exhaustive and detailed questionnaire than this would be.

Senator PROXMIRE. Yes; he would go to every plant which employs a hundred people or more, as I recall.

And how detailed would yours be?

Mr. DELEEUW. Well, if it were part of the annual survey, it would be that detailed, also; because the annual survey I think does cover all plants, manufacturing plants, that employ more than a hundred people. The quarterly plant and equipment survey does not have such broad coverage.

But as I understood it, his proposal would involve a series of questions trying to pin down what firms meant by capacity, and what kind of operating conditions they are specifying. Mine is a more impressionistic proposal.

I think probably the reason underlying the difference is that his interest is in detailed defense planning and other programing operations of a very large-scale nature, where our main interest has been broad appraisal of costs, prices, and so on.

Senator PROXMIRE. But if his proposal were adopted, it would be perfectly acceptable, I presume, to you, and you could use it very well, too?

Mr. DE LEEUW. Oh, yes. It would be more accurate than what is proposed here, I am pretty sure.

Senator PROXMIRE. OK. Then, finally, you have a very interesting proposal.

You say:

In conclusion, a more specific suggestion; namely, that the American Iron and Steel Institute resume its annual capacity survey.

It has been suggested that on the basis of recent experience the Federal Reserve has more influence with the steel industry than the Congress does.

Thank you very much, Mr. de Leeuw, for a fine presentation.

Mr. Widnall?

Representative WIDNALL. I regret I was not here to listen to your full presentation, Mr. de Leeuw. I have been trying to catch up by reading it.

You refer to "obsolete capacity"; what is "obsolete capacity," and why is it even considered, if it is obsolete?

Mr. DE LEEUW. This is in connection with iron and steel?

Representative WIDNALL. Yes.

Mr. DE LEEUW. The reason it is obsolete is that the costs per unit of output are so high, using that capacity, that it is not economical to operate it except under, say, wartime conditions, or emergency conditions.

The American Iron and Steel Institute made the determination. I do not know the details of how they made it, but they made a determination every year of which open hearth furnaces fell into this category, and they would remove those from their capacity total.

Representative WIDNALL. Then when you are talking about the potential capacity of the steel industry today, it includes modern milling methods all the way through, because you have eliminated and excluded the obsolete?

Mr. DE LEEUW. Well, yes. That is the general idea; but I do not know exactly where the line is drawn between modern and obsolete. It is possible that some of the capacity that is included is very old. That certainly is true; some of it dates back several decades.

Representative WIDNALL. I get quite confused when they talk about capacity, anyway, because as new mills are built, or there is an expansion of facilities, that increases productive capacity. But what is 62 percent in 1955 is entirely different from 62 percent in 1962, because of the expansion in the industry. So a true figure, in relationship, should not be percent of capacity, but the amount of ingot production, should it not?

Mr. DE LEEUW. Well, the amount of production is certainly important, and it is measured every week, in fact, in the steel industry.

If you are interested in the problem of when price pressures begin to build up, or when the industry is going to have strong pressures to buy new plant and equipment, then perhaps the first figure is more important, the measure of how close they are to their capacity.

Representative WIDNALL. You could operate, say, at full capacity in 1955 and produce 50 million tons; and today you could operate possibly at 50 percent capacity and produce 50 million tons. Now, which is the better way of relating our progress, the tonnage, or the percent of capacity?

Mr. DE LEEUW. As a measure of economic growth, I think the output is more directly relevant. But as a measure of what kinds of pressures are building up, or are not building up, when the steel industry is turning out 50 million tons, you want to know what percent of capacity that represents.

In other words, the output which the steel industry was turning out at the end of 1955 and early 1956 represented quite a strain on

its facilities and generated quite a demand for new capital goods on the part of the steel industry. That same output today would not, presumably, have the effects it did then.

Representative WIDNALL. But how many more tons could the seeel industry produce today without needing expanded facilities?

Mr. DE LEEUW. Well, as I mentioned, the capacity survey that the Iron and Steel Institute used to conduct every year was discontinued after 1960. Now, at that time, early 1960, I think the capacity was something like 148 million tons, and in 1955 it must have been about 120 or something like that.

Representative WIDNALL. Do any of your figures or methods show the capacity to compete? By that I mean the methods used in the steel mill here as against the methods used in the steel mill in Sweden and in Germany, that go beyond just percentage of capacity of operation. Are we reaching a point where we may be operating at 50 percent of capacity, but losing more of our business overseas because of their ability to compete better through newer methods? Do we have any check on that?

Mr. DE LEEUW. Well, there are statistics that one could bring to bear on that problem; but these capacity figures that we have been discussing are pretty far removed from the evidence that you need to discuss that problem.

Representative WIDNALL. That is all. Thank you.

Senator PROXMIRE. Thank you, Mr. de Leeuw.

We also have with us this morning Mr. Raymond Bowman, Director of the Office of Statistical Standards. Mr. Bowman, as I said before, we are delighted to have you with us, as always, and we are looking forward to your testimony.

You can go right ahead.

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

Mr. BOWMAN. Thank you, Senator.

I have a brief statement.

I certainly welcome the opportunity to appear before the committee again, and to participate in this discussion of a very important topic, I think especially important from the standpoint of the statistical approach.

Mr. Chairman and members of the committee, the measurement of capacity as a tool for economic analysis presents major difficulties.

I shall attempt very briefly to indicate some of the variations as I see them, in concepts of capacity and, hence, in measurement when they are used for different analytical purposes. At the close of my remarks, I shall outline certain general directions in which it seems desirable for the statistical program of the Federal Government to move in order to assist in providing reasonably valid estimates of capacity or related measures for economic analysis. It should be recognized, however, that efforts to measure capacity, to clarify the uses of such measures and to refine concepts, should include the entire economic research community.

Such expressions as "the economy's capacity," "the industry's capacity," "the capacity of a firm, or of an establishment," "the ca-

pacity to produce a particular product," or in some instances "the capacity of a machine" or of an "industrial process" are used quite frequently by economists, business management, and many others.

In general there is a fairly common criterion in mind on which the notion of "a capacity" is premised; namely, fixed capital facilities at some point in time. To increase capacity would then mean to increase capital facilities.

Now, it is quite obvious that it is possible to think of other than capital facilities as limiting production—manpower and raw materials are also limiting factors. It is clear that the capacity of a machine tool plant to produce machine tools has little meaning if there were no machinists or no materials from which they can be produced. But for most concepts of capacity, the limiting factor is considered to be fixed capital. This, however, is a short-run concept.

Capital facilities can be expanded for particular products, but because industries are interrelated and the final products of some are the intermediate products of others, expansions tend to be associated together, but not necessarily proportionally. In the long run, the more basic limitations on the output of an economy are its manpower and natural resource, coupled with the willingness to invest in fixed capital facilities under the technological conditions prevailing in relationship to costs and prices.

In the short run, it is also generally assumed that fixed capital facilities are specialized so that the capacity for different industries or products can be estimated separately since there exists only a certain amount of capital facilities specialized to the production of each type of output.

It is recognized, of course, that this is not completely true, and that under certain circumstances automobile factories could stop producing automobiles and turn out machine tools, guns, or tanks. Automobile production facilities are, partly, at least, transferable to other purposes if circumstances are such as to warrant a transfer.

The capacity concept dealt with thus far is largely an engineer's concept of a limitation on physical output related to fixed capital facilities, and to some extent applicable independently to each type of output as well as to the aggregate of such outputs, and assumes manpower and materials are available.

Under the engineer's physical limit concept of capacity, it is clear that while elements of the economic process are present, the basic idea is physical relationships between what can be produced and what is being produced, and what changes in capital facilities are required to expand or contract the capacity.

However, if more attention is directed toward economic factors, the meaning of capacity as a specific physical limit becomes much less appropriate. Some industries work one shift, others two, and still others three. These practices represent a general adjustment to demand conditions as well as to conditions of labor and materials supply and efficient utilization of capital facilities. To assume that all facilities could be operated three shifts would be unrealistic in terms of general economic considerations. The notion of a physical capacity output level based on available capital tends to change the idea of capacity as a preferred or most profitable output level.

Under certain conditions, if output reaches a certain level, it may be more economical to expand capital facilities, although with exist-

ing facilities utilized more intensively, it would be possible to produce a larger physical output. But reaching a level of output with existing facilities which is beyond the preferred level of output may, under some circumstances, not justify capital facility expansion, if it is anticipated that the high level of output will not continue. It may appear desirable to the enterprise to produce "over the preferred level" and in excess of what is thought of as capacity, rather than expand capital facilities, when expectations as to future sales are uncertain. At other times, capital facility expansion may take place before the preferred limit is reached because expectations concerning demand are considered very favorable. Furthermore, technological improvements may bring about the addition of new facilities, even though physical output capabilities are quite adequate, because resulting cost reductions are expected to improve profit positions.

It is these economic aspects of capacity which are most important for understanding cyclical fluctuations and growth of an economy but which are least susceptible to definitive measurement. These are some of the problems which must be faced by economists who would like to construct a model of the economy in which demands for capital facility will be induced, when outputs in specific industries reach economic capacity levels.

Other testimony has outlined much of the work now going on in the field of capacity measurement, both outside and within Government. I shall study these materials carefully for guidance in the development of Federal statistical efforts. In concluding my remarks, it may be appropriate, however, to indicate three areas in which I think the statistical program of the Federal Government might contribute to the advancement of capacity measurement or provide materials useful for such measurement.

First, the Federal program should provide an estimate of the growth of capital facilities on the basis of the perpetual inventory method. One project, which is well underway in the Office of Business Economics of the Department of Commerce, is an estimate by the perpetual inventory method of business capital stocks and related items for the period since 1929. The estimate will cover gross capital stocks, discards, depreciation, net capital formation, net stocks, net-gross stock ratios, and the age composition of net and gross capital stocks. They will be carried through on alternative assumptions as to service life, depreciation formula, and valuation. An equipment-structure breakdown will be provided, as well as a farm-nonfarm breakdown.

A second project, which is still in an exploratory phase, is designed to provide data on capital stocks and the related items on an industry basis. The time period for the estimates has not yet been specified. It would be desirable to provide the industry data for the same kinds of magnitudes as will be provided in connection with the first project, and, also as in the case of the first project, on the basis of alternative assumptions as to service life, et cetera; but it is clear that lack of data will preclude the preparation of complete industry estimates of this type. We do not know as yet what series, breakdowns, and variants it will be possible to provide on an industry basis.

Senator PROXMIRE. Could I interrupt there?

You say:

> One project, which is well underway in the Office of Business Economics of the Department of Commerce, is an estimate by the perpetual inventory method of business capital stocks and related items for the period since 1929.

This will be compiled to show the stocks each year since 1929.

Mr. BOWMAN. The growth in the stocks.

Senator PROXMIRE. On an annual basis?

Mr. BOWMAN. On an annual basis.

Senator PROXMIRE. Is it contemplated that this would then be carried on as a regular annual survey?

Mr. BOWMAN. Yes.

Representative WIDNALL. Why is 1929 selected as the beginning point?

Mr. BOWMAN. Because that is where we basically have gathered the data from which we can make the perpetual inventory estimates.

