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VARIABILITY OF PRIVATE INVESTMENT IN PLANT AND EQUIPMENT

MATERIALS SUBMITTED

TO THE

JOINT ECONOMIC COMMITTEE
CONGRESS OF THE UNITED STATES

PART II

SOME ELEMENTS SHAPING INVESTMENT DECISIONS

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LETTER OF TRANSMITTAL

JANUARY 29, 1962.

To Members of the Joint Economic Committee:

Transmitted herewith for use of the Joint Economic Committee and other Members of the Congress is the second of several reports to be issued in connection with our study on the variability of private investment in plant and equipment. This report, entitled "Some Elements Shaping Investment Decisions," has been prepared for the committee by various academic and business experts acting at the committee's request.

WRIGHT PATMAN,
Chairman, Joint Economic Committee.

FOREWORD AND ACKNOWLEDGMENTS

This is the second of a series of prehearing studies on the variability of private investment expenditures on plant and equipment and whether anything needs to, or can, be done toward regularizing the employment-giving aspects of the nonhousing, noncommercial investment. The overall inquiry, of which this plant and equipment study is a part, is one of several of the more volatile and troublesome elements in the economy which the committee has been studying, following our extensive, earlier study in 1959, focused on the longrun secular aspects of employment and growth.

The committee report on the "growth" study (Rept. 1043, 86th Cong.) pointed expressly to the need of knowing more about the rates and factors affecting plant and equipment investment, and urged that "further studies should be undertaken to determine what can be done to reduce the instability of plant and equipment investment. It may well be," the report continues, "that it is impossible to stabilize these outlays, or that stabilization would lead to a lower average level. Nonetheless, the problem should be thoroughly explored" (p. 33). A comment at the hearings (p. 2997) on that study by the present Chairman of the Council of Economic Advisers, Dr. Walter W. Heller, is also worth repeating. Dr. Heller said, "The whole problem of instability arising out of plant and equipment is one that is devilishly hard to deal with by public policy."

Part I of the series, entitled "Investment and Its Financing," was prepared for the committee in the Department of Commerce. It brought together data on savings and investment covering the generation since the late 1920's and analyzed with some very significant conclusions the first war fluctuations in business demand for new plant and equipment.

The present volume, "Part II: Some Elements Shaping Investment Decisions," presents selected papers graciously submitted in response to the committee's invitation by various academic and business experts. While the present collection does not undertake to touch upon all of the many considerations which must inevitably enter into each business decision to buy a capital good, each of the statements represents a thought-provoking contribution on the factors affecting the volume and timing of investment expenditures.

The papers themselves need to be studied rather than summarized but understanding of the problem cannot but be advanced by the evidence (1) of growing emphasis on the rate of return and the declining reliance on "payoff period" in formulation decisions; (2) supporting the statistical connection observed in part I (p. 66) that variations in investment outlay are more closely associated with "cash flow" than with profits; (3) that inventive activity in a field (especially in today's world of research and development) tends to follow economic activity rather than that innovation is a central cause of business

cycles; and (4) that, because of the great role of anticipations, measures which affect the role of profit may be less determinant of investment timing than such things as expected trend of sales, costs, and capacity.

Without further study and hearing the views of other experts neither the Joint Economic Committee nor its individual members are prepared to accept or reject the views of these expert contributors. The committee nevertheless greatly appreciates the cooperation of the individual and company experts who have contributed from their experience and research.

The overall study of the variability of private investment expenditures in plant and equipment is under the general supervision of Dr. William H. Moore, economist of the committee staff.

Part II consists of the following papers:

THE CHANGING CRITERIA IN INVESTMENT PLANNING

By William H. White [1]

SUMMARY

The view has been prevalent among economists, since the prewar and early postwar surveys of businessman's attitudes toward capital expenditure decisionmaking, that business investment reflected non-rational investment selection based on "hunch" and "judgement"; such procedures precluded that quantification of the factors in an investment decision which is almost a prerequisite for adequate attention to the longrun aspects of the investment and to the role of the cost of money. Alternatively, it has been assumed that the high uncertainty about the outcome of an investment—particularly about the results after the first year or so—made the expectation of very high returns a prerequisite to the undertaking of any project. The minimum acceptable rates of return on investment would be so high and subject to so wide a margin of error that changes of one or two percentage points in the cost of (money) capital could be negelected. In fact, it could be rationally concluded that the great height of required returns made efforts at quantification superfluous: acceptable projects were obviously acceptable; borderline cases were by definition unacceptable. Even when it was a question of choosing between two projects both fairly close to the margin of acceptability, quantification, or, at any rate, the adjustment of estimated profitabilities for secondary factors such as differences in earning power that might develop after the first 2 years of use or changes in the cost of capital, would represent merely spurious accuracy; either project would probably yield roughly satisfactory returns, and given the uncertainties about the sizes of all returns there was no point in trying to decide which one project's returns would be more satisfactory.[2]

Contrary to this reasoning, it appears that uncertainty—or at least the weight given it—has greatly diminished since the depression-dominated prewar and early postwar periods. The businessman's cultural lag which in the 1930's prevented the marginal efficiency of capital (rate of return on investment) concept from being more than an economist's phantasy has now been shortened and, to some extent, supplanted by an economist's cultural lag: having belatedly adjusted his thinking to the realities of business depression era practices, the economist persists in the no-longer-justified assumption that business cannot have narrowed the gap between its practice and theory. Evidence that the gap has been narrowed can be derived by reference

[1] This paper is part of a study of the influence of interest rates on business investment being prepared for the Brookings Institution. The views expressed are the writer's and not necessarily those of the Brookings Institution. The author is an economist, Research and Statistics Department, International Monetary Fund, Washington, D.C.

[2] For a different interpretation of the prewar and early postwar survey evidence, see W. H. White, "Interest Inelasticity of Investment Demand—the Case from Business Attitude Surveys Reexamined", American Economic Review, September 1956, pp. 566-587.

to the advanced investment-selection techniques now actually in use by many large businesses, from evidence on the comparative lowness of required rates of return, and evidence that financial pressures are leading business executives to use the advanced techniques and accept the low returns.

These evidences of improved investment selection techniques and longer "economic horizons," certainly are insufficient to demonstrate that current, temporary conditions, such as boom peak or recession trough, are losing their major influence on the volume of fixed investment spending. But the new evidence is sufficient to suggest an appreciable reduction in the influence of extreme current conditions. The evidence is also sufficient, when buttressed by other neglected considerations, to establish at least a borderline case for significant effects on big companies' investment from interest rate changes having the magnitude of cyclical variation recently observed.

THE A PRIORI ARGUMENT FOR HIGH RISK CHARGES AND IMPRECISE INVESTMENT CRITERIA

The arguments for giving uncertainty a dominant role in the investment decision have been persuasively stated by one of their early proponents:

> If the machine could be expected to last forever or for a long period * * * there would be no difficulty in supposing that a difference of 1 or 2 percent in the long-term rate of interest might turn the scales of the calculation as to whether it was worth while to introduce the machine. In fact, however, most modern labor-saving machinery has a comparatively brief period of effective life * * *. This, however, makes it much harder to translate the problem into terms of a calculation of annual gain and loss in which the rate of interest is likely to be a material factor. For if such a calculation is made, the allowance for obsolescence or depreciation will inevitably be a much larger item on the debit side than the charge for interest. Yet the allowance for obsolescence must necessarily be of an arbitrary, rough-and-ready character * * * The machine which is assumed to have an effective life of 5 years may actually be retained for 7 or, on the other hand, it may become obsolete in 3. Thus a high degree of uncertainty would necessarily attach to any calculation of annual gain or loss, and it is hard to suppose that a difference in interest rates, which could only represent a small item in the calculation, could play a material part in the decision reached. It is doubtful indeed whether many manufacturers calculate the profitability of a new machine along lines which take account of variations in the rate of interest.
>
> A large part of manufacturers' fixed capital may not, of course, be of a highly obsolescent character. It will represent rather buildings and fixed equipment which will usually have a long period of effective life. But if it is easier in this case to calculate * * * [depreciation], it is much more difficult to calculate with precision the annual return which it is likely to yield. If a manufacturer is considering whether to put up new works which will enlarge his productive capacity, his dominating question, it is natural to suppose, will be whether he is likely to be able to sell profitably the extra output of goods. This is a question which seldom lends itself to precise calculation and it is again hard, therefore, on general grounds, to suppose that many manufacturers would pay much attention to the prevailing rate of interest in deciding to enlarge their productive capacity.[3]

Expressed in "interest elasticity" terms, Henderson's position is that uncertainty makes necessary the inclusion of a large "risk charge" in any required rate of return on investment. At the best this greatly reduces the interest elasticity of investment demand, since a rise in

[3] H. D. Henderson, "The Significance of the Rate of Interest," Oxford Economic Papers, I, October 1938 pp. 4, 5, reprinted in Oxford Studies in the Price Mechanism, T. Willson and P. W. S. Andrews eds., (Oxford, 1951), pp. 19, 20. Supporting detail is found in the presentation of a similar case by Maurice Moonits; "The Risk of Obsolescence and the Importance of the Rate of Interest," Journal of Political Economy, August 1943, pp. 348–356.

the interest rate from 3 to 4 percent—a one-third increase—would have to be matched by an increase in the minimum acceptable return on investment from, say, 30 to 31 percent—a mere 3-percent increase. More likely, the uncertainty makes expected return forecasts so crude that changes in required returns of even 2 percentage points are within the margin of error of the return computation and hence ignored. An even more likely consequence of this crudity is that quantification of the rate of return on investment becomes a meaningless, rarely used exercise.

Uncertainty versus risk

The developments of recent years in expectations economics are commonly thought to have provided a practically unchallengeable deductive proof of the overpowering role of uncertainty. In fact, however, the role now claimed in expectations economics for uncertainty often is smaller than generally thought, and the deductive basis of even the more limited role seems open to question.

> The outstanding characteristic of situations of uncertainty is their uniqueness. To say an event is unique does not mean that * * * a sufficiently similar event, has not * * * happened in the past, or could not happen in the future. It does mean (*a*) that the agent has no empirical data of previous like or similar events, and (*b*) that the present event is crucial to the agent in the sense that he has no interest in the possibility of similar events occurring in the future. * * * because of the uniqueness of the event, probability analysis is formally inadequate.[4]

If some measure of the probability dispersion around the computed expected return on investment were known and relevant, business could apply simply a fixed (and small) insurance (i.e., true "risk") charge. If the firm could count on some investments' yielding 4 percentage points more than estimated when an equal amount yielded, say, 5 percentage points less than estimated, then the firm's minimum acceptable rate of return on investment projects could be simply raised by, say, 1 percentage point to compensate for the imbalance (or by 2 percentage points for "safety"). In that situation, there would no longer be any logical barrier to a strong role in the investment decision for the expected profits of more remote years or for changes in the cost of capital. These conditions are, in fact, conceded to be met for one appreciable segment of "new ventures"—where the firm has a monopoly in the product involved—as well as for those innovation investments of large firms taking the form of gradual product improvement and plant modernization; here businessmen do think that, and act as if, uncertainty were absent.[5]

It seems, moreover, that the scope for application of the uncertainty rule in the remaining field of investment (Keirstead speaks here of innovation investments) should also be restricted. Probability distributions should be irrelevant for the small enterprise, which gambles all (or—what is sufficient to create uncertainty—gambles enough to damage its future) on a single throw of the dice. On the other hand the large businesses which probably do the greater part of innovating investment have an existence and a scale which are independent of the sucess or failure of any single investment project, and even of the collection of projects carried out in any single year. For these firms

[4] B. S. Keirstead, An Essay in the Theory of Profits and Income Distribution (Oxford, 1953), pp. 18, 19.
[5] Keirstead, pp. 25, 26, 27, 45, 46. Required rates of profit are thought to be comparatively low for both monopoly and gradual innovation investments (pp. 45, 46).

success is necessary only over the average of many throws of the dice; it is not necessary to gamble so conservatively that each separate throw will be reasonably sure to be a success. Hence, it is not possible to conclude a priori that for these firms the "probability analysis is formally inappropriate" because of uniqueness. Of course the secondary cause of uniqueness may be operative: Lack of a large enough accumulation of experiments businessmen would consider "sufficiently similar" to permit an estimate of the dispersion of the shots around the target rate of return aimed at. But, as Keirstead notes, this latter possibility does not constitute a valid a priori basis for the presence of very high risk (uncertainty) charges; it is possible that a sufficient number of homogeneous observations will be available and even more possible that the businessman will consider them available.[6]

Another writer argues that, while probability distributions are relevant and business can be assumed to act on the basis of probabilities, there is still an element of uniqueness in the investment decision in the sense that if by cruel chance many of the throws of the dice should turn out badly, the firm would go bankrupt. That event is equivalent to having lost at one throw of the dice; there no longer exists any chance to continue playing until the law of averages reasserts itself and the game is saved. It seems reasonable, however, that the risk charges required by large firms to insure against such improbable conjunctures of improbable events would not be high ones.

Aside from this possible element of uniqueness, there is the risk that the rules of the game may be changed (or may not have been properly determined from the evidence provided by the past), so that the entire set of probability assumptions is invalidated. This consideration would reinstate the high risk charge even if it were otherwise unnecessary. Such a situation is represented by inability to forecast impending recessions by use of evidence of the past. But that does not seem a strong basis for very high risk charges by the very large firms here at issue; their throws of the dice are so numerous partly because they can be counted on to occur over a long stretch of time. To some extent such firms can thus afford to ignore the possibility of unforeseen recessions in making their (long-term) investment decisions, and, as will be shown later, the large firm invests with an eye to the income that will be earned over a period very much longer than the business cycle. In any case, these a priori arguments for high uncertainty could not be conclusive, for their propounder agrees that business could reasonably be expected to act as if something approaching valid probability distributions did exist.[7]

STATISTICAL EVIDENCE FOR HIGH RISK ALLOWANCES IN CAPITAL INVESTMENT DECISION-MAKING

One of the American studies frequently cited as proving a very high required rate of profit is a McGraw-Hill survey of 1948 showing that a majority of large- and medium-sized manufacturers required that an equipment investment be recovered out of gross profits in 5 years or less. (See table 1.) Other surveys over the past generation have shown similarly short payoff ("high profit") requirements, with a

[6] Op. cit., pp., 24–5. G.L.S. Shackle concurs in the idea that the requirement of sufficeintly similar experiences is comparatively easily satisfied ("Probability and Uncertainty," Metroeconomica, I, December 1949, p. 162).

[7] J. Duesenberry, "Business Cycles and Economic Growth," New York 1958, pp. 69–70 and 72.

majority of the firms queried requiring recovery of the cost of investment in machinery and other equipment in from 3 to 5 years.[8]

TABLE 1.—*Payoff periods for new equipment and building purchases, 1948*

Industry	Percent of firms requiring—								
	For equipment					For buildings			
	1 and 2 years	3 years	4 and 5 years	6 to 10 years	10 or more years	0 to 5 years	6 to 10 years	11 to 15 years	16 or more years
Steel	0	0	80	20	0	35	65	0	0
Petroleum	0	0	50	50	0	50	50	0	0
Electric machinery	11	33	45	11	0	11	34	11	44
Chemicals	10	10	40	40	0	57	14	29	0
Automobiles	29	28	15	14	14	0	72	0	28
Machinery	13	25	47	15	0	11	47	13	29
Food	7	20	40	33	0	23	39	15	23
Transport equipment	0	29	71	0	0	0	28	44	28
Textiles	7	29	21	43	0	0	50	13	37
All manufacturing	10	19	46	25		61		16	23
Coal mining	20	15	30	30	5	7	40	20	33

Source: "Capital Spending Plans 1949-1953," Business Week, Jan. 22, 1949, p. 56; the aggregate figures for "all manufacturing" are from ibid., pp. 54, 59, and from E. L. Grant, "Principles of Engineering Economics," 3d edition, New York, 1950, pp. 542-543, footnote 9.

(a) Understatement of average payoff period

The first point to be made is that the short payoff evidence commonly cited refers only to equipment investment. A neglected part of the 1948 McGraw-Hill survey reveals very much longer payoff requirements for investment in buildings. The most striking difference is found in the responses of electrical machinery manufacturers: although 89 percent of the group required equipment investments to pay for themselves within 5 years, for buildings 44 percent accepted 16-year or longer payoff periods and another 11 percent accepted payoff periods of 11 to 15 years. (See table 1, third row.) Given that construction is well under half of total manufacturing investment, the average payoff requirement should be closer to that for equipment than to the construction requirement. Nevertheless, the construction period is so great that its presence in the data should raise the average payoff period appreciably above the equipment period usually cited.

(b) Special conditions underlying short payoff period findings

Although their 1948 findings of very short payoff periods for the larger manufacturing firm have been widely cited, the McGraw-Hill investigators have recently reported that those findings were a reflection of the large early postwar backlog of modernization projects which had the consequence "that companies could spend all their available funds on projects with short payout periods." [9] Only by 1951 had many of the companies worked these backlogs down to the point where "marginal" projects were being accepted.[10] It is there-

[8] E. L. Grant, "Principles of Engineering Economy," third edition, 1950, p. 200.
Another survey found that, although required payoff periods were typically 1 to 3 years for minor projects, they were 5 to 7 years for major projects; see W. W. Heller, "The Anatomy of Investment Decisions," Harvard Business Review, March 1951, p. 101.

[9] Universities—National Bureau of Economic Research, "The Quality and Significance of Economic Anticipation Data," Princeton, 1960, p. 377.

[10] McGraw-Hill, "Business Plans for New Plants and Equipment, 1952-55," p. 7.

fore necessary to devote attention to the later report on equipment payoff requirements. In 1955, despite a diminished proportion of big companies, McGraw-Hill found 5-year or longer "payoff periods for new equipment purchases" for nearly half of the manufacturing companies surveyed (see table 2), and there is evidence which indicates a concentration of the larger firms into that group.