It really begins with the national income and product accounting work that was done, so that we have capital formation year by year. And what is really involved in this method of estimating is that you take the additions to capital each year. You start with some notion of the amount of capital you had at the beginning of that period. You estimate the life that capital lasts, and on a perpetual inventory basis you build up the amount that is dropping out, the amount that is being added, and the amount therefore that must be a net addition.

Now, we are going to do this in several different ways, assuming different lifetimes for the property; so that we will have alternative measures of the way in which the effective capital stock is growing.

And the reference, here, to doing it for farm and nonfarm means that we will be doing it for the farm sector and the nonfarm sector; and as to the other reference, to equipment and structures, we will be doing it for the equipment separately and for the structures separately.

Representative WIDNALL. Do I understand, then, that 1929 was selected because it was the first time when you had sufficient figures available as a base point?

Mr. BOWMAN. That is right.

Probably there will be more interest in the period since the war than there is in the earlier period, but we statisticians always like to look at a historic picture as well as merely what is happening now, because it gives us a much better perspective; and so we are trying to build this up over the period for which we have the data.

Now, to return to my statement, the second project, which is still in an exploratory phase, is designed to provide data on capital stocks and the related items on an industry basis; covering the same things. The time period for the estimates has not yet been specified.

It would be desirable to provide the industry data for the same kinds of magnitude as will be provided in connection with the first project, and also, as in the case of the first project, on the basis of alternative assumptions as to service life, et cetera. But it is clear that lack of data will preclude preparation of complete industry estimates of this type. We do not know as yet what series, breakdowns, and other categories it will be possible to provide on an industry basis.

Second, the Bureau of the Census is considering a possible approach to approximating capacity measures in the area of manufacturing.

This approach would utilize data collected by the Bureau of the Census. Briefly, the method is as follows:

1. The Census Bureau records for shipments by product class for individual establishments would be brought together and maintained in a continuous time series on tape.

2. The computer would determine the largest shipments figure for each product class of each establishment in the previous 4 or 5 years. Price adjustments would be introduced to express performance in past periods in terms of current prices, so that the appropriate relationship of past periods to the present could be established for determining the "real" peak.

3. An "attained activity" figure would be developed each year for each of the 1,100 product classes.

4. These 1,100 product classes would be combined into the 55 monthly industry survey categories, two-digit major SIC groups, or Federal Reserve market categories, as desired, and divided into the corresponding estimated actual shipments developed by standard methods from the annual survey of manufactures to get a "percent of peak attainment."

Note that we do not call this a peak of capacity, but a percent of peak attainment.

Third, to improve the content and accuracy of the capital stock estimates, it would be desirable to take a census of wealth before the close of this decade, and then about every 10 years. It is generally acknowledged that estimates of wealth (capital stocks) suffer materially from the lack of more precise and detailed benchmark data. Over the past few years, my office, the Office of Statistical Standards of the Bureau of the Budget, has been giving thought to various aspects of this problem, and held discussions on the subject within the Government. Recently the American Economic Association Advisory Committee to the Bureau of the Census considered needs for a census of wealth, and efforts are now being made by the interested economists to undertake to further develop specifications for such a wealth census.

In view of the need for better benchmark data, it seems to me that it is now time to begin the development of a comprehensive proposal for wealth measurement. But success in the development of meaningful and accurate data in this area will require careful planning and scheduling. The planning should anticipate a complete survey of all physical wealth within a single time reference during which all of the components are properly related to each other and to the aggregate. This means the planning of wealth measurement in relation to other pertinent census programs, either as parts of them or as preceding or following elements, both in order to hold the time interval to a minimum and to reduce the burden for any one program. The planning also involves, of course, consideration of any data from other sources which could be made available for the time reference selected and incorporated into the overall body of statistics on wealth.

Careful consideration will have to be given to valuation problems, and to the distinction between the use of and the ownership of wealth. The age of the asset will also be important for many purposes. These and many other problems require careful analysis and planning for their solution.

Thank you, Mr. Chairman.

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Senator PROXMIRE. Thank you, Mr. Bowman.

Mr. Widnall?

Representative WIDNALL. No questions, thank you.

Senator PROXMIRE. We have had a number of proposals, Mr. Bowman. Have you had a chance to read the proposals that Mr. Norton made yesterday?

Mr. BOWMAN. I have read most of the papers, and I have had a chance to look at his paper; and there are some interesting proposals in it.

I think this is in line with some questions that you asked Mr. de Leeuw, also, and I would like to merely make this point a little clearer.

Mr. Norton's interest is largely related to postattack planning. Therefore, for many of his purposes, he does want an engineer's concept of capacity. In other words, he wants to know what is the highest physical output that the plant could produce, because if he found such a plant after an attack, he would want to be able to say this plant can produce so much.

He knows it cannot produce anything if he does not have any workers to put into it, or any materials to supply it; but at least he has one item of information: this is what the plant could do.

In that way, he has to keep his data not in aggregates; he has to keep his data for every individual plant, and he has to know the location of that plant.

He also knows that for many purposes the plant can do different things. He wants data, therefore, that will indicate that the plant could do this if it is not doing that; so he wants it by departments of the plant.

These are all very desirable elements for one purpose, but our job would be to examine this to see whether or not, if we collected capacity statistics for that purpose, they would be useful for these other purposes as well.

Senator PROXMIRE. Mr. Norton did not read his paper but it is included in the record of these hearings (p. 90). He summarized it, and I presume he may have provided some interpretations that may or may not have been in his paper entirely. But he gave me the impression that while this was perhaps more important than anything to him, he recognized as far as the committee was concerned we would have to take the universal view that you take, too. And he therefore, I thought, did a pretty good job of relating it to the broad utility.

And it seems to me that in view of the fact that what he wanted could be very useful, as Mr. de Leeuw said, to the Federal Reserve Board, I am just wondering, to start on the most ambitious basis: Supposing we had both Mr. de Leeuw's data gathered, which is on a quarterly basis, and Mr. Norton's data gathered, which is on an annual basis, I understand, both of which are somewhat different. Mr. de Leeuw was asking for operating rates and Mr. Norton was asking for capacity and production figures.

How expensive would that be, if they were done on the comprehensive basis suggested? Because it would seem to me that there would be very great utility to public officials such as Federal Reserve Board members, and Members of Congress, the Secretary of Labor, the Council of Economic Advisers, the President of the United States, as well

as invaluable to business, in making their estimates on the future. And if the cost is modest, then I think it is something we could practically consider. If the costs are very great, we will have to start cutting down and see what we can do on a practical basis with limited expenditure.

Mr. BOWMAN. What Mr. de Leeuw suggested, and what was a possibility within Mr. Norton's proposal, was merely securing, when you make a survey, the plant's estimate of its capacity, indicating only very briefly that you are after what the plant thinks it can produce under certain circumstances, so that it becomes an economic consideration.

This does not appear to us to be particularly costly. We could attach this to the Annual Survey of Manufactures, which would give us an annual figure.

I think I would be more inclined to use that survey than I would the other one suggested, which was the narrower plant and equipment expenditure survey, because the plant and equipment expenditure survey is directed to firms, and I think we would do better in moving to industrial capacity figures if we could get capacity by establishments, from which we could build clearer cut industrial capacity, along with the knowledge that we get as to the output; because we want not only capacity but we want related output measures as well.

Now, the other thing that would make me at least want to view this rather carefully, before we did it, is whether or not we are going to get the kind of answers that we feel are reliable and meaningful if we tabulate what people say they think is their capacity; or whether we really would have to do a lot more to define what we have in mind and ask the respondent to do a lot more, so that we would be certain the figures we were getting were really meaningful.

Now, I do not deny that the work in this direction has been useful. But if the Government undertakes a program of going to all manufacturing establishments and getting a figure on capacity, and then putting it together industry by industry, we want to be real sure we know what the figure means after we get it. So that would have to be reviewed.

We are considering something a little more than the annual survey of manufactures now; namely, we are considering whether we should put any questions on the quinquennial Census of Manufactures, which will cover 1963. This would be a somewhat larger undertaking.

Senator PROXMIRE. The quinquennial census; every 5 years?

Mr. BOWMAN. That is right.

Senator PROXMIRE. I just wanted to be sure I understood.

Mr. BOWMAN. That is right. They will cover 1963 and 1968 and every year ending in 3 and 8, according to the provisions of the law now.

So we would be taking the regular 1963 Census of Manufacturing, Mining, and Business, and we are considering the possibility of putting some capacity questions into this.

Now, the program I outline is one that we could start more quickly. We would not have to gather any data at all. And we would be using something like the Wharton School scheme, because we would be using as a measure of capacity what has been attained in the past, and we would be comparing current output with the highest attain-

ment in the last 4 years, and would merely have to accumulate already existing data on electronic tapes. The computer would be programed so as to pick out the highest peak output over the last 4 years, and relate the current outputs to it. And whenever a new peak output is reported the computer would make the relationship to this peak output.

Now, there are a lot of questions here, also——

Senator PROXMIRE. Were you thinking of that as an alternative?

Mr. BOWMAN. I am thinking of that as one of the things we could do more quickly than almost anything else to make the data we now have available.

This will be discussed with the Board of Governors and other people in the near future, and I think they may have already received the memorandum from Max Conklin on this. I am not sure.

Senator PROXMIRE. Do you have any discussion on this kind of thing with the Statistical Users people? They have been very helpful to us. I realize this is not the kind of specific organization that a business group might be, perhaps, because they do represent not only business but farmers, unions, universities, and foundations, although it is quite predominantly business.

Mr. BOWMAN. We are in contact with the Statistical Users group at all times. Mr. Lowry, who is their executive secretary, keeps in touch with us, and we keep in touch with him. We attend most of their annual conferences, and we know most of the people that are particularly interested in this area of work.

Senator PROXMIRE. And you would discuss these alternatives with them, too?

Mr. BOWMAN. We certainly would.

Senator PROXMIRE. Now, how about the cost? Supposing we do go ahead with Mr. Norton's proposal. You indicated, I would say, in your response, that the primary consideration is whether the capacity would be meaningful or not, and there is some question in your mind, apparently, as to whether, if you ask a particular plant of 250 or 500 or 700 employees, the capacity, you would come up with all kinds of different answers. You would have to spell out very carefully whether you can do this concisely and without burden to everybody involved.

That is apparently what is in your mind. Is that right?

Mr. BOWMAN. The Norton proposal as I read it in the paper goes a little beyond what I think it would be worthwhile for the Government to make the expenditures for, for general purposes, unless it was recognized that much of this is going to be thought of as a cost for postattack planning.

The second point that I always bear in mind is not only the cost to the Government, but the cost to the respondents.

Senator PROXMIRE. That was my next question. I was going to ask: How about the burden on respondents in this situation?

Mr. BOWMAN. For the sort of thing that we have been discussing here orally, the burden on the respondents would not be very great. But to get them to spell out the structure of their capital facilities, to get them to indicate what the capacities would be if they changed the product mix from what they are now producing to something else, and to get meaningful results, I think, would be quite an undertaking. I would not say it could not be done.

Senator PROXMIRE. So you would suggest possibly that this might be done on a sample basis, or something of that kind, on a smaller sample basis?

Mr. BOWMAN. I would suggest it probably ought to be done in those areas where what are known as survival items are really important; and we are doing some of this now at the Business Defense Service Administration in the Department of Commerce. We probably ought to do more in this agency on survival items.

And I am not saying we should not do it, in the Bureau of the Census, at all. I am merely saying we should consider the cost of doing it, and the relevance of it for economic analysis as contrasted with post-attack planning. These are different end products.

Senator PROXMIRE. And how about the confidentiality? Is there a special problem? I know we always have this problem. I am not talking in general, but in relation to these particular questions. Do they raise any special or different confidentiality questions that would not already be raised by data already supplied?

Mr. BOWMAN. In the terms in which we have been talking about them, I do not believe so.

Senator PROXMIRE. There is no particular reason why they would be concerned about providing this kind of data when they already provide the data they do?

Mr. BOWMAN. I think if we get into details on capital stocks by age, there may be some elements of that present. But confidentiality, therefore, becomes important, because you are not letting the knowledge move from one competitor to another. But in terms of its being used for statistical purposes, I do not feel this would be a critical area.

Senator PROXMIRE. Just one other question on detail. You say:

> The planning also involves, of course, consideration of any data from other sources which could be made available for the time reference selected and incorporated into the overall body of statistics on wealth.

This is following your discussion on wealth.

What is the purpose of gathering statistics on wealth and indicating who owns it, and so forth? I am very interested in that, but I am just wondering.

Mr. BOWMAN. Well, you notice that the first project I mentioned is one in which the Government has already started, one which we think is important as contributing to the study of capacity. We do not think of it as a measure of capacity itself, but as knowledge of the capital facilities that are available to the American economy.

Senator PROXMIRE. Maybe I should have asked first for a definition of wealth. When you say "wealth," I think not only in terms of these technological and even economic considerations you are talking about now, but in terms of social considerations, too. You would relate this, for example, to the individual wealth, to the proportion of the population, for example, that owned and controlled the wealth of the country, and that kind of thing?

Mr. BOWMAN. Right now, I am merely thinking of an inventory of the physical wealth, the buildings, machines. Whether or not it should include what is often called consumers' wealth in the inventory is a different problem, that is, whether it should include refrigerators, automobiles, residential houses.

Senator PROXMIRE. All that we think of as wealth, stocks, bonds, savings accounts, et cetera?

Mr. BOWMAN. This would be what we call claims on wealth. If we would be able to do everything we would want to do, we would really like to be able to show the wealth as physical assets, and then who owns that wealth, as stock owners, bond owners, mortgage lenders; in other words, so that one would have the physical assets themselves and the claims against the physical assets.

Now, this is a little more ambitious than we are thinking of for the census, but not more ambitious than we are thinking of eventually in setting up a system of accounts like the national income and product accounts, but which will be what we call sector balance sheets, in which we will have some notion of what the physical assets are in each of the principal sections of the economy, and who owns those physical assets.

Sector balance sheet can be tied in with the flow of funds accounts, which show how the sources and uses of funds move into the financing of the economy and its capital structure.

Senator PROXMIRE. And who owns these? For example, would you indicate the wealth the farmers hold, the wealth of urban people in some kind of category? How would you break this down?

Mr. BOWMAN. Insurance companies, people, banks.

Senator PROXMIRE. Also classified in terms of 1 percent of the people owning 10 or 15 percent, or something like that?

Mr. BOWMAN. No; this is the distribution of wealth among individuals. Our interest in recent years has not been so much with the distribution of wealth as with the distribution of income, and we do have information on the distribution of income, how many people receive incomes of certain amounts.

Senator PROXMIRE. They are both interrelated and both very important. It is very hard to make all your analyses in terms of social justice on the distribution of income. Wealth is important, too.

Mr. BOWMAN. Historically, the interest was in wealth. It shifted to the distribution of income. There is now some interest shifting back, because people want both. But what I am proposing here does not relate to the personal distribution of wealth, but to the distribution among the sectors of the economy in terms of the physical assets, which I think is very important for really knowing what is true of the capital facilities of the country from which our production stream flows.

Representative WIDNALL. Mr. Bowman, would that include a compilation of the wealth of labor unions, their holdings?

Mr. BOWMAN. Well, insofar as they have buildings, it includes those buildings. Insofar as they are holders of claims, stocks, and bonds and so forth, the Census of Wealth would not go into that. It would merely deal with the physical assets.

Representative WIDNALL. But did I not understand you to say you would do it for individuals? You would have a compilation of the wealth of individuals?

Mr. BOWMAN. If I were trying to explain the ownership of the physical assets in terms of broad economic groups, it would be ownership by individuals, ownership by banks, ownership by insurance companies. These would be the claims on the physical stock of wealth,

and this would give you a picture, therefore, not only of what the assets of the economy are in physical terms, how these assets are distributed among the various sectors of the economy, but where the ownership for these various types of wealth are also lodged, in terms of the mortgages or claims against them that are represented by stocks and bonds and mortgages and so forth.

Senator PROXMIRE. Mr. Knowles has a question.

Mr. KNOWLES. I want to clarify that, before there is a misimpression, though. What you are saying we should look forward to trying to do before the end of this decade is merely one side of that sheet that you are talking about?

Mr. BOWMAN. That is right.

Mr. KNOWLES. Namely, an inventory of what the assets are. You are not proposing at this time that it include a tabulation of who holds the claims against the assets, now. So you are in effect going to tabulate one side of the balance sheet and not the other. Is that correct?

Mr. BOWMAN. That is what we mean by a census of wealth. Eventually we hope to be able to get the information for the other side, but not in the census of wealth. It will be physical assets that we will be making an inventory of.

Senator PROXMIRE. What are the statistics available now on the claims or individual holdings in wealth? To what extent are they available on a reliable and accurate basis?

Mr. BOWMAN. Well, there is a considerable amount of information available on the ownership of securities, bank deposits, insurance company holdings, and so forth.

One of the problems of a balance sheet is, of course——

Senator PROXMIRE. There is no global, universal data, though?

Mr. BOWMAN. Well, estimates have been made. Raymond Goldsmith has made estimates of the wealth of the United States, in which he shows physical assets on one side and the claims against it on the other.

Now, these have all been made on the basis of what are known as perpetual inventory methods, so far as the physical assets are concerned, and many other methods, so far as the claims are concerned.

We have not made any attempt at a physical inventory of wealth since about 1922. I think it is about time that we did this; and this is why I am advocating it; and I do not think it is unrelated to what has been brought out here concerning capacity.

Senator PROXMIRE. Is that a pretty comprehensive and accurate survey, that of 1922?

Mr. BOWMAN. Well, it was fairly complete. It did not survey all items; and the area in which we probably had the least experience is what we call commercial assets, commercial buildings.

Senator PROXMIRE. There was far less utility in that in 1922, in view of the things they did not have related, than in 1962.

Mr. BOWMAN. This was the Federal Trade Commission survey, as I remember, at that time.

Senator PROXMIRE. Thank you very much, Mr. Bowman and Mr. de Leeuw. We appreciate this testimony a great deal.

This concludes the subcommittee's hearings on the measures of productive capacity. The hearings have been most helpful to the Congress and to the general public.

We owe a vote of thanks to all the witnesses who have prepared statements and have testified, giving their valuable time.

The record will remain open for the next 2 weeks to include the supplemental statements that we anticipate receiving.

The committee stands adjourned.

(Whereupon, at 11:40 a.m., the committee was adjourned.)

SUPPLEMENTAL STATEMENTS

Measuring Capacity in the Paper Industry

(By Robert S. Schultz, 3d, Director of Statistical Analysis, Union Bag-Camp Paper Corp.)

(This report was developed as a talk on paper capacity and operating rates for presentation at a seminar, "Statistical Problems in Measuring Industrial Capacity," at the 1961 American Statistical Association convention. Since the time available for any single speaker was naturally limited, the discussion as presented, and as to be published in the 1961 Proceedings of the Business and Economic Section of ASA, represented a most summary treatment of the questions involved.

(Because various problems in measuring paper capacity, and particularly the relation between capacity and technology, are treated elsewhere inadequately if at all, it has seemed worthwhile to present a somewhat more extensive version.

(This report, however, while more detailed than the text published in the proceedings, is only a start. It is hoped that this beginning analysis may prompt others to more detailed and definitive study of the various problems presented here.)

Capacity is a very difficult thing to measure in any industry. The concept is not precise, to begin with: Does it refer to a maximum output under certain specified conditions, or to an optimum, most profitable output? Do you measure capacity with one 8-hour shift? Or two? Or three? What is the role of seasonal factors? Of design changes; of shifts in the mix? How do you define your industry? Who is in it? What is the role of technological change?

The problems are so general that at least some economic statisticians have concluded it is impossible to measure capacity. But difficult or not, we must make the attempt, because of the importance of capacity measurements for studies of individual industries and of the general economy. With a capacity measure it is possible to determine the operating rate, which is an important influence on, if not the major determinant of, profit margins. With a measure of capacity, over time, we can determine change in capacity, and change in capacity is closely associated with, if not immediately a function of net private domestic investment. Thus from the static concept of capacity, at given points in time, we can obtain two values of great significance in the two dynamic fields of the business cycle and economic growth.

This particular analysis is concerned with capacity in the paper industry. By comparison to the average industry, the paper industry has a very easy time measuring capacity. The industry is rather precisely defined, and data can generally be adjusted for any particular definition desired. There are only a finite number of paper machines, whose output is more or less given, and which run 24 hours a day, so there is no question about number of shifts per day. Maximum daily output and optimum output are substantially the same for

any given machine. Seasonal factors, while significant, have less impact than in many industries; changes in product mix can have sharp effects at any particular moment, but tend to average out over time. Technological change, while continuous, has not confronted the industry with anything like the steel industry's oxygen lance, rendering capacity temporarily indeterminate.

Ostensibly we can simply determine the capacity of each paper machine at a given point in time, and sum to get a capacity figure for the industry. And actually there are figures on this basis going back to 1899. There is no lack of capacity data in this industry, but there are several problems of concepts and of comparability to be solved in any attempt at a precise statement of these capacity figures. The particular difficulties are in many cases unique to the paper industry, but they may be illustrative of the types of problems which must be solved in measuring capacity in manufacturing industry generally.

TECHNOLOGY

Before proceeding further, we should consider briefly some questions of technology. Technology is a field in which the economist tends to feel uncomfortable, but it is a factor we need to allow for more explicity. As someone said, I believe it was Werner von Sombart:

> "The Wealth of Nations" would have been a very different book if Adam Smith had seen a cannon foundry instead of a pin factory.

In one way or another the problems of measuring capacity in the paper industry reflect the technology of the paper industry, and this is undoubtedly true in industry generally.

Paper is defined as:

> The name for all kinds of matter or felted sheets of fiber (usually vegetable, but sometimes mineral, animal, or synthetic) formed on a fine wire screen from a water suspension.[1]

There are two basic parts of the papermaking process: (1) separating the fibers and (2) matting or felting them. The first part may be regarded as making pulp; the second as making paper. Where wood is used as the fiber source, and 72 percent of the fiber used in papermaking came from wood in 1960, the fiber separation is accomplished by a grinding process for mechanical pulp and, for the chemical grades (74 percent of 1960 woodpulp production) by a chipping process completed with a "cook" with a chemical solution under extreme heat and pressure.