TABLE 2.—*Payoff periods for new equipment purchases, 1955* [1]

Industry	Percent of firms requiring—					
	1 and 2 years	3 years	4 years	5 years	6, 7, and 8 years	9 or more years
Iron and steel	16	18	8	50	8	0
Nonferrous metals	0	25	13	50	12	0
Machinery	23	16	15	30	11	5
Electrical machinery	0	37	11	31	16	5
Motor vehicles and transportation equipment	16	16	24	24	8	12
Other metalworking	20	12	28	28	4	8
Chemicals	6	11	36	26	15	6
Paper	5	21	21	21	5	27
Rubber	20	40	10	10	20	0
Stone, clay, and glass	10	27	0	32	10	21
Petroleum refining and chemical	7	28	29	29	0	6
Food and beverages	22	16	16	25	10	11
Textiles	26	19	25	19	9	2
Miscellaneous manufacturing	24	18	13	18	14	8
All manufacturing	17	19	18	27	11	8

[1] Payoff figured before deduction of taxes.

Source: McGraw-Hill Department of Economics, "Business Plans for New Plants and Equipment 1955–58" (New York, n.d., 1955?) p. 11.

Evidence on the length of payoff period used by the very large firms of chief interest here is provided by a 1955 survey of 57 New York Stock Exchange listed manufacturers. This survey found mean "payout periods" for investment in equipment of 7.3 years for firms with 7,500 or more employees (median 6 years). For smaller listed companies the mean period was 4.7 years and the median 5 years.[11]

(Although no information on the tax and interest-charge assumptions behind the reported payoff periods is available, the results for the larger firms indicate quite low required rates of return under any assumptions.)

Further lengthening of the relevant average payoff period is justified by the opinion of an authority on engineering economics that the 2- and 3-year payoff requirements found by McGraw-Hill apply to restricted classes of specialized machinery having short economic lives; he considers that firms reporting 2- and 3-year requirements must have been doing major parts of their equipment investment on the basis of much longer payoff periods.[12]

(c) *Exaggeration of rate of return and undervaluation of expected life implied by short payoff*

Those who allege high uncertainty, short economic horizons, and low sensitivity to interest changes interpret evidence like the

[11] A. L. Grey and M. D. Brookie, "The Rate of Interest, Marginal Efficiency of Capital and Investment Programing: A Rejoinder," Econ. Jour., June 1959, p. 341.

[12] Grant, op. cit., pp. 199–201.

Insofar as short payoff periods in prosperous years reflect engineer and management shortages and equipment delivery delays, they can, of course, represent insulation of large firms from conditions on the capital market and from other external economic conditions such as increases or moderate decreases in GNP.

McGraw-Hill equipment findings as proving very high required annual rates of expected profit on investment. Thus, if an investment is required to pay for itself in a 4-year period, it must earn 25 percent per annum on its original cost.[13] Various students of the subject compare with this 25 percent changes in the cost of capital of 1 or 2 percentage points; the latter being only 4 or 8 percent of the expected "profit," it is unlikely to catch the attention of those who determine the volume of investment. But this conclusion is incorrect, for it compares the capital-cost change with a gross rate of profit, one including—according to most indications—interest or dividends, depreciation, obsolescence, and income taxes (and a charge for risk). Allowance for all of these items should reduce the 25-percent annual gross profit figure to a net value that is low enough so that, for example, a 2 percentage point change in interest costs could seem quite significant.

The definition of the payoff period used in the 1955 McGraw-Hill investigation was the number of years' expected profits on the investment (measured gross of depreciation, income taxes, and perhaps interest) necessary for covering the investment's cost. By this definition, even under the assumption usually made in payout computations—an undiminishing level of annual gross income over time—a 5-year payoff period would connote merely a 10 percent after-tax rate of return on the average investment (a 5 percent rate on the investment's original cost) if the earning life were expected to last 10 years, and no more than a 12½ percent net return if the earning life were assumed to be 15 years. Moreover, the constant annual income assumption is merely a rule of thumb; the firm knows that depreciation and obsolescence should reduce the asset's earning power with the passage of time. Assuming a gradual decline in earnings—one that reduces the amount of net profit in proportion with the reduction in the book value of the asset net of accrued depreciation—the after-tax rate of return on investment connoted by the 5-year payout period that would actually be foreseen would be only 6⅛ percent for an expected earning life of 10 years and just 7.7 percent when the expected life is 15 years.

A substantial fraction of the firms reported payoff period requirements longer than 5 years. A 7-year requirement and a 15-year earning life would connote no more than a 7.6 percent after-tax rate of return on the average investment assuming undiminished earning power over the 15 years and a mere 4.8 percent return assuming a gradual decline in earning power over the 15-year period.[14]

With required rates of return so low and/or economic horizons so long, the proper inferences to be drawn from the reports of fairly short payout period requirements is that large manufacturing companies in

[13] For example, Kelrstead infers (p. 28) a minimum acceptable expected rate of return on venture capital of 40 to 50 percent partly from a survey showing that the majority of firms purchased new equipment only when "the production [cost] savings will return the initial investment" in 3 years or less. (His source may not have indicated the hoary age of this survey: 1927; see Recent Economic Changes, I, New York 1929, p. 139.)

[14] The formulas used will be presented in the full version of this study. They are based on the simplest assumptions: The constant gross income formula assumes straight line depreciation charged at year ends but with the average amount invested net of accrued depreciation assumed to be half of original cost. Non-depreciating assets (land, inventory) are assumed zero. Interest charges are also assumed to be zero. The last three assumptions yield an exaggeration of the rate of return actually expected.

The declining income formula assumes that a constant depreciation charge is earned in each year but that net profit declines in such a way that the rate of return on net investment (original cost less accrued depreciation) is the same in each year. This formula yields the same rate of return as the time-discounted marginal efficiency of capital. The constant income formula produces a higher rate of return.

the mid-1950's were not obsessed with the risks of loss; rather they felt confident that—over the average of a number of years and over the average of a large number of investments and products—they could accurately forecast the prospects for sales and profits. This result is in marked contrast with the evidence on big business executives, attitudes in the late 1940's, when memories of the great depression and expectations of the "normal" (and severe) postwar depression were common.[15]

These inferences are not completely airtight. The length of the reported payout periods could in many cases be the consequence of limited investment opportunities plus idle retained profits that were in search of some sort of employment within the firm. However, evidence is presented below which indicates that the required after-tax rate of return on investment is prevailing only 10 percent among large and expanding manufacturerers who are known to call on outside money to finance investment; in conjunction with the indications that the longer payoff periods tend to be accepted by larger companies, this tends to confirm the above inferences of low risk, limited uncertainty and long economic horizons.

Another sort of substantiation is available for these long payoff period results in data on the age distribution of machine tools used by the metalworking (machinery, automobile, office machinery, etc.) industries. In contrast with the long record of reported short payoff requirements, over half of the machine tools were 10 or more years old in 1953 (almost 20 percent being over 20 years old). Moreover, despite the claims of very rapid obsolescence for machine tools two-thirds of the equipment in use was of pre-world War II design. And in conflict with the customary claims of rapid obsolescence—the reason usually given for rapid payoffs and high returns—is the American Machinist's conclusion that, on the average and roughly speaking, metalworking machinery does not become obsolete until it has been in use for 10 years.[16]

The 1955 McGraw-Hill inquiry did not repeat its earlier question on manufacturers' payoff period requirements for buildings; but strong evidence that industry makes its new plant investments with one eye glued to the long run is provided by the finding, from a 1959 survey of executives of a hundred large- and medium-sized manufacturing firms, that "most companies make it possible for the [new] plant to reach full capacity (which usually matches sales projections *5 or 10 years ahead*) with one-shift operation and not too much strain."[17] This finding is corroborated by a General Electric economist's statement that "Management builds capacity for the potential market usually 5 but sometimes even 10 years in the future,"[18] and by an earlier statement from one of the Big Four tire and rubber firms that it "wants to build [capacity] 5 or 6 or 7 years ahead" of demand.[19]

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[15] See D. T. Smith, Effects of Taxation on Corporation Financial Policy, Boston, 1952, p. 41. Smith foresaw that continued prosperity would modify these pessimistic expectations but that experiencing of another severe recession would make them permanent.

[16] The findings above hold within most of the 15 industrial groups into which the 4,000 factories surveyed were classified as well as for most of the 39 machine types investigated.

It should be noted that most of the over-20-year equipment constituted active, rather than standby, capacity.

See 1954 production planbook, supplement to the American Machinist, mid-November 1953, pp. A-2, A-3, A-5; and the Management Review, January 1954, p. 42.

[17] Dun's Review, March 1959, p. 60. Emphasis added.

[18] D. J. Watson in American Statistical Association, "Proceedings * * * 1957," p. 340.