In the case of wastepaper, which accounted for 25 percent of 1960 fiber consumption, fiber separation is accomplished through mechanical disintegration in water. (In the remaining 3 percent, chiefly straw and rags, fiber separation is accomplished by various shredding and "cooking" methods.)

At the end of the fiber-separation process the fiber is suspended in water, and the papermaking process per se consists of removing the water, leaving the fibers matted or felted together in a sheet of paper. There are two principal types of machines for accomplishing this removal of water from the fibrous solution: the Fourdrinier machine,

[1] American Paper & Pulp Association, Dictionary of Paper, 2d ed., 1951.

which accounts for most production of paper and board, and the cylinder machine, generally used for the so-called boxboard grades. (In addition, there is a third type, the forming machine, used for certain special grades.)

There are various differences in the basic types, but the general principle is the same. With the fiber suspended in water, most of the water is drained away through a fine wire screen, and the balance removed by heat and pressure. (Where woodpulp is produced for use in a separate papermill at a different site, the pulp is dried in a similar way, though the drying process is not so complete.)

In a Fourdrinier machine, as an example, the slurry, about 1 part fiber to 200 or more parts water, flows from the head box over fine wire screens, through which most of the water drains away. The moist sheet is then pressed between rubber-covered rolls and heavy woolen felts to squeeze out additional moisture, and finally the remaining moisture is driven off by passing the sheet over massive, steam-heated dryer rolls. With the moisture removed, the dried sheet may be further squeezed between heavy cast-iron rolls (calenders) to make it smoother and to control its thickness. (It is an exciting experience to stand by a paper machine—tremendous monsters they may be—and to see at the "west end" a fast-flowing stream of water; to follow it along, by eye, and watch it imperceptibly acquire and then increase in consistency, so that before leaving the "couch roll" it is no longer a stream of water but a moist sheet of paper.)

EFFECTIVE DAILY CAPACITY

There are several variables affecting the effective daily capacity of a paper machine. Some of these factors are reflected in the design of the machine and can be changed only by changing or modifying the machine; others are susceptible to short-run variation. For example, the "trim" or width of a machine limits its capacity, and this can be changed only by rebuilding the machine. Similarly, the speed of a machine may be increased more rapidly than "trim" but the process still requires changes in capital equipment. Another basic factor, not too easily changed, is the grade of paper for which the machine is designed. The grade or type of paper is a term generally referring to some concept of end use, usually related to the physical characteristics of the paper, e.g.: newsprint, tissue paper, writing paper.

Machines can be designed for a high degree of flexibility, although there is a general tendency to emphasize a particular grade. "A noteworthy feature is the adaptation of paper machine design to the manufacture of very definite products as a result of the far-reaching specialization of the paper industry in standard grades. In this way the highly developed single-purpose machines for the highest speeds and capacities have been evolved." [2]

However, despite this tendency to concentrate on particular grades, there remains a fairly high degree of operating flexibility, at least within major grades. A kraft paper machine may make wrapping paper or shipping sack paper; a tissue machine may make napkin stock

[2] OEEC, "The Pulp and Paper Industry in the U.S.A., 1951," p. 209.

or toweling stock. Some machines can alternate between paper and paperboard (the heavier grades used primarily for boxes). Potential production—capacity—for any given machine tends to be highest for some particular grade or grades, according to the design of the machine, but it is usually necessary for any machine to produce grades or subgrades other than those for which it has been particularly designed, and the effect of this is to reduce the tonnage output—to reduce the capacity.

These differences between grades (and subgrades) reflect various factors: type of wood pulp (or other fiber source) used, degree of refinement of pulp, extent of "calendering" of the sheet of paper, and so forth. In addition to these factors there is the question of weight of the paper.

By varying either the concentration of fiber in the suspension (which may range from 0.2 to 0.7 percent of the quantity of suspension admitted to the wire screen, or both), you can vary the thickness and weight of the paper produced. The weight—the "basis weight"—is determined by the weight of a ream of paper. The definition of a ream varies from grade to grade, but is usually in the neighborhood of 480–500 sheets of paper, measuring anywhere from 17 by 22 inches to 25 by 38 inches.

The heavier the basis weight of the paper, obviously, the greater the potential tonnage output at any given speed; thus the "capacity" of a machine increases with an increase in the basis weight of the paper produced.

In addition to this "definitional" relation between basis weight and capacity, the speed at which a machine can be run tends to increase as the basis weight of the paper increases. (This situation holds for any particular machine, but not necessarily between machines designed for different grades. A machine producing lightweight tissue may run as fast as a machine producing heavy-weight board. But generally a heavier tissue, or a heavier board, can be run at a higher speed than a lighter tissue, or a lighter board.) However, there is an offsetting factor to this increase of speed, and thus of capacity, in relation to basis weight. The heavier the weight of the paper, the greater the drying problem. The speed of the machine is limited by its drying capacity. The machine cannot produce paper at a more rapid rate than the driers can handle. Thus there is some optimum basis weight of paper at which capacity of a given machine is maximized. When producing other weights, either higher or lower, the machine has a lower capacity.

However, a machine can seldom operate for long on this particular optimum basis weight, nor on the optimum grade. Market requirements will usually require production of other basis weights, other grades, so that the effective daily capacity of a given machine is rarely as high as the potential capacity if production could be concentrated exclusively on the optimum basis weight of the preferred grade.

In addition to these questions of grade and basis weight, there is the problem of length of run. In times of peak demand, a paper machine can operate on long runs, with little down-time needed for switching to other grades or subgrades, or other weights of the same grades. Conversely, when demand is slack, machine orders are short,

and changeovers require more down-time. (Paper is too bulky a commodity to permit mills to offset demand reductions to any significant extent by producing for inventory.)

In summary, the basic design of the machine, its "trim" (width), its speed and drying equipment, determine some optimum maximum daily output of a particular grade at some optimum basis weight. The effective maximum daily output, the effective capacity, can run sharply below this optimum because of shifts to other basis weights, other grades, or because a short order book enforces frequent down-time for changeovers.

Despite the varying impact of these different factors, there is enough constancy in their combined effect so that it is possible to determine a reasonably significant effective daily capacity for any given machine, based on its operating record. Actual output in any particular 24-hour period may run above or below this estimate, sometimes significantly, with the machine running full, but it is rare for the divergences to persist for any significant length of time. A week may be adequate to average out a large part of any temporary divergent effects; over a month, or a quarter, these divergencies substantially disappear.

(The reader may have noted that in the above discussion I have used the term, "effective capacity," rather than the more usual term "rated capacity." There are basically two different concepts of capacity: (1) the capacity estimate developed, before the machine is installed, based on the design of the machine, the anticipated mix; this is an engineering estimate. The second concept is the one discussed in this study, where the estimate of machine capacity is developed after the machine is installed and has been in operation long enough to determine from production records what its maximum output may be, under representative conditions. The first concept is always referred to as "rated capacity" and it seems worthwhile to limit the term to capacity estimates based on design, adopting the term "effective capacity" to refer to capacity estimates based on actual performance. This distinction was suggested to me by Dr. Benjamin Slatin, economist of the American Paper & Pulp Association, and I am most happy to adopt it. This differentiation is not meant to impugn the accuracy of estimates of "rated capacity" which may be highly accurate.)

Having determined the effective daily capacity of each paper machine, we can sum and obtain the effective daily capacity of all machines, the effective daily capacity of the paper industry. However, obtaining the effective daily capacity of the industry is only the first step in measuring the effective total capacity of the industry; it is also necessary to allow for the number of operating days in a week, or a year, to allow for the operating policy of each mill or company.

OPERATING POLICY

To a large extent technology and the cost structure determine operating policy. In addition, institutional factors such as union contracts often play a role, but these factors can presumably be modified if the dictates of technology should change. Traditionally, even in periods of peak demand, a paper mill runs 24 hours a day, 6 days a week, shutting down on Sundays. (In weak markets the machines

can stay down longer than just the 1 day.) Papermaking is a flow process, but the cost of interrupting the flow is relatively slight. Little material is lost in shutting down a machine, or starting it up again; only a small amount of labor is used unproductively. Sunday shutdowns avoid payment of premium wage rates, and there are frequent opportunities for maintenance and repair. (Certain mills, particularly in New England, have union contracts which absolutely prohibit Sunday operations.)

The situation is different, however, in a wood pulp mill, particularly a chemical wood pulp mill.

Shutting down a pulp mill is a high-cost process of interrupting an elaborate complex of interdependent operations in accordance with the production sequence. The process must be carried out with extreme care, involving a high labor cost for which there is no return. An expensive proportion of raw material is lost; boilers and lime kilns must be cooled carefully, with the subsequent heavy expense for reheating. Depending on the length of the shutdown, the pulp in the stock chest may require the addition of preservatives to avoid spoilage. (The process is somewhat similar to shutting down and starting up an open hearth furnace in a steel mill.)

In this cost situation, with shutting down and starting up an expensive process, the pulp mill tends to operate 24 hours a day, seven days a week, so long as demand warrants, with shutdowns limited to those scheduled for repair and maintenance work, generally four times a year, around major holidays.

Historically, pulpmaking and papermaking have been separate operations, carried on at separate sites. Wood pulp has been partially dried as the final stage of the pulpmaking process, and then shipped to a paper mill where a new fiber separation has been accomplished through mechanical disintegration in water, as in the case of waste paper.

With this physical separation, there has been no need to coordinate production schedules, and it has been entirely feasible for a paper mill to operate 6 days a week, a pulp mill, 7.

In the past quarter century or so, however, and particularly since the war, a new factor has arisen, with the development of the so-called integrated mill, a combined pulp and paper operation. This combined operation has a great cost advantage.

As mentioned earlier, wood pulp is produced in a water suspension, and before being shipped to a paper mill the pulp must be dried; then at the paper mill the pulp must be put in a water suspension again, before going over the paper machine. But in an integrated mill the drying and rewetting processes are eliminated; the pulp slurry goes to the wet end of the paper machine, with no need for previous drying.

The nonintegrated mill has certain advantages of flexibility, but where mass markets permit machine specialization and high speeds, the loss of flexibility is of limited importance, and the cost advantages of having to achieve only one fiber separation, and of integrated operations generally, are decisive.

The growth in mass markets for paper, particularly in the postwar years, has been associated with a sharp growth in the relative importance of the combined pulp and paper operation, the integrated

mill. And in the combined operation, the paper mill, keeping up with the pulp mill, must operate 7 days a week.

It is not feasible to run the pulpmill while the papermill is down, and since it is expensive to shut down the pulpmill, the integrated papermill, to keep up with the pulpmill, necessarily runs on a 7-day schedule.

The important point here is the plant design: two stages combined into a single integrated operation. It is not simply a question of ownership. A firm is described as integrated if it owns a pulpmill and a papermill, even though they are at different sites, and still require the extra drying and fiber separation processes. But while the firm would be integrated, the mill would not be; the papermill is under no more pressure to operate 7 days a week than a mill purchasing its pulp in the market.

This integration of pulp and paper operations is more typical of the newer southern mills than of the older northern mills, and it is often said that the northern mills tend to work a 6-day week; the southern, 7. But actually it is not a question of geography; papermills integrated with pulpmills tend to operate on a 7-day basis in New England, the Middle Atlantic area, the Lake States, or the Far West, just as in the South. Special factors may result in a different policy, but generally the integrated pulp and paper mill tends to operate 7 days a week, the separate papermill, 6.