[19] Robert Eisner, "Determinants of Capital Expenditures," Urbana, 1956, p. 87.

Not only are these policies diametrically opposed to the views of observers such as Henderson about the high uncertainty associated with long-term commitments in industrial buildings (See above) but they must also connote very low required rates of return for extra-long-term investments. The construction cost savings on the, say, 7th year of excess capacity (added to the capacity of the new plant being built now) could not possibly be great enough to yield as much as a 10-percent after-tax rate of return on the extra investment. (The willingness to make extra-long-term plant investments at low rates of return can probably be explained by the view that industrial buildings are a salable commodity, their value not being necessarily determined by the prospects for successful expansion in the given firm but rather by the prospects for the variety of industries and firms that could make use of the plant if the given company's expectations failed to be realized.)

PREVALENCE OF SCIENTIFIC INVESTMENT SELECTION TECHNIQUES

The fact that large manufacturing companies were able to answer the 1955 McGraw-Hill inquiry about length of payoff periods might itself be sufficient to call into question the sophistication of companies' capital expenditure selection. As indicated by the crucial assumptions that had to be introduced above, before sense could be made of the payoff periods specified, the payoff period method is a very crude one; its use would seem inconsistent with the claims of rapid advances in scientific investment selection during the 1950's made in this paper. The inconsistency is only apparent, however. In the first place, McGraw-Hill requested the respondents to supply their profitability requirements in the payout period form. Secondly, many firms could be using the payout period standard as a rule of thumb for the numerous small-scale, almost routine investment decisions, or as a first screening, but employing the more meaningful but more complicated rate-of-return standard for major investments and for borderline cases. Finally, evidence presented below will show that rapid increases in use of scientific management techniques have occurred even since the year 1955.

A survey made somewhat later than the McGraw-Hill tabulation supplies a limited amount of direct evidence on the frequency of use of both the payout-period and rate-of-return methods of investment selection. Among the 30 respondents to a survey of manufacturers ranking among the 500 largest made in perhaps 1958, the forms of investment selection procedure used were as follows:[20]

TABLE 3.—*Frequency of alternative criteria investment selection*

	Percent
Payout period only	24
Average rate of return on investment only	20
Marginal efficiency of capital (time discounting) only	13
Combination of all 3 methods	43
Total	100

Subject to some reservation because of a somewhat low (40 percent) response rate and because of the possibility that the sample was biased in favor of sophisticated investment planning as a result of the sur-

[20] Frank Schwab, Jr., "Capital Expenditure Evaluation," The Comptroller, August 1958, pp. 357-360. The industries represented in this survey are autos, oil, paper, steel, and textiles.

veyor's function as research director of the Systems & Procedures Association (held in addition to his position as management engineer for a large paper manufacturer), this survey shows that exclusive use of the payout period by large firms is rare but that a majority of large firms do make some use of it.

A larger scale, comprehensive survey made more recently and covering 127 industrial and distribution firms, found that only a bare majority made any use of the payout criterion and that merely one out of seven used that criterion exclusively.[21]

TABLE 4.—*Prevalence and functions of the rate-of-return criterion*

	Percent
Payout period alone	14
Payout period with rate of return	38
Average rate of return on original cost of investment	46
Discounted cash flow (time discounting)	30
Total using either form of rate of return standard in investment decision-making	77
Other uses of rate-of-return measurements:	
Check of realized against forecast rate of return on investment	57
Setting profit goals	[1] 56–60
Determining management incentive payments	25
Guide to size of inventory	[2] 22
Product price fixing	27

[1] Larger figure may include some payout period cases.
[2] As discussed in W. H. Shite, "Inventory Investment and the Rate of Interest," Banca Nazionale del Lavoro Quarterly Review, June 1961, pp. 141–186, interest rate effects on inventory investment may reasonably exist independently of use of the rate-of-return criterion.

This survey may also suffer from some degree of bias because of concentration on "excellently managed" companies and to some extent because of its moderately low (63 percent) rate of response to the survey mailing. However, the list of excellently managed firms is fairly inclusive for the big companies,[22] and what remains of these biases should tend to be offset by opposite ones due to inclusion of fairly small firms and of the comparatively backward distribution industry.

Evidence that scientific management biases in the firms covered by the two surveys do not cause overstatement of large industrial companies' use of the rate of return standard is provided in a Controllership Foundation survey mailed to 800 companies (mostly manufacturing and mining) and getting nearly 400 responses. The responses included so large a proportion of the country's larger companies that the results can be given much weight even though the questions asked did not include use of the rate of return criterion specifically for new capital expenditures. The survey's reliability was confirmed by extensive interviewing of 35 more firms for which the possibility that the procedures being reported were merely perfunctory and of little concern at decisionmaking levels was tested and was ruled out: the procedures were taken seriously by upper management. The relevance of the 35-firm results is indicated by the fact that their

[21] J. H. Miller (controller, Chemical Division, General Tire & Rubber), "A Glimpse at Calculating and Using Return on Investment," N.A.A. Bulletin, June 1960, pp. 71–75.
[22] Two-thirds of the hundred largest, and decreasing proportions of smaller manufacturing firms were ranked "excellently managed" in 1957. It is said that "a substantial number" of firms were evaluated on the basis of financial reports [*Fortune*, November 1956, pp. 120–221, 252]; there is no presumption that firms rated excellent on that basis were greater users of scientific management than the typical firm, especially so in view of the newness of the scientific techniques at issue and the likelihood that a record of low profits would have stimulated their adoption.

percentages of "yes" and "no" responses to specific questions were strikingly similar to those of the 400 mail-survey respondents.[23]

The survey indicates that elaborate financial, sales, and capital-spending planning is common among the larger firms. Nearly three-quarters of the respondents had formalized long-range capital expenditure plans. Just under half of the small (under 2,500 employees) and medium-sized (2,500 to 10,000 employees) firms and three-quarters of the large firms made market surveys to forecast sales. Three-eighths of the small, half of the medium-sized, and two-thirds of the large firms had definite profit objectives expressed in terms of the rate of return on capital employed. (The allegedly conflicting objective, "maintenance of share of market," was reported as being used by only half of the large firms and lower proportions of the others.) Finally, return on capital employed was used "as a technique for overall control of company performance" by, respectively 43 percent, 57 percent, and 76 percent of the small, medium, and large firms.[24]

Further corroborative evidence of the prevalence of the rate of return criterion in investment selection is provided by a large manufacturing firm's vice president. (This evidence is particularly significant in one respect because the evidence comes from the part of management usually thought most skeptical of subtle, financial devices like the return-on-investment criterion: a marketing vice president.) An "informal survey of about 30 representative companies" made by this executive for Dun's Review made the striking finding that for new-product investments the kind least susceptible of the accuracy of income forecast that reliance on return computations requires—the rate of return criterion was tied for the most important position with "market potential." Moreover: "The most universal standard employed by enlightened management is the return on investment the project will produce. * * * Well managed companies of the future will be those that have established profit criteria and stick to them." [25] With enlightened managements found relatively more frequently among larger firms and with the return criterion presumably in wider use for expansion than for new-product investments, this survey constitutes very strong evidence for the pervasiveness and precision of the return criterion.

If the plausibility of dominance by the rate-of-return criterion has been demonstrated through the evidence presented above, the likeli-

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[23] B. A. Sord and G. A. Welsch, "Business Budgeting, a Survey of Management Planning and Control Practices," Controllership Foundation, New York, 1958, pp. 351, 353.

[24] Op. cit., pp. 23, 88, 128, 143–144.

The percentages for the large manufacturers alone might be smaller than the 76 percent for all large firms, for 80 percent of all public utilities and transport firms who total 10 percent of the sample—reported use of this technique. Manufacturers are dominant in the large-size class, however.

The representatives of the survey sample remains at issue because the 820 firms queried were companies "with a reputation for utilizing effective budgeting practices." However, the actual manufacturing respondents to the mail (and the interview) survey can be determined to have constituted 50 percent of all the over 200 manufacturers with 10,000 or more employees (and approximately half of each of the 4 subclasses within that "large" size group).

Three-fifths of the medium-sized manufacturers queried did not return the questionnaire. This might suggest that those who did return it were a biased group that was proud to boast of its advanced techniques. But since the mail questionnaire was an extremely formidable document, a sizable nonresponse rate (say, at least, 25 percent) can be expected solely because of unwillingness to cooperate. It follows therefore that the large majority of "large" and probably of "medium sized" manufacturers are users of "effective budgeting practices" and therefore were among the 750 manufacturers who were mailed the survey questionnaire. The large (and medium) firm portion of the survey population therefore ought not constitute a seriously biased sample. See op. cit., pp. 58, 59, 353.