These, then, are the problems involved in measuring capacity in the paper industry. The effective daily capacity of a machine, preferably based on its operating record, is a measure of its potential production in a 24-hour period.

Actual production may diverge from this effective capacity because of changes in the mix or changes in length of run, as well as random factors, but the effect of these various forces tends to be offsetting, so that the effective capacity tends to be constant, as long as there are no changes in the machine.

In addition to these factors affecting potential daily output, there is the question of operating policy, which generally depends on whether the individual papermill or machine is physically integrated with a pulpmill.

The sum of effective daily capacity of all machines, adjusted for the operating policies of the mills, represents the annual capacity of the industry, as of a given point in time.

STATISTICS OF PAPER CAPACITY

The paper industry is rich in statistics, and this richness extends to the field of capacity statistics, where several different series are available, from governmental and trade association sources. Each series represents a survey of individual mills, or machines, with a summation to obtain industry totals. The capacity estimates may be presented on the "historic" basis or the "maximum or all-out" basis, or both. The "historic" basis represents capacity on the assumption of the "historic" 6-day workweek which, as indicated above, was typical prior to the growth of the integrated pulp and paper mill. The "maximum or all-out" basis represents capacity on the assumption of the actual operating policy of each mill: it is determined as the effective daily

capacity, multiplied by the number of days a year the mill reports as representing its preferred operating policy.

(1) Census—Association capacity surveys: Historic basis

For most of the years before World War II the U.S. Census Bureau compiled figures on paper capacity, on the "historic" 6-day basis which was typical in those days. Except for 1947, the Census has not published capacity data since 1940, but the surveys have been continued on a substantially comparable basis by the American Paper & Pulp Association (APPA). In recent years, as explained below, these surveys have been conducted jointly with the National Paperboard Association (NPA).

Capacity data have also been provided by the surveys of Morris Dobrow, executive secretary of the Writing Paper Manufacturers Association. These figures, compiled since 1915, are based on reports from paper machinery manufacturers. The surveys were amplified during the war years, when no other capacity estimates were available, but in recent years have been limited to new machine installations, without attempting to get data on rebuilding and modernization of existing machines.

(2) Census—Association surveys: Maximum basis

The capacity data obtained by the Census for 1947 were based on actual operating policies, rather than the assumption of a 6-day week. In 1953 John Vogel, then economist for APPA, attempted a survey to obtain capacity on both the "historic" basis and an operating basis, but apparently a limited response resulted in too low an estimate of actual number of workdays for the average mill. Nothing more was done along these lines until 1957 when APPA and NPA conducted a joint capacity survey in connection with a report on the pulp and paper industry prepared by the Business and Defense Services Administration of the Department of Commerce, at the request of the Congress.[3] In support of this study (the "BDSA report") the two associations obtained capacity estimates on both the "historic" basis and the "maximum or all-out" basis, representing an attempt to allow for actual mill operating policy.

Each year since then similar surveys have been conducted by the two associations. These surveys have been concerned not only with existing capacity but also with expansion plans. Since it requires 1 to 3 years to install a new paper machine or to build a new mill, expansion plans 1 to 3 years ahead are generally firm, although possibilities of deferral or cancellation are always present, and although lack of an operating record compounds the difficulties mentioned earlier in determining effective capacity. The various problems of the early years have now largely been solved, and these figures provide a measure of actual operating potential, as well as indicating the expansion plans of the industry over the coming 2 or 3 years.

(3) APPA—Weekly ratio report

This report, published each week since the midthirties, is based on reports from concerns currently accounting for some 90 percent of production of paper exclusive of paperboard (and of building

[3] "Pulp, Paper, and Board Supply—Demand," Report of the Committee on Interstate and Foreign Commerce, 85th Cong., 1st sess., H. Rept. No. 573.

paper). The report is based on estimated tonnage capacity by individual mills, adjusted as necessary to reflect capacity changes, and on weekly reports from these mills on tonnage production. The report presents no data on capacity or on production but simply shows the operating rate (production as a percent of capacity). Originally, this report was compiled on the assumption of a 6-day week for all mills. As noted earlier this assumption was largely valid in the days the report was first developed, but has become increasingly less so with the growth of the modern mass production pulp and paper mills. In 1951, when the report continued to show operations consistently running 5 to 10 percent above capacity, the report was shifted to an operating basis, the "maximum or all-out" basis.

Mills were asked not only for daily capacity but also for number of days in their standard workweek, and the total reported production was then measured against total capacity adjusted for operating practice. At the time of the change, the old report was reworked to the new basis for 1945–50, giving a useful set of overlapping data.

This report presents a reliable measure of activity in the paper industry. Unfortunately, it does not include paperboard, and while originally paper and paperboard were rather different industries with different characteristics and problems, they have become increasingly one industry in recent years, so that a measure dealing only with paper is less useful than formerly.

(4) NPA—Paperboard production ratio report

This report, published weekly by the National Paperboard Association, is also based upon capacity and production reports from individual companies, with capacity data adjusted from time to time as necessary to reflect additions to—or reductions in—capacity. Unlike the APPA report, this report is still based on the assumption of a 6-day workweek (the "historic" basis), instead of reflecting the actual operating policies of the individual mills. A second difference from the APPA report is that operations and capacity are both measured in terms of time, on the so-called inch-hour basis, instead of tons. Reports are made for each paperboard machine as to number of hours operated, and the hours are weighted according to the "trim" (width) of the machine. There are several advantages to this inch-hour method. Since the report is in terms of hours of operation the estimates of operations to capacity are unaffected by such matters as changes in basis weight, or even a shift of the machine from paperboard grades to paper grades. The major drawback to measuring capacity in terms of time is that such data cannot readily be compared with the more prevalent tonnage data. A strong case could be made for expressing all capacity data in terms of time, but convenience and custom tell against it. (A strong case could also be made for measuring output in terms of area rather than weight, but again custom and convenience contravene.)

As in the case of the APPA report, this NPA report includes no data on capacity as such, although such data can be imputed from the published data on operating rate and production tonnage. (In its yearbook, "Paperboard Statistics," the association publishes tonnage capacity estimates based on average operating rate for the year, and total tonnage production, but these are simply imputed estimates, not separate compilations by NPA.)

"OUTSIDE" ESTIMATES

There are also various measures of paper capacity developed by individuals or groups outside the paper industry, usually as components of some broader measure of industrial capacity. Such components usually deal with "paper and allied products," a concept embracing wood pulp for nonpaper uses such as rayon and cellophane as well as converted paper products such as bags and boxes. Because of the methods of computation, and because of the need for comparison with data on other industries, these estimates are generally presented as indexes, or in constant dollars, rather than as statements of potential tonnage output.

Examples of such estimates are the continuing McGraw-Hill capacity surveys,[4] which include a paper and pulp category, and the recent estimates by Dr. Daniel Creamer, National Industrial Conference Board, of manufacturing capacity, which include a segment on "paper and allied products."[5] The McGraw-Hill capacity measures are indexes related to sales, determined by asking manufacturers at what percent of capacity they are operating at specified times. Dr. Creamer's estimates have been developed from Treasury Department data on balance-sheet items, by industry deflated to allow for price changes.

HISTORIC BASIS VS. MAXIMUM BASIS

There is a marked preference among paper industry economists to use capacity data on the "historic" basis, the 6-day basis (the 310-day basis; 313 days for paperboard), instead of data on the "maximum" basis. One reason, of course, is that this provides comparability with data for prior years. Capacity data on the "historic" basis, are available, with a few gaps, back to 1899. By contrast, capacity data on the maximum basis are available only for 1947 and 1955 to date, and there are "bugs" in the data for certain years.

A second reason for preferring capacity figures on the "historic" basis is that the "maximum or all-out" basis invariably overstates capacity. This is because the ideal or preferred operating rate reflects an optimum combination of market circumstances, regarding both demand and supply, which rarely occurs. As the U.S. Pulp Producers Association, faced with somewhat the same problem in measuring pulp capacity, has phrased it, "Stated annual capacities make no allowance for time lost due to * * * emergencies beyond the control of management. While stated annual capacities are often achieved for relatively short periods, they have never been achieved for an entire calendar year * * * 'practical' annual capacity can be estimated, for purposes of supply-demand studies, by examining operating rates for years of full operation * * *"[6]

However, despite this overstatement in the "practical maximum" figures, there are drawbacks to the use of the "historic" basis capacity. Since integration is more pronounced today than, say, in 1947, there

[4] McGraw-Hill, "Business Plans for New Products and Equipment, 1961–1964," 14th annual survey by McGraw-Hill, Department of Economics, and earlier issues.
[5] Creamer, Daniel, "Capital Expansion and Capacity in Postwar Manufacturing," National Industrial Confeernce Board, Studies in Business Economics, No. 72, June 1961.
[6] U.S. Pulp Producers Association, "Wood Pulp Statistics," August 1961, and earlier issues.

is an upward trend in effective capacity, because of an increase in the average number of working days, which does not appear when using capacity figures on the "historic" basis. In 1947 the average work year equaled 322 days; currently it is 338 days.

Capacity data on the "maximum" basis would offer a more useful guide to effective capacity, and particularly to changes in capacity over time, than do the figures on the "historic" basis.

YEAREND DATA

In addition to this preference for using capacity figures on the "historic" basis, there is a second, minor flaw in many studies of operating rates in the paper industry.

The various surveys have generally called for capacity as of the end of each specified year—unlike the steel industry, for example, where capacity (in the days when this figure was published) was called for as of the first of the year. In publishing the data, naturally enough, the tendency has been to date the capacity figures according to the calendar year, with only a footnote—and often not even that—to indicate that the data referred only to the end of the year. As a result, industry studies have frequently compared production in a calendar year with capacity as of the end of that year. In a growing industry this practice necessarily tends to overstate capacity and understate the operating rate, and in years where there are unusually heavy additions to capacity the overstatement of capacity can be significant. The error involved in the opposite practice, of measuring production against capacity at the start of the year is probably less, since newly installed capacity usually requires some amount of operating experience before the bugs are removed and it is really operating at potential. But basically this practice is also unsatisfactory. The ideal, of course, would be to adjust capacity figures as machines come in, are modified, or retired. With such information unavailable, the best procedure is to estimate capacity for any calendar year as the average of capacity at the end of the specified year and at the end of the preceding year. Such an approach, of course, rules out analysis of the current year unless you possess—as we do in the paper industry, thanks to the various association surveys—estimates of planned capacity as of the end of the current year.

DEFINITION OF THE PAPER INDUSTRY

As indicated earlier, one problem in measuring capacity is defining the industry. The paper industry today may generally be regarded as having three parts: Paper, paperboard, and building paper and board, including wet-machine board (a specialized grade of board made on a forming machine). Each of these groups employs the same fibrous raw materials (largely wood, rags, or wastepaper); each is made by the same basic process of fiber separation, suspension in water, and water removal. Production figures for each are included in the monthly and annual census reports; capacity data for each are included in the annual APPA–NPA capacity surveys.

By the major meaningful criteria, these three groups make up a single industry.