[25] R. M. Oliver (vice president, Thomas A. Edison Industries), "How To Plan a Profitable Product Line," Dun's Review, January 1957, pp. 39, 105–106.

hood of a major role for the cost of capital has not. Unfortunately, the rate-of-return surveys did not refer to cost of capital, and the many instances of report of the return criterion in particular large companies collected for this study commonly did not even include mention of a specified minimum acceptable rate of return. At the same time, in many instances the return criterion may be excluded from large portions of a firm's investing or may be combined with other, imprecise, subjective criteria.[26] Of course, many of the firms are emphatic about the importance of the return criterion; e.g., Continental Can, the Dewey and Almy Division of W. R. Grace, Du Pont, General Dynamics, General Electric, Monsanto, and Westinghouse.[27] Quotations from the report of an official of Armstrong Cork, one of the more enthusiastic users of the rate-of-return criterion, are appended to this paper to show how unimportant those segments of investment can be for which return computations are either very crude or impossible.[28]

BUSINESS REPORTS ON REQUIRED RATES OF RETURN ON NEW INVESTMENTS

The low minimum acceptable rates of return on investment derived from the mid-1950's payoff period surveys discussed above find corroboration in the occasional statements that large companies are willing to make on their return standards and in reports by business specialists.

Brookings investigation

A valuable source of information on particular companies' required rates of return on investment is provided by a Brookings Institution study of the price-setting practices of large companies. Although the relevance of that study is somewhat reduced by the fact that the evidence was in large part gathered at the end of the 1940's and in the early 1950's (when the rate of return standard was less frequent) and by the price-fixing frame of reference, the investigation still yields valuable information on rates of return considered acceptable by large firms.

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[26] Exclusive reliance on self-financing would reduce the return criterion's function to selection among available investment projects without, normally, any influence on total investment. This is a real barrier to capital cost sensitivity, although a far less important one than it is usually thought to be. (Some of the evidence developed which indicates sufficiently broad reliance on the capital market for investment financing in prosperous years is summarized in W. H. White, "The Rate of Interest, the Marginal Efficiency of Capital and Investment Programing," Econ. Jour., March 1958, pp. 52–53; and in White, "Inventory Investment * * *," p. 145.)

[27] General Electric tends to be a self-financer and, at least in some recent years, has required such a high rate of return that capital costs of external financing may have been unimportant (but see below, p. 30). The same may be true for Du Pont also.

[28] A clue to the reliability of rate-of-return forecasts is given by the fact that most firms describing in detail their use of the rate-of-return criterion insist that an essential part of the procedure is holding the management officials who sponsor a project responsible for divergences, in either direction, of the realized from-the-forecast rate of return (excepting those divergences caused by unforeseen business cycle movements). See, for example, G. E. Altmansberger (associate director of financial analysis, Ford), "Ford Motor Co., Building an Integrated Reports System: An Outline," "Reports to Top Management for Effective Planning and Control," American Management Association, New York, 1953, p. 103; R. B. Read (Westinghouse director of planning), "Importance of Capital Investment Control," loc. cit., p. 97; T. C. Davis, "The Accountant and the Profitability of Productive Facilities," N.A.C.A. Bulletin, January 1956, pp. 650–651. Although Du Pont is considered the generator par excellence of rapid product obsolescence, Davis endorses the rate-of-return criterion for new-product investment as well as for expansion investment (ibid., pp. 648–649).

J. B. Matthews of the Harvard Business School found, from intensive study of the investment selection procedures of 12 large firms, that over half used good selection techniques. Six of the firms used procedures that included reference to expected rate of return on investment and considered comparison of the realized and the forecast rates of return a very important part of the investment selection process; the check was made by senior officers or by the investment selection committee, and these were enthusiastic about the value of the check of degree and causes of divergence between forecast and realized rate of return on investment projects (J. B. Matthews, Jr., "How To Administer Capital Spending," Harv. Bus. Rev., March-April 1959, pp. 95, 96.)

There are good reasons to believe that there is an increasing tendency for large companies to adopt some form of target rate of return pricing. The reasons for this are—

(1) Large firms say that because of their market position they must plan ahead for markets, products, and investment expenditures (plus the ability to do so—financial strength and market position);

(2) A profits target provides a good standard in relation to the many competing uses for investment funds by many divisions in the large firm and a good standard for appraising the performance * * *[29]

Two other reasons for the spread of the rate-of-return standard are the effects of cost-plus pricing in Government contracts and desire to copy Du Pont and General Motors, users for years of target-rate-of-return pricing.

* * * most large companies have as an objective certain specific long-term goals other than simply year-to-year survival. The most common types of objective of large corporations appear to be—

(1) Pricing to achieve a specific longrun target rate of return on capital investment (including long-term debt) * * *.[30]

The other pricing objectives found were stabilization of prices, margins, and profits; realization of desired share of the market; meeting or preventing competition; following the price leader.

* * * what appears to be the most prevalent objective * * * [is] a long-term target rate of return on investment. Also, even in those cases where one or another of the company objectives are tied more closely to actual pricing decisions, a close interrelationship exists with the desire to match or better the company's recent or average profit rate.[31]

The ability or desire to price for target rates of return on investment seems to have been restricted to the large, heavy-industry half of the group of 20 firms interviewed for the Brookings project. The 11 firms not using target returns as their primary pricing policy included 2 retail food chains and 2 food processers and a copper miner,[32] for all of whom the return requirement might be in use for investment decisionmaking even though discretion in price fixing may of course have been limited. The same would be true of the medium-sized steel manufacturer in the group and perhaps for a sixth member, Sears Roebuck (who did use rate of return as a "secondary" pricing objective—secondary to increasing share of the market).[33] The presence of American Can, Goodyear, and Gulf Oil cannot be explained in this way, but it is possible that they were (or later became) users of the rate-of-return criterion where investment rather than price-fixing decisions were involved (as is known to have happened in the case of American Can). The 11th nonuser of the return requirement as primary pricing objective, Standard Oil of Indiana, did use the requirement as a secondary objective.[34]

The range of target rates of return on investment found was 8 to 20 percent after taxes (apparently, see above, on the equity plus long-term debt cost of the investment) or 16–40 percent before taxes. The firms and their return requirements, as of a decade ago, are:[35]

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[29] R. F. Lanzillotti, "Some Characteristics and Economic Effects of Pricing Objectives in Large Corporations," Joint Economic Committee, "The Relationship of Prices to Economic Stability and Growth," 85 Cong., 2d sess., Washington, 1958, p. 443. The main study from which Lanzillotti's material is derived is published in A. D. H. Kaplan, J. B. Dirlan, and R. F. Lanzillotti, "Pricing in Big Business: A Case Approach," Washington, 1958.

[30] Lanzillotti, op. cit., p. 442.

[31] Op. cit., pp. 442–443.

[32] R. Lanzillotti, "Pricing Objectives in Large Companies," American Economic Review, December 1958, p. 926.

[33] Ibid.

[34] Ibid.

[35] Lanzillotti, "Some Characteristics and Economic Effects of Pricing Objectives in Large Corporations," p. 445; and "Pricing Objectives in Large Companies," pp. 924–927.

TABLE 5.—*After-tax return on investment (percent)*

Used as primary pricing objective:	
Alcoa	10
Du Pont	[1] 20
Esso Standard Oil	[1] 10–15
General Electric	20
General Motors	20
International Harvester	10
Johns-Manville	[2] 15
Union Carbide	[3] 18
United States Steel	8
Used as secondary pricing objective:	
Kroger	10
Sears, Roebuck	10–15
Standard Oil (Indiana)	[4]

[1] Estimated.
[2] Approximate.
[3] Estimated average.
[4] Not available.

In a majority of cases the firms would require somewhat higher returns on new-product investments, although this was in part an allowance for the tendency for new products to yield higher returns than they would in later years when they had become "mature." [36]

One of the companies reported in table 5 as having a rather high return is known to have changed to a fairly low requirement in the last few years.

With these adjustments, the required returns of 5 to 7 of the 11 leading companies for which return figures were given suggest long economic horizons, low weight for uncertainty, and careful estimating of the investment's profitabilities. These levels of required return are also consistent with appreciable sensitivity to interest costs. While they certainly are not so low as to create a strong presumption of interest cost sensitivity, they still are not so high as to create a strong presumption against sensitivity. It will be noted, however, that three of the leviathans, who represent a goodly portion of total capital spending, required 20 percent net-of-tax returns—returns which suggest limited possibilities for capital cost sensitivity. That finding, however, only duplicates evidence that these firms tend to be made insensitive to capital market conditions by infrequency of need for long-term external financing.[37]

Interview findings

That the required returns found to be used in price fixing 10 years ago are representative of the levels set for investment decisionmaking today is indicated by the evidence derived from interviews made for this study in 1958. Officers of five large companies and a banker-director of several medium-large firms reported required rates of return on investment ranging from 5 percent to 18 percent, with 10 percent the figure most frequently cited.

[36] R. Lanzillotti, "Pricing Objectives in Large Companies," p. 451.
[37] Self-financing should be expected to coexist with the very high rates of return these firms are able to claim, for the reason that their high retained profits permit them to carry out very rapid rates of expansion without any need for reliance on outside funds.

TABLE 6.—*Required after-tax returns on new investment in 1958 (percent)*

Informant	*Required rate of return on new investment*
Financial officers:	
Very large firm	8 (time discounting method).
Very large oil companies:	
Own firm	Not available.
Others	10 to 18.
Large firm	Something over 10.
Banker-director, medium large firms	5 to 7½.
Manager, economic evaluation, fairly large firm	10 to 15 for chemical industry.
Head, fairly large firm:	
Own firm	10.
Others	10.

It is likely that the above return figures are all, except the first, based on the original cost rather than the average value of the investment project (as is known to be true for the reports by the last two informants cited). As discussed earlier, that treatment might in some cases require upward adjustment of the required return figure if a comparison was to be made with the cost of capital, for accrual of depreciation charges means that the average amount invested is well below the investment's original cost; hence the annual interest payment at a, say, 5-percent rate averages well below 5 percent of the investment's original cost. However, since major investments include both depreciating assets and nondepreciating assets (circulating capital and land) it could not be argued that the required returns should be as much as doubled for comparison purposes; an increase of perhaps 50 percent in the required return figure would be sufficient. More important, as described elsewhere, the original cost is often the correct base for measurement of rate of return that would be comparable with a cost-of-capital rate figure (because annual income shrinks as the asset depreciates and obsolesces or because depreciation accruals will be reinvested to maintain the capital asset in "new condition"); and firms are known to treat the original cost base as yielding the correct rate of return for such comparisons.[38]

It should be noted that not all of the 10-percent or 15-percent profits reported above are supposed to represent funds that would be available for paying the cost of capital. The last two informants listed above stated that the returns specified included allowance for risk. Moreover, the case of a 10- to 15-percent range was said to include earnings to cover the needed return on the nonproductive investments (safety and worker welfare facilities, etc.) which are complementary to major productive investments, so that the true required rate of return on total investment was lower than the 10- to 15-percent range.

REQUIRED RETURNS ON NEW INVESTMENT REPORTED BY SPECIFIC LARGE COMPANIES

The large companies for which published statements by officers on required rates of return on new investment were found are Allis-Chalmers, Continental Oil, General Electric, Stromberg-Carlson (General Dynamics), and Westinghouse Electric. With the exception of General Electric, all of these set no more than 10 percent of original cost after taxes as the return standard. Because their reports permit

[38] White, "The Rate of Interest, the Marginal Efficiency of Capital and Investment Programing," pp. 57–58.

a glimpse into the investment decision process in big companies, a few details of the investment criteria will be given in each case.

Allis-Chalmers is represented by its comptroller's report that "The rate of 6 percent has been established as the required rate of return on invested capital." However, because of the extreme lowness of that return figure and because the statement was made in the context of a discussion of replacement investment decisionmaking that involved comparison of projects' discounted present values with their costs (under the MAPI formula),[39] the 6-percent figure cannot be safely accepted as representative of Allis-Chalmers' large-scale investment standards.

The rate required by General Electric in 1957 for new investments was the same as that reported in table 5 for use in price setting some years earlier: 20 percent. There is evidence, however, that just prior to 1957 GE had required a lower return and that a restoration of the 20-percent figure took place because of "tight money."[40] If it is true, as the evidence seems to show, that GE raised its required rate of return in 1957 because of "tight money"—which in its case could mean only high cost of money—then General Electric would constitute a case of interest-cost sensitivity despite apparently high minimum required rates of return on investment.[41]

Continental Oil has been described earlier as relying heavily on the rate-of-return standard for investment selection. In its case the 10-percent return requirement noted above is known to be computed by the sophisticated time-discounting method. And the return requirement might well be varied with changes in the average cost of capital (debt plus equity) to the company, for the 10-percent figure was arrived at by averaging the then existing earnings-price ratio of the firm's common stock and the net-of-tax interest rate; to this average (7 percent) was added 3 percent to provide for the growth in per share earnings which the company's stockholders expected to result from the company's capital expenditures. The return requirement appeared to be taken very seriously, for the firm apparently expected to be very reluctant to accept for nonquantifiable reasons projects that promised lower returns, and it expected to be obdurate when such projects' expected returns fell below the actual cost of capital (7 percent).[42]

Stromberg-Carlson's president reported requiring a 10-percent rate of return after taxes on the original cost of new investments but with

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[39] T. D. Lyons, "A scientific Formula for Solving Replacement Problems," "Tested Approaches to Capital Equipment Replacement," American Management Association, New York, 1954, pp. 48, 52.

[40] The Wall Street Journal stated that GE had cited "tight money" as a factor in its putting off three expansion projects (Wall Street Journal, Jan. 8, 1957, p. 7) and a Fortune magazine report of March 1957 gave GE as an example for the firms "applying much more stringent profit tests before approving a new capital appropriation as a result of "the money pinch" (C. E. Silberman, "The Strange Money Shortage," Fortune, March 1957, p. 262).

The New York Times reported that GE's president said the company would continue the previously planned [self-financeable] amount of spending "but only on new installations that have prospects of earning * * * a 20-percent return after tax on the money invested in any particular expansion" (New York Times, May 3, 1957, sec. 3, p. 1).

[41] Another, non-interest-sensitivity explanation of GE's apparent reaction to tight money would be that demand for its products was being restricted by tight money. That explanation does not hold, however, for the effects of tight money on customers' demands would automatically be reflected in reductions in the forecast rates of return on investment; raising the return requirements would be unnecessary. (A conceivable interpretation of the raising of investment standards is fear that recession would follow tight money and a consequent unwillingness to permit so much spending that external financing would be required.)

[42] "Continental Oil Company, Appraisal of Capital Investment," Harvard Business School, accounting 117, 1955 (mimeograph), pp. 16, 10. The return required is raised to allow for abnormal riskiness in the case of refining facilities (to14 percent) and development wells and petrochemicalfacilities (to 18 percent), but since these risk charges are precisely quantified they should not constitute a ground for disregard of capital cost changes (although they may reduce the size of reaction to given changes).

lower returns for projects promising long economic lives and higher returns required for short-lived, unstable projects.[43]

Westinghouse reports allowing some of its divisions to deviate from the firm's 20 percent required minimum pretax rate of return on new investments—divisions making low-profit products being allowed to set somewhat lower returns and high-profit divisions being given higher minimum return standards. Westinghouse requires satisfaction of the rate of return criterion by those of its investment projects intended for expansion, for new products, and for cost reduction. On the other hand, "necessity" projects (health, safety, legally required expenditures, employee relations outlays) are not subjected to the return test, nor are "product improvement projects" which are evaluated in terms of effect on the product's "competitive position." All the expansion, etc., projects are arrayed by rate of return, with the lowest-yielding projects (those yielding at least 10 percent) all winning acceptance, provided (apparently) that internal funds are sufficient for their financing. And "* * * if there are projects below the cutoff point [that set, apparently, by the internally available funds] which exceed the minimum acceptable rate of return [10 percent after taxes], it will be necessary to reexamine the supply of funds and the assumption which underlies it [apparently, the assumption that only internal funds will be used]."[44]

Some question whether the estimated returns are taken seriously enough by Westinghouse to imply capital-cost sensitivity when outside financing is considered is introduced by statements which seem to indicate that the arraying of projects by rate of return and cumulation into a demand curve for funds is made only after the expected returns are grouped into classes 5 percentage points wide: those expected to yield over 20 percent being rated A, those expected to yield 15 to 20 percent being rated B, and the 10 to 15 percent projects being rated C.[45] That grouping does not necessarily preclude finer classifications when external financing does become an issue, however. Evidence that the actual return figures are given attention is found in Westinghouse's considering subsequent confrontation of the project-sponsor's estimated return with the return ultimately realized very important.[46] More significant, a report similar to the one drawn on above and written by the same Westinghouse officer mentioned that the demand curve for funds was derived from a listing of projects "in order of their ability to produce return on investment," without any qualification for grouping into a return class.[47] And this report also recommended that the minimum acceptable return for externally

[43] Statement by R. C. Tait, American Management Association, "Launching a Company Expansion Program," New York, 1956, p. 13.
Stromberg-Carlson was absorbed by General Dynamics (Tait becoming the latter's executive vice president) which is known to have continued the smaller firm's investment selection policies at least to the extent of "* * * quite rationally approving the appropriations [for projects proposed by the company's various divisions] in order of their estimated effect on earnings. Priority is going to be given to those projects or capital investments that give promise of the largest return on the investment, and those with the smallest promise or prospect of the smallest or most distant net return on investment are rejected" (R. C. Tait in Commercial and Financial Chronicle, Mar. 13, 1958, p. 13).
The strength of General Dynamics' belief in the rate-of-return criterion is indicated by the statement of its assistant to the executive vice president that the rate-of-return criterion is preferable to "playing by ear" and to the payoff period even for the very uncertain investment in the production of new airplanes, which are likely to have become obsolete as soon as large-scale production is attained (K. Stiles, "Capital Expenditures, Perpetuating for the past or Forecasting the Future," Journal of Accountancy, September 1956, p. 38).
[44] R. B. Read (director of planning, Westinghouse), "Importance of Capital Investment Control," "Planning the Future Strategy of Your Business", E. C. Burak and D. G. Fenn, eds. New York 1956, pp. 93–95.
[45] Ibid.
[46] Op. cit., p. 97.
[47] R. B. Read, "Return on Investment—Guide to Decisions," N.A.C.A. Bulletin, June 1954, p. 1243.

financed investment be at least equal to what seems to be the firm's cost of capital.[48]

Although recommendations by specialists that high rates of return are necessary could doubtless be found, a number of specialists are known to have recommended quite low minimum acceptable expected returns on new investment. In the 1950 edition of his classic work, "Principles of Engineering Economy," E. L. Grant stated that to cover interest, risk, and pure profit the required minimum rate of return "should probably fall between 5 and 10 percent in the great majority of cases [excluding public utilities, which should require a lower rate]." [49]

At another point Grant endorsed the principle that the risk charge should vary with the cost of capital: "A good general rule is not to make investments in plant and equipment unless the prospective rate of return for such investments is at least double the real cost of borrowed money [in order to cover risk and to leave something for pure profit]." [50] Where this rule is followed, inclusion of risk and pure profit charges in the required rate of return does not reduce interest elasticity of investment demand at all.