Nevertheless, there are certain pragmatic reasons for developing data exclusive of the construction grades. Building paper and board are not included in the weekly production ratio reports of the two major associations; major producers are often identified, for example, by Wall Street analysts as belonging to the building materials industry, rather than to the paper industry. The demand for the construction grades is concentrated in one particular industry which is highly cyclical and with a cycle often diverging sharply from the general business cycle, while the demand for paper generally tends to be diverse, coming from a wide variety of end-use activities, following the general business cycle, but with relatively modest cyclical amplitude. There are serious objections to defining industries on an end-use basis, and this should not be done with the basic statistics of an industry (as compiled by the Government, for instance). But it seems potentially useful, at least for certain limited purposes of analyzing production and capacity, to consider paper and paperboard exclusive of the construction grades. (Limited availability of capacity data is an additional incentive for omitting these grades, and wet machine board as well.)

ESTIMATING PAPER CAPACITY, 1946–64

As indicated so far, there are various weaknesses in each of the several measures of industry capacity. They may have limited coverage, may fail to reflect actual operating practice, or may not extend over any great number of years. The balance of this paper presents the development of a measure of capacity in the paper industry, exclusive of the construction grades and wet machine board, reflecting operating policy, covering the years 1946–59, and integrated with the capacity survey just issued by APPA–NPA covering the years 1960–64. Thus these capacity estimates provide guides for analysis of production in relation to capacity over the postwar era, and a basis for interpreting the current capacity plans of the paper industry.

There were four stages in obtaining these capacity estimates: (1) Daily capacity, as of the end of the year, was obtained for each year from 1946 on; (2) figures on number of operating days were obtained for each year; (3) daily capacity was then converted to an operating basis—the maximum or all-out basis—for each yearend; the yearend figures were averaged to get an estimate of average capacity during the calendar year.

For paper, figures on daily rated capacity were readily available or easily imputed, for each yearend from 1945 on. These figures were available by major grades: newsprint (other), printing papers, fine papers, coarse and special industrial papers, tissue papers. (It was necessary to estimate newsprint capacity for a few years.)

In the case of paperboard, the available data were much less satisfactory, even on a total basis, let alone by grades. (As mentioned earlier, the National Paperboard Association has traditionally measured capacity on an inch-hour basis, and has only within the last few years confronted the problem of measuring capacity in tons.) Accordingly, capacity was imputed for each yearend on the basis of tons produced and inch-hour operating rate per week for November and December of the specified year and January and February of the following year. The early weeks of the new year were included to

catch any capacity which might have been operating by the end of year, but not entered in the association records. This estimating procedure is very similar to that used by NPA in preparing capacity estimated for the BDSA report, but covers more years, and checks the end-of-year results against those of the start of the following year. It was desired to recompute the capacity data for the entire period, partly to get the check of the first-of-year data, partly to remove the approximately 200,000 tons of wet machine board capacity added by BDSA to the NPA figures, and partly to get a consistent series for recent years as a check on the NPA tonnage capacity figures, which as noted above have sometimes had some "bugs" in them in the joint APPA–NPA capacity surveys of the last few years. It should be noted that the NPA operating rate is only carried to two significant figures—or three for operations at 100 percent or greater. Accordingly the use of five figures in the imputed capacity lacks mathematic validity. However, experience has indicated that it is preferable to accept a fictitious accuracy—as long as it does not mislead—than to have to round all data in a sum; e.g., paper capacity by grades, to the lowest degree of accuracy.

The capacity figures so developed cover total paperboard with no estimates for individual board grades; e.g., containerboard, special food board, etc. It is hoped that, on the basis of fragmentary data useful estimates of board capacity by grades can be developed, but such a refinement is outside the scope of this current analysis.

With daily capacity figures developed, it was necessary to obtain figures on number of operating days in managerial policy. Such data were available from the Census of Manufactures for 1947, and from the APPA–NPA surveys from 1955 on. Analysis of fragmentary information indicated that interpolation would give a reasonable estimate of number of planned operating days, for the years where such figures were not published, and accordingly this practice was followed, with 1945 and 1946 operating days taken as identical to 1947. Examination of the data indicates that, apparently, because of a misunderstanding of the concept, the original capacity surveys for the BDSA report including 1955 and 1956 exaggerated the number of operating days, and so interpolation was used between 1947 and 1957.

With estimates of daily capacity and of operating days it was then possible to determine end-of-year capacity on the maximum or all-out basis, and by averaging, to approximate the effective capacity for the calendar year.

The capacity estimates so obtained should not be regarded as precise measures of capacity; as indicated, capacity cannot be measured with the precision the statistician would like. Nevertheless, it is felt that this capacity series at least provides a useful addition to the previously available figures. Earlier data have been revised to meet present concepts and definitions, so these figures are directly comparable with the capacity figures now published in the APPA–NPA surveys of existing capacity and planned changes. Covering both paper and board, this series permits a broader measure of operating rate than either weekly association series. Excluding the construction grades, it presents a capacity series matching the usual concept of the paper industry. Based on actual operating policies it avoids the downward bias of the 6-day measures over a period when the 7-day mill has

been increasing in importance. The capacity figures, together with production data, are presented in table 1 below.

TABLE I.—*Production and capacity—Paper and paperboard*

[Excluding building paper, building board, wet machine board]

	Production	Capacity, maximum basis		Production to average capacity (percent)	Capacity change in year (percent)
		End of year (thousands of tons)	Average for year		
1946	17,129	19,101	[1] 18,680	91.7	4.6
1947	18,603	20,093	19,597	94.9	5.2
1948	19,163	22,006	21,050	91.0	9.5
1949	18,196	23,660	22,833	79.7	7.5
1950	21,565	24,670	24,165	89.2	4.3
1951	23,245	25,243	24,956	93.1	2.3
1952	21,670	26,300	25,772	84.1	4.2
1953	23,703	27,221	26,760	88.6	3.5
1954	23,840	28,524	27,872	85.5	4.8
1955	26,772	29,910	29,217	91.6	4.9
1956	28,224	31,053	30,482	92.6	3.8
1957	27,643	32,896	31,974	86.5	5.9
1958	27,667	34,361	33,629	82.3	4.5
1959	30,481	36,001	35,181	86.6	4.8
1960	31,250	36,840	36,421	85.8	2.3
1961	32,200	38,277	37,358	85.7	3.9
PROJECTIONS					
1962		39,336	38,806		2.8
1963		39,939	39,638		1.5
1964		40,498	40,218		1.4

[1] 1945 yearend capacity, 18,259,000 tons.

Source: Production: U.S. Census Bureau. Capacity, estimates by the writer based on data of the American Paper & Pulp Association, The National Paperboard Association, and the U.S. Census Bureau.

CAPACITY AND OPERATING RATES

This study is primarily concerned with the various types of problems involved in measuring capacity, and with developing a new measure of capacity which seems to be preferable to earlier series for certain purposes. Any detailed study based on the new series is outside the scope of the current paper, but some discussion along these lines seems called for. Probably the most obvious point shown by the table above is the tremendous growth of the industry. This, of course, is well known, but is worth repeating here since these figures, excluding construction grades, more nearly represent what is generally meant by "the paper industry" than do the usual totals. Capacity has grown steadily, each year showing an increase from the year before, ranging from 2.3 percent in 1951 to 9.5 percent in 1948. Production of course has also increased, reflecting the growth in basic demand, but also responding to demand shifts of the business cycle.

In addition to showing growth, the table indicates a need for capacity comfortably above demand, to meet seasonal and other peaks, to provide operating flexibility. Even in years of peak demand, when paper was in tight supply, production remained below maximum capacity. The highest rate achieved for a full calendar year was 94.9 percent, in 1947. In 1951 and 1956, also peak years, the operating rates were 93.1 percent and 92.6 percent, respectively.

In the McGraw-Hill survey, the paper industry reports 100 percent as its preferred operating rate.[7] The contrast between the actual results and the stated preference suggests that the respondents may be somewhat overly optimistic in their replies to McGraw-Hill. Possibly they are thinking of the historic basis.

OPERATING RATES AND PROFIT MARGINS

There is frequent discussion, both in the paper industry and in the financial community, regarding the relation, if any, between operating rates and profit margins. There have been various difficulties in determining such a relation. The operating rate has usually been determined on the basis of total paper and board, including the construction grades, although the data on profits generally exclude these grades. Further, capacity has been measured in terms of the historic basis, introducing an upward bias in the data for the operating rate. In addition, profit margins have been increasingly affected over the years by the rise in depreciation charges.

On the basis that profits are maximized in relation to variable costs, it appears that margins of gross cash flow, rather than profit margins, should be related to operating rates. Such a study indicates that gross cash flow, as a percent of sales correlates fairly well with operating margins. The maximum deviation of actual gross cash flow margin from the calculated margin is 9.6 percent, and the average deviation, disregarding sign, is only 5.6 percent. This is not as close a relation as one would wish, but it is not bad for so volatile a series as profit margins.

TABLE II.—*Paper industry profit margins and operating rates*

[Percent]

	Gross cash flow to net sales	Production to capacity	Calculated GCF to sales [1]	Deviations, actual from calculated
1947	18.3	94.9	17.6	4.0
1948	15.5	91.0	16.4	−5.5
1949	13.2	79.7	12.6	4.8
1950	17.2	89.2	15.7	9.6
1951	18.5	93.1	17.0	8.8
1952	15.2	84.1	14.0	8.6
1953	14.6	88.6	15.5	−5.8
1954	14.2	85.5	14.5	−2.1
1955	15.4	91.6	16.5	−6.7
1956	16.3	92.6	16.9	−3.6
1957	13.8	86.5	14.8	−6.8
1958	13.1	82.3	13.4	−2.2
1959	15.4	86.6	14.9	3.4
1960	13.7	85.8	14.6	−6.2

[1] Calculated GCF=13.925+0.3324 (production to capacity).

Source: Gross cash flow, APPA compilations based on U.S. Treasury data. Production to capacity, see table I.

Dr. Louis T. Stevenson of Tucker, Anthony & R. L. Day, formerly economist for the American Paper & Pulp Association, has emphasized the importance of other factors than operating rates in affecting profit margins.[8] This study of cash flow margins bears out this concept

[7] McGraw-Hill, op. cit.
[8] See, for instance, Louis T. Stevenson, "What Is Excess Capacity in the Paper Industry," August 1957.

of the importance of other factors, although indicating a closer relation to operating rates than shown in Dr. Stevenson's studies.

COMPARISON WITH "OUTSIDE" ESTIMATES

It is difficult to compare the capacity series developed here with such "outside" estimates as those of McGraw-Hill and the National Industrial Conference Board, referred to earlier. This capacity series represents paper and paperboard exclusively. The McGraw-Hill series, by virtue of its derivation, includes woodpulp capacity, both "own use" and market, as well as some indeterminate amount of "converting" operations (converting paper into bags, boxes, etc.). The NICB series is even more inclusive: based upon balance sheet data, it covers all company assets. Timberlands and laboratories, for example, which may play important roles in the more profitable operation of a company, are included in Dr. Creamer's figures, even though they are not part of the "capacity" of the industry, strictly defined.

Another problem in the conference board estimates is inherent in the determination of industry data. A company is classified according to its major activity: thus, the asset values represented by Olin Mathieson's paper operations, for example, are included in the chemical industry capacity, while the wood chemicals plants of Union Bag-Camp Paper Corp. are included in the capacity of the paper industry.

It is impossible to adjust the capacity series on paper for exact comparability with either of the "outside" estimates, but by adding an allowance for woodpulp capacity, compiled by the U.S. Pulp Producers Association, we can obtain reasonable similarity.

When this adjustment is made, we find a tolerably close comparability between the trend of paper capacity and the trend of the McGraw-Hill estimates. The comparison with the conference board estimates, while adequate, is less satisfactory: there seems to be some tendency to overstate the growth in capacity. Since these estimates cover a period of generally rising prices in capital goods it is possible that this apparent tendency to overstatement of the rate of increase in capacity reflects an understatement of price increases in the indexes used as deflators.

A more detailed analysis of these various estimates, particularly one studying indicated operating rates as well as trends in capacity, would be useful. Tentatively, however, we can conclude that the techniques used in developing these "outside" estimates have a substantial degree of validity, although it is obvious that caution must be used in interpreting the data. This is scarcely suprising; as indicated in this study even where there are actual volume data on industry capacity, the figures may have certain weaknesses and must be interpreted carefully.

In view of the importance of capacity measurements for business economists, we must welcome attempts to measure it, while at the same time warning of dangers and pitfalls. There are problems in measuring any statistical aggregate; with experience we can refine our estimates.

TABLE III.—*Capacity measures for pulp and paper*

[Indexes, 1953 equals 100]

	Maximum basis, paper and pulp	McGraw-Hill	Creamer, NICB
1950	88	84	(1)
1951	92	87	(1)
1952	96	94	(1)
1953	100	100	100
1954	107	105	(1)
1955	113	112	118
1956	118	118	129
1957	126	124	140
1958	132	130	(1)
1959	138	138	148
1960	142	145	(1)

[1] Not available.

Sources: Maximum basis: APPA, NPA, USPPA, and estimates by the writer. Others: As specified in headings.

SUMMARY

In spite of problems of technology and technological change, in spite of difficulties of concept and of coverage, it is possible, on the basis of available data, to develop a consistent set of capacity figures for the paper industry. Such figures are presented in this report, for the postwar years, covering "the paper industry" as generally understood. The figures have been developed from trade association data, based on surveys of individual machines, and have been adjusted to reflect changing operating policies and practices.

These figures provide an effective measure of capacity changes and of capacity utilization in the paper industry. In addition they can be used to study the relation between operating rates and profit margins, and offer a criterion for analyzing the accuracy of capacity estimates developed by different approaches. In preparing this study I have received invaluable assistance and suggestions from many friends and colleagues in the paper industry. In particular I am indebted to Messrs. John H. Doherty and Malcolm C. Taylor, of Union Bag-Camp Paper Corp.; to Dr. Benjamin Slatin, economist of the American Paper & Pulp Association; to Dr. Louis T. Stevenson of Tucker, Anthony & R. L. Day, formerly economist of APPA; to Mr. Alvin A. Newburg, statistician, National Paperboard Association. Many thanks are also due to my assistants, Miss Mary Conlon and Mrs. Alla Murtechaly, and to my secretary, Miss Helen Pagnotta, whose keen ability to decipher my hieroglyphics has been both remarkable and invaluable.

I should also like to express my obligation, and that of everyone working with statistics of paper, to the men whose vision and effort have developed such a fine body of statistics for this industry. In addition to the statisticians and economists already mentioned, reference should be made to Mr. John Vogel of Oxford Paper, formerly APPA economist; Mr. Cyril J. Wildes, U.S. Census Bureau; Mr. James L. Ritchie, U.S. Pulp Producers Association; Mr. W. LeRoy Neubrech, Business and Defense Services Administration; Mr. Morris L. Dobrow, Writing Paper Manufacturers Association; as well to three great pioneers in the field, now unfortunately deceased, Messrs. Charles W. Boyce, Oliver M. Porter, and Grafton Whiting. Many

others, in companies, in trade associations and in government, both executives and technicians, have worked over the years with diligence and insight to develop a most effective and comprehensive body of statistical data for the paper industry. We are indebted to them all.

Industrial Capacity: Concepts and Data

(By John Thorkelson, Assistant Professor, Department of Economics, the University of Connecticut)

Two notable problems of statistical studies concerned with productive capacity are the variety of definitions of "capacity," and the thinness of the primary data base. A little thought about the nature of industrial productive capacity will lead one to anticipate the many difficulties of conception and definition, but in view of the problem's importance, it seems that more extensive and continuous series of solid empirical data ought to be available. The raw data are sparse; quantitative generalizations are extremely rough; extrapolations, estimates, and inferences from small samples are the rule.

DEFINITIONS

One of the greatest obstacles to statistical clarity and precision in this field, as in others, is the difficulty of defining productive capacity in a way that is unambiguous, practical to apply (operational) and useful to the policymaker. As is shown in the following paragraphs, a definition that suffices for collecting definite data will conceal significant aspects of the problem. On the other hand, the definition that would have the most usefulness for policymaking is very difficult to convert into reality.

At least three conceptions of the problem are available: Should capacity be defined in some physical, technical sense of the highest level of production that the industry or economy is capable of, regardless of costs? Or should the term be used to refer to economic capacity; that is, should "capacity" mean a rate of production which would minimize costs of production? Or should the conventional idea of rated capacity be adhered to?

1. The advantage of the first (physical maximum) definition is that it is simple and a readily calculated measure. In principle, it should always be possible to establish the highest rate of production that a factory, firm, industry, or economic sector is capable of, given enough engineering data. Machines and factories have an objectively measurable capacity in terms of maximum units produced per hour. Multiply by the number of hours in the year and one has the annual capacity. This, however, would be something like measuring the capacity of a telephone booth in the style recently favored by those college students who have gotten some part of 20 or so human bodies into the space normally occupied by 1. Few machines, assembly lines, factories, or farms are ever run at the highest rate of which they are physically capable; the concept of a normal rate is always used (or implied), to allow for breakdowns, repairs, fatigue, accidents, replacements, and so on. Just how to define "normal" here is another question, but an acceptable though arbitrary meaning might be

"the highest rate of production which the industry (or other productive unit) is physically capable of sustaining indefinitely."

There are other problems connected with this sort of approach; for instance, what should be done about the customary changeover period in stylebound industries like automobiles or women's clothes? This could be solved by simply deducting the actual average annual shutdown period from the year.

More serious is the "part whole" difficulty: It is feasible to ascertain the technical maximum capacity for each of the steel-using industries (autos, commercial construction, machine tools, etc.), but it is improbable that the capacity of the steel industry itself could keep all of them supplied with enough steel to operate at their maximum rates simultaneously. Likewise, the labor force might not be capable of manning all existing equipment continuously, though the pool of unemployed workers and persons not normally seeking employment is certainly ample to operate a substantial part of the available economic equipment around the clock every day.

The sensible way around this stumbling block would be to use the empirical data on sectoral interdependence of Leontieff's input-output studies. It should not be difficult to calculate the limits imposed on each industry's capacity by the existing and potential supplies of labor, fuel, iron ore, and other basic inputs. The result of the calculation presumably would reverse the conventional relationship, that is, establish that the capacity of the whole is less than the sum of its parts.

The apparent difficulties of applying a "physical" definition of maximum capacity thus seem to be capable of solution. A figure in units per year could be arrived at for each major industry and an index number base for the whole economy as well. Thereafter annual or quarterly indexes could be derived by calculating the effect of each period's increase in manpower, the number of new blast furnaces, machine tools installed, etc.—all readily accessible data. However, although a measure of maximum physical capacity, defined in technical terms of the highest sustainable rate of production, is statistically feasible, there are serious flaws in the concept for policy purposes.

For one thing, it would make "capacity" correspond to a forced draft or crisis level of output, one which, if achieved or approached, would quickly generate ridiculous surpluses of manufactured goods even more unmanageable than the farm surplus. Only in an all-out war would this defintion of capacity have operational meaning—and even then the altered composition of output would materially reduce its usefulness. The concept of capacity ought to imply a rate which can conceivably be approached under (foreseeable) conditions of demand.

Another major disadvantage is that a physical maximum disregards money costs. Given the well-established pattern of premium pay for night work and overtime, anything approaching round-the-clock operation would raise average labor costs some 25 percent above normal. Again the part-whole problem arises: one firm or industry could pay the extra labor cost, but if the whole economy did so, there would be a built-in inflationary effect, which again makes the usefulness of this concept of capacity somewhat questionable.

2. A second type of capacity concept might be called the economic approach. Here the central idea is not the highest physical level

which the productive unit can sustain, but the rate of output that gives the lowest cost per unit of output. Given the costs of inputs, and given a common way of combining them, there ought to be a certain level of production for each factory (hence for each industry and the economy) that would result in the lowest money outlay per unit of output.

One striking advantage of utilizing this approach to the problem is that it would clarify key questions of policy: In brief, there are two broad categories of unused capacity, one, idle plants and equipment which would cost more per unit to operate than the part actually in use, and the other, that part which would lessen unit costs if it were utilized. The former is usually the result of too slow a rate of economic growth; the latter in part the result of too rapid a growth rate. What cures the one, causes the other. Hence, if any policy is intended to lessen the amount of excess capacity, it would be absolutely necessary, if corrective action is to be effective, to know which of the two kinds predominated.

However, this economic definition of capacity would be achieved at the expense of far greater difficulty in data collection. For the relation between rates of output and average costs, in actual fact, is hardly ever known over a continuous range of production levels, nor can it be easily calculated. Particularly is this the case in a complex modern factory, whose products are partly but not wholly standardized, which produces a mix of products and models, and whose operating management seeks to achieve minimum cost for a designated output—not to find that single output (among many) whose average cost is lowest.

Another problem: Cost-output data for a particular plant would obviously be of some value to competitors, and producers might therefore be reluctant to release it. But this difficulty presumably could be circumvented by conventional safeguards over anonymity if the collecting were done by a public agency.

A further complexity: This economic measure of an industry's capacity would not be as stable over short time periods as the physical maximum definition outlined earlier. A good deal of the continuous research conducted in a modern enterprise is aimed at discovering ways of reducing costs without increasing the consumption of fuel, raw materials, etc. This kind of cost-cutting development—in recent years known as operations research—is largely a sort of counter or response to a continuously changing cost structure of inputs, and is hence a continuous process. The result is that the least-cost or economic capacity of a firm or industry changes from month to month or year to year even when physical capacity remains fixed.

Continuous collection of sufficient data to make accurate allowances for this sort of change would be prohibitively expensive. Presumably a periodic sampling of representative firms' practices would provide enough information to make gross adjustments, but the fact remains that figures based on this economic concept or definition would probably be a less accurate approximation of the situation as defined than would physical capacity.

It should be noted, however, that this economic definition would be less likely to create either the built-in inflation implication or the part-whole problem mentioned earlier. This follows from the fact that

an industry would reach 100 percent of economic capacity before premium labor costs or competitive bidding would raise the average costs of production markedly, and because the most efficient level of output for productive units is usually a level fully compatible with the capacity of basic materials and fuel suppliers.

3. Still a third definition of capacity is available, i.e., rated capacity, used by many industrial trade associations to keep track of trends in their own industries. In general, rated capacity is a measure of the number of basic productive units actually installed. Thus the rated capacity of the textile industry is measured by the number of spindles, the rated capacity of railroads by the number of freight cars, the rated capacity of communications facilities by the number of telephones, and so forth.