Corroboration for all these indications of frequency of fairly low required returns is provided, finally, by the 7 to 10 percent net-of-tax required return on a new plant described as typical by a leading businessman member of the Commerce Department's Business Advisory Council "who is well acquainted with the financing problems of many corporations." [51]

In sum, the evidence of the lowness of individual large companies' required rates of return on new investment, reinforced by the payoff period evidence that was found to connote fairly low required rates of return, rules out the presumption of return requirements so high that risk was predominant, the immediate future the only concern, or cost of capital ignored.

OUTMODING OF PRE-MID-1950'S EVIDENCE BY RAPIDITY OF ADOPTION OF SCIENTIFIC INVESTMENT PLANNING

The brief descriptions of recent business planning and investment selection techniques reproduced above indicate that the conditions in terms of which economists have formed their judgments about investment determination and in which the widely known empirical evidence was obtained are now outmoded. Direct evidence which shows explicitly the rapid advances in business planning, financial control, and investment selection techniques is easily available.

The concept of planning and control for profits achieved wide acceptance only about 1950.[52]

Long-range planning of capital expenditures, unquestionably has become in recent years an essential and indispensable function of large-scale corporation management. Its effectiveness in the attainment of its objectives, the improvement in the tools of the planner, and the increasing skill with which he is using them, together with the extent to which planned programs are continuing in

[48] "In pouring capital into the business, the added capital should produce earnings which will at least equal, if not improve, the earning power of the stockholder's equity. An analysis of the company's own cost of capital from this standpoint can be quite revealing" (op. cit., p. 1244).
[49] Grant, op. cit., pp. 80–81.
[50] E. L. Grant and P. T. Horton, "Depreciation" (New York 1949), p. 246.
[51] Journal of Commerce, May 10, 1957, p. 6.
[52] Herrymon Maurer (and the staff of Fortune magazine), "Great Enterprise," New York, 1955, p. 127.

spite of current unfavorable conditions, all suggest that greater and greater reliance will be placed upon projected programs in the years ahead.[53]

* * * the large firms [among a dozen varying in size from $50 million to over $1 billion of sales] are the ones most involved in long-range planning [of capital expenditures and of the associated economic and financial conditions]. Most of these have installed long-range planning operations only during the last several years.[54]

Twenty years ago few companies employed economists or attempted elaborate forecasts of markets. Today most large companies do and some maintain staffs of dozens of economists.[55]

The extensiveness of the long-range planning which this change has brought is reflected in a 1959 Dun's Review survey of presidents of 104 large firms (average annual sales, $205 million). Only 11 percent of the group lacked over 1-year sales, etc., plans. Seventy-five percent of the group used at least 4-year or 5-year plans.[56]

The growing frequency and lengthening horizons of capital expenditure planning is reflected in the change in McGraw-Hill's large-scale annual capital spending survey:

When McGraw-Hill first started surveying the outlook for plant and equipment spending in 1948, less than half the companies reporting had any real investment plans at all. Now 9 out of 10 companies included in the survey report on plans at least 4 years ahead.[57]

The newness of capital expenditure budgeting is more precisely shown by the fact that it became possible to produce the National Industrial Conference Board's quarterly series on large manufacturers' new and expended capital expenditure authorizations only by 1953: prior to that year too few of the large companies possessed such information.[58] But by 1960 the NICB was able to collect such data from 600 among the 1,000 largest firms who accounted for 80 percent of the group's assets.

The contrast between investment selection procedures already in use by the middle of the last decade and those assumed by the economists who have participated in the formation of accepted opinion about the dominance of near-future profits and the unlikelihood of capital-cost sensitivity is illustrated by comparing the views of various authorities cited in the Brockie-Grey survey of 1955 with the actual findings of that survey.[59] The long payoff periods found by that 1955 survey (a 7.3-year mean for manufacturing firms with over 7,500 employees) have been noted above. That length of period contrasts with L. R. Klein's 1946 report that business planning had a horizon of only 5 years and required payoff periods of only 1 to 5 years.

Similarly in 1949, George Terborgh (research director, Machinery & Allied Products Institute) reported in his widely cited "dynamic equipment policy" that payoff periods were under 5 years. Klein

[53] "Horizons Consultations: Planning Capital Expenditure—and the Company's Future" (a seminar of several officers of business, bank, financial, and business research units), Business Horizons, spring, 1958, p. 82. The passage is concluded with the statement that the capital expenditure process still needs refinement.

[54] J. B. Matthews, Jr., Harvard Business Review, March-April 1959, p. 88.

[55] B. E. Goetz (professor, industrial management, MIT), "The Last Twenty Years in Management," Advanced Management, March 1956, p. 28.

[56] "Corporate Size As Company Presidents See It," Dun's Review, May 1959, pp. 52-53. The respondents probably make up Dun's regular "presidents' panel," in which a quarter of the respondents are from companies ranking below the 500 largest; the presence of such firms probably would bias downward the indicated role of long-term forecasting.

[57] L. S. Silk, "Forecasting Business Trends," New York, 1956, p. 74.

[58] Morris Cohen, "Anticipations Data in the Capital Goods Field," American Statistical Association. Proceedings of the Business and Economic Statistics Section, September 1957, Washington, 1958, p. 196.

[59] The following materials are based on White, Economic Journal, March 1958, pp. 55-56. References to other authors cited are ibid.

said that, contrary to theory, businessmen did not charge themselves an "opportunity cost" interest rate on their self-financed investments and Terborgh stated that the interest rate was commonly disregarded in investment profitability computation, and that if it was used that it tended to be a conventional, rarely changed rate. But by 1955 the Brockie-Grey survey found that 41 percent of the respondents took account of the interest rate in calculating the profitabilities of self-financed investments, and it can be assumed that many more did so where investments actually using borrowed funds were concerned and if reactions to the "interest" cost of equity capital were at issue. Furthermore, the interest rate in use by 1955 was reported to be the market rate of interest rather than a conventional, rarely changed rate.

Finally, the 1955 findings yield a strong contrast with the commonly held view of the crudeness of the estimation of future profits on a projected investment: not only in Terborgh's 1949 study but as recently as the early 1950's survey by Eisner it was found that esti mated profits over the life of the investment tended to be merely the profit rate estimated for the first year of the project's full operation.[60] But 58 percent of the 1955 respondents made separate earnings estimates for a number of successive years, with nearly half the respondents carrying the estimates of income more than 5 years ahead ("a large proportion" of the latter group reporting that an investment's useful life determined the length of the period of profit estimates).

Although a reluctance among "unscientific" firms to answer the questionnaire might have made this survey's sample of respondents biased in the direction of firms using scientific management, the changes from the practices found in the past are so striking—and the proportions of respondents reporting the changed practices are so large—that the results must demonstrate rapid growth in use of scientific management even after allowance is made for a possible bias. With continuing advances in use of management techniques, and with high interest rate levels replacing many years of "cheap money" after 1955 had passed, it can be assumed that there has been further popularization of investment selection techniques of the sort that connote attention to conditions prevailing in more than the next few years and to the cost of capital.

The rapid spread of quantitative techniques in big business management need not necessarily be interpreted as reflecting increased concern with profit maximization and declining attention to risk. It is still possible that the changes observed are evidence merely of increasing efficiency in maintenance of those minimum standards of performance that will keep the stockholders from getting restless. Managements might still be serving the safety first objectives, unwilling to take risks, heedless of longrun prospects when shortrun prospects are unfavorable, and reluctant to raise outside money except for projects that promised extremely high profits.