This way of measuring capacity certainly provides the easiest data to collect, and this fact alone accounts for its relatively wide use.

But, as compared to either of the two other measures, rated capacity has such serious drawbacks as to limit its usefulness pretty severely. In the first place, rated capacity ignores the process of continuous improvement in technological methods. Freight cars move faster over the road and are more quickly shunted through yards now than 20 years ago. A given number of cars, therefore, can carry more freight. Physical capacity and economic capacity may increase in this fashion while rated capacity falls off. Something of the sort seems to have happened during the 1930's.

A second drawback is this: Rated capacity assumes that one dimension of an industry is an accurate index of capacity in the whole complex. It thus ignores any changes other than those in the number of installations of some one input. It cannot be assumed, for instance, that the number of licensed automobiles is an accurate index to passenger-carrying capacity when average speed is increasing, the number of passengers per auto is decreasing, traffic patterns and routes are increasing density of flow, alternative transportation facilities are disappearing, and so on. Capacity is a resultant of all changes in all inputs and external conditions as well. Rated capacity probably understates economic capacity, and would therefore be a poor indicator of the amount of excess or slack in the economy at any time.

In the third place, rated capacity leads to problems about depreciation. If 10,000 spindles are added to 100,000 already in existence, has capacity gone up by 10 percent? Clearly, part of the answer depends on how many were simultaneously retired. If some arbitrary rate of wearing out is established and adhered to, there will be a cumulative error if discrepancies between real and assumed deprecation rates are not recognized at once. Related questions involve appropriate adjustments if producers keep unused equipment as standby facilities, or if a discrepancy exists between the book rate of depreciation and the physical rate, or if the real rate of depreciation depends on the rate of industrial activity, and so on. All these are difficult enough for single companies to handle. They are much more troublesome when the application is to an industry or the economy as a whole, and what is most serious, they cannot be avoided in any of the many variations on the rated capacity measure. Stabilization or growth policies based on rated capacity indicators will always overshoot or undershoot the mark, and may miss the target entirely.

A fourth defect of rated capacity is in some ways the most serious of all: It is not what it claims to be. Rated capacity is an index of growth in capital equipment, and while this is obviously a factor in overall capacity, it is not the same thing. The stock of capital goods measures overall capacity in exactly the same sense as does manpower, fuel, raw material supplies, or any other primary input. If the United States had a shortage of capital goods, together with ample supplies of other necessary elements, it would indeed be useful to regard the physical stock of capital goods as the strategic, limiting element in the capacity of the entire complex. But this is obviously not the case; American production is not limited by a shortage of machinery; the shortage is at the other end, in effective demand. Capital goods are commonly discarded long before they are really worn out, and the stock of capital equipment in place is therefore not a good measure of capacity in this country.

Under the considerations raised in the preceding paragraph, it is clear that the exact nature of productive capacity is much more difficult to define and apply than appears at first glance. It is preferable to adopt an economic definition that measures capacity directly, rather than to utilize a less accurate and in some degree misleading indirect measure such as rated capacity.

Unfortunately, the term "economic" is not wholly unambiguous, either. Creamer's definition of "economic output" includes facilities whose costs "would not exceed the prevailing unit selling price of the product."[1] But this procedure, though designed to eliminate obsolescent, high-cost equipment, could be defective if rigorously applied. Extraordinary demand might raise price, thus bringing obsolete capacity in and swelling the total; slack demand thereafter could reduce the price level and thus eliminate part of the capacity. A measure of capacity that rises and falls with changes in output hardly seems free of imperfections. "Economic" should probably carry more of the "efficient" connotation, and less of the "profitable" connotation.

DATA

The preceding discussion of definitions indicates some grave difficulties, some of which help explain why so few studies of industrial capacity to produce have been made. And yet, given the importance of the matter, it does seem that more efforts to examine the problem empirically should have been made in the past. Some statistical measure has been available for decades with respect to other dimensions of the economy—population since 1790, manufacturing and farming output since the Civil War era. But we still lack a widely used or reliable productive capacity series.

Clearly, a substantial part of the explanation lies in the difficulties of definition, some of which were referred to above. Creamer notes that the "surprisingly little firm statistical evidence" on capacity stems from "the inability to devise broadly based measures of capacity output."[2] And the construction of any index depends, in part, on solving difficult problems of sampling and weighting, and these in turn require agreement as to the precise meaning of the phenomenon being measured.

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[1] Daniel Creamer, "Capital Expansion and Capacity in Postwar Manufacturing." National Industrial Conference Board: New York, 1961, p. 17.
[2] Ibid.

Even so, the paucity of data has a further explanation: A series on productive capacity has not been available partly because, until quite recently, the importance of this dimension of economic behavior was not fully understood, and even now its significance is not fully clear. This is not to say that the economy has always operated at full employment of available resources, far from it. But as a general matter, the existence of unused resources has become apparent only intermittently, and in such a way as to suggest some noneconomic explanation. To take an early instance, Somers and Williamson remark that during the American Revolution, "far from the fullest use was made of available resources." [3] But the conventional explanation is that the cause was the administrative organization—or lack of one—established by the Continental Congress, as well as the special problems of converting a colonial economic structure to warfare. The appearance of unemployment after the War of 1812 seemed to contemporary observers like Carey to be traceable to American tariff policy. Unemployment in 1858 was traced to the previous year's financial panic. And so on; each time the phenomenon of unused capacity appeared, there was a tendency to seek a special or exogenous explanation. When a problem suddenly becomes acute, the tendency is first to find a ready and reasonable solution, rather than carry out the time-consuming task of definition, data collection, calculation of weights, and so forth. Only recently has the existence of excess but not obsolescent capacity appeared under circumstances that suggest a chronic condition, and hence only recently have there been efforts to define, collect, and publish the data. And even now there is a tendency to find a single solution, like tax reduction, rather than painstakingly to collect the enormously great quantity of information that the problem requires.

The 1930's witnessed three more or less simultaneous developments: one, the fact that the depression was most clearly visible in the form of widespread excess capacity; two, the fact that this excess or idle productive equipment was most concentrated in industries previously characterized by rapid growth, and three, the view that the prime reason for overall unsatisfactory performance was that new investment had slackened and generated the depression because capital goods were redundant; i.e., that excess capacity would disappear if full employment could be reached.

The consequence was to identify excess capacity with general stagnation, and to see its elimination as depending on a policy of stimulating the rate of general economic growth. Hence, statistical studies of the extent of capacity remained few and far between, and no serious effort was made to establish a continuous index or series. As in earlier periods, the phenomenon of unused capacity appeared to be explained by unique circumstances, or institutional characteristics, that could be gotten rid of by a sufficiently vigorous policy.

This is of course not the whole story. The Brookings study, "America's Capacity To Produce" evoked wide discussion in the 1930's; various devices to measure capacity were attempted in planning the war production effort; and in attempting adequate preparations for the

[3] Harold F. Williamson, ed., "The Growth of the American Economy." Prentice-Hall: New York, 1951, p. 85.

postwar transition. But these again were special situations, not such as to call forth the development of continuous series. More promising for policy purposes, it appeared, were the refinement of definition and collection of material bearing on the national income accounts, the reconciliation of various approaches and discrepancies. So, on balance, interest in continuously measuring industrial capacity diminished after the war because it appeared that the problem was how to enlarge output rapidly enough to keep up with buoyant demand for consumer goods. Excess capacity appeared to have vanished because its symptoms were not serious. Once more it seemed that the problem was sporadic, temporary, submerged as soon as aggregate growth reached a high enough rate. After surveying the postwar decade in contrast to the 1930's, Fichandler wrote in 1954 that "Fears of excess capacity need not trouble us unduly." [4]

But it has become increasingly clear in the past 5 years or so that we do need to be troubled about excess capacity, apparently arising out of growth, not from stagnation. The problem of measuring it has accordingly arisen once more.

This sequence of events has been recounted partly to justify the proposition that most data on excess capacity are defective or suspect because of a general refusal to see that the phenomenon well may be chronic, not intermittent. Too many studies implicitly assume that there is no excess in peak years of recovery (1929, 1955, say) whereas these may simply be years when levels of unemployment were so low that they could be rationalized as irreducible transitional minimums.

The point is somewhat important, because the common assumption among the standard series of capacity (McGraw-Hill, National Industrial Conference Board, and Federal Reserve Board in particular) is that the level of production reached in 1955 or whatever the benchmark year is, is the highest level possible given the then existing stock of capital goods. But, as remarked earlier, it is not at all impossible that the same plant and equipment, with little or no change in average costs, could have produced 5 percent or even 10 percent more in peak years, if consumer demand for end products had warranted it. The same, obviously, is true to an even greater extent for years of less than peak production; the process by which we have come to our present interest in excess capacity has probably given a bias in the direction of too low an estimate of true economic capacity to nearly all of the standard studies.

There is also a built in possibility of error in any series which uses constant ratios of capital to output (or any of the common variations thereof) as a part of their procedures for calculating capacity. The book value of capital stock is no more reliable as a measure of productive capacity than is the number of textile mill spindles in place. Technological changes are bound to weaken statistical transformations based on such an assumption.

Aside from the possibilities of error arising from the statistical assumptions mentioned, it is rather notable that a good deal seems to be done by manipulating certain standard statistical series. The Department of Commerce estimates of annual investment in producers' durable equipment figure in nearly all capacity series. Without cast-

[4] J. Frederic Dewhurst and Associates, "America's Needs and Resources." Twentieth Century Fund: New York, 1955, p. 833.

ing doubt on the value or validity of that series, it should be kept in mind that it is designed for a quite different purpose than the one at hand. It makes no attempt to indicate changes in the physical productive capacity or technical efficiency of the durable equipment sold. Yet if anything is clear from a study of industrial research in recent years, it is that a dollar's worth of machinery today represents a far more productive component in the total capital stock than did a dollar's worth 10 years ago. Moreover, there are surely significant changes in equipment's flexibility, in the crucial sense of the range of operations over which average costs are declining or constant. None of these changes is reflected in the Commerce Department's plant and equipment production data, nor could they be.

The rate of obsolescence in terms used for corporate profits tax requirements is not necessarily the rate at which equipment really wears out in the economic sense. Yet the Internal Revenue Service tables of average life of machinery are widely used for this necessary correction.

There are other weaknesses in existing data, though little would be gained in detailing them. Directly or indirectly, they all point to the same problem; inadequate primary data. Nearly all existing studies have in common the fact that their index of capacity is inferred from some other data (highest operating rates in the past, annual spending on plant and equipment, executives' estimates, etc.) while almost no recent study has attempted a censuslike survey of the economy's capacity as economic capacity. The variations among commonly used estimates of capacity and capacity utilization are not the major problem; they can in general be explained by comparative study of the methods of statistical inference used. What is needed most of all is a thorough study, surveying a large sample, utilizing a consistent definition of productive capacity, and free of preconceived ideas about the relation between dollar value of capital goods and their productivity, and free also of preconceptions as to the utilization of capacity in any given base or benchmark year.

Above all, it is vital to measure capacity in terms of the output-cost relationship. Policies based on any other concept—whether designed to stimulate investment, or demand, or something else—cannot be purposefully designed or applied in practice, and their effect can easily be perverse.

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