Although the clues to business attitudes already described are insufficient by themselves to rule out completely this negative evaluation, they gain strong support from an investigation of the ways in which management employs its new tools. Inquiries were sent large and medium sized "excellently managed" manufacturing firms in the

[60] Robert Eisner, "Determinants of Capital Expenditures," p. 31.

early and mid-1950's seeking information on the extent to which use of investment, expense, and sales "budgeting" was associated with profit maximization. Profit maximization would be indicated by use of the budgeting data not merely to set minimum standards of performance or for fixing of product prices by the routine "full cost" or average cost method, but for purposeful forward planning and adaptation and for fixing (some) prices by the more lucrative marginal-cost method. The results of this investigation could not be conclusive owing to the nature of the group sampled and because need to avoid leading or emotionally loaded questions forced resort to questions that yielded only indirect evidence. Nevertheless, the evidence collected did suggest a major or leading role for the alternative profit maximization and more-than-short-run planning of profits.[61]

IDENTIFICATION OF MANAGEMENT WITH STOCKHOLDER INTEREST IN GROWTH OF COMPANY PROFITABILITY

Further corroboration of the evidence presented above to show that risks are considered low, required profit rates are moderate and planning periods are long is found in another major development of the 1960's one that should have increased the desire of business executives to exploit the possibilities of the new methods.[62] The rapid growth of financial incentives to a position of importance in managerial income rounds out the discussion of factors that have created favorable conditions for the triumph of rational, sophisticated, and enterprising investment policies.

It is persistently stated that because of the divorcement of management from ownership in the large firm, the managerial group finds that its interests lie in conservative management of the company, avoiding risks that would jeopardize jobs or would lower profits to the point where status in the executive's world could be damaged, and simply seeing that the company's sales stay up and that moderate expansion is achieved. This interpretation of the executive's role sees him as prevented from accepting low rates of return on investments when that would connote spending rates high enough to require resort to external financing; he requires such large safety factors that changes in the cost of capital would be found unimportant (if any detailed estimate of capital spending projects' profitabilities were made) and the near-term prospects would dominate investment planning.

Meyer and Kuh in their study, "The Investment Decision," describe this viewpoint as reinforced by the high cost and limited availability of equity financing in those cases where the comparatively risk-free equity financing might have been used; as for the less-expensive alternative of debt financing, the personal advantages to the managers if the debt-financed investments were successful are far too

[61] J. S. Earley, "Business Budgeting and the Theor of the Firm" Journal of Industrial Economics, November 1960, pp. 23-42.

[62] The ability and disposition of company officers to think in terms of quantification and in terms of the scientific approach (as distinguished from reliance on "judgment" and "hunch") should also have been increasing in recent years. A commonly neglected fa tor in the businessman's attitude is that a major portion and perhaps the majority of the managerial group are graduates of schools of engineering. By training, therefore, they should be particularly recepti e to the quantitative approach to decisionmaking. A 1949 survey indicated that the engineers claimed 40 percent of the large company management and executive positions, and their share was thought to be subst ntially higher by 1957 (Brooks McCormick, "Management and the Industrial Engineers," Journal of Industrial Engineering, January–February 1957, p. 20.)

small to compensate for the risk of loss of job in case the project fails.[63]

These attitudes, as modified by the desire to "maintain share of the market," [64] are found to be consistent with their own empirical findings: "the investment decision is explained within the framework of a modern industrial economy typified by large corporations distinctly separated in management and ownership and highly imperfect equity and monetary markets." [65]

These conclusions, depending on statistical investigation of the depression-haunted, high equity-capital-cost years 1946–50, have only limited value as evidence for conditions in the early 1960's. More recent evidence must be examined. The pioneer discoverers of the gulf between ownership and control and of the undesirable effects therefrom, Berle and Means, continue to detect its existence, however.[66]

The consequences foreseen from the separation of ownership and control has been refuted, at least with respect to the now-pertinent conditions of the second postwar decade, in several stages of this study: Required rates of return have been shown to be fairly low, and in a related study external financing has been shown to be quite extensive. The changes which these new conditions represent have been acknowledged in part by those who recognize the aggressive application of the maintenance of market-share attitude among executives, but that attitude is also commonly interpreted as inconsistent with careful investment selection or sensitivity to the cost of capital: Achievement of respectable growth rates is the prime consideration; profitability is secondary, and (given the existence of oligopoly) it can be assumed that all "competitors" will be able to earn some profit at least on their expanded activities.

Another new development, largely a product of the 1950's, to a great extent seems to have mended the rupture between the economic interests of ownership and control. Executives in manufacturing and mining have increasingly had their economic interests identified with those of the owners of the company by the spread of incentive bonus and stock option plans. By 1958, 82 percent of the manufacturers having sales of $50 million or more (86 percent of those with sales of over $400 million) had stock option plans for their executives.[67] Because his interest is primarily in capital gains and, in addition, involves a quantity of the company's shares that is probably much larger than he could or would want to hold if he invested through the open market,[68] strong pressure toward identification of the option-receiving executive's economic interests with the stockholders' welfare—with the company's (medium-term) growth in earning power per share—must be created.

A second powerful force for identification of the executive with stockholder interests is provided by the executive incentive bonus

[63] J. Meyer and E. Kuh, "The Investment Decision," Cambridge 1957, pp. 18, 19. See also references there given.

[64] Op. cit., p. 20, and references there provided.

[65] Op. cit., p. 204. See also p. 205.

[66] A. A. Berle, Jr., "Power Without Property," New York, 1959, pp. 66, 68, 90; G. C. Means, "Is Economic Theory Outmoded?" Harvard Business Review, May-June 1958, p. 167.

[67] H. Fox, "Current Stock Option Plans," Management Record, September 1959, p. 270 and V. H. Rothschild, "Financing Stock Purchases by Executives," Harvard Business Review, March-April 1957, p. 136.

[68] As of 1956, when option plans were younger and less widespread than they are now, Fortune quoted a Wall Street banker as saying that (owing to taxes and his heavy living expenses) about the only financial assets the typical $100,000 annual-salaried executive owned was stock options (Fortune, February 1957, p. 133).

plans, which have tripled in number over the last decade and a half, being now used by the large majority of the "large" industrial companies.[69] By 1957 the typical amounts paid in 62 companies using incentive bonuses were 40 to 50 percent of salary for company officers (four-fifths receiving at least 20 percent) and 20 to 30 percent for "middle management."[70] With 1957 not an abnormally profitable prosperity year for a large segment of big business, these bonus rates must understate the scope for bonuses—and hence the economic inducement to profit-enhancing activity—that the incentive bonus system provides. (It should be noted, on the other hand, that while the officer bonuses paid out by the company can be gigantic, the incentive which the possibility of such payments provides is somewhat smaller owing to the fact that the marginal tax rate on income above the regular salary level is appreciably above the average tax rate paid on the salary.)[71]

The merging of executives' economic interests with those of stockholders is particularly close under the incentive bonus system because the aggregate of bonuses provided out of a given year's profits (*a*) is extremely sensitive to profit changes and (*b*) is typically adjusted to make some allowance for the rate of return on the total investment rather than depending merely on the aggregate of profits earned.[72]

In the light of these developments it can no longer be claimed that management motivation conflicts with the stockholder's interest in seeking expanded income per share even at the risk that some ventures will prove unprofitable. The executives now have part of the owners' economic incentive to relax personal caution in favor of profitability. (For the same reason, the recently recognized executive compulsion to expand for expansion's sake regardless of profit rates should also be increasingly tempered by the growing dependence of executive income on these very profit rates.) These economic pressures may, of course, be insufficient by themselves to induce as much reduction of safety factors as stockholder interest requires. It should be noted, however, that the monetary pressures in these directions are abetted by the sense of security created by the prolongation of the depression-free postwar period. And whatever the uncertainties about the actual state of the executive psyche, the new conditions must be taken as sufficient to rule out any presumption of high risk aversion and reluctance to use external financing. Once the presumption is eliminated, the evidence presented earlier in this paper in support of low risk charges, long forward planning periods, and comparatively low required rates of return on new investment must be persuasive.

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[69] R. C. Smyth, "Bonus Plans for Executives," Harvard Business Review, July-August 1959, p. 66, and Arch Patton, "Payoff for Performance," Dun's Review, April 1960, p. 48.

[70] Smyth, op. cit., p. 67.

[71] Smyth considers rates similar to the typical ones cited above for 1957 adequate "to provide sustained high-level performance," although the "middle management" bonuses shown above would be rated somewhat low for that purpose. However, it should be recalled that the 1957 figures represent the realized bonuses of a given year, whereas Smyth's standards are properly to be compared with the much larger potential bonuses (op. cit., p. 68).

The tax problem is partly avoided by paying 1 year's bonus over several years or by postponing part of it until retirement.

[72] Op. cit., pp. 69-70; G. W. Torrance, "Trends in Executives' Bonus Plans," Management Review, February 1960, p. 13.

Appendix A

Example of Great Reliance by Business of Rate-of-Return Criterion

The following quotations from a report by the assistant controller of Armstrong Cork show how successfully the rate-of-return standard can be used as the chief planning tool. The passages cited reveal (*a*) the recency of adoption of the rate-of-return criterion: (*b*) the predominance of the return criterion; (*c*) the limited importance of the segments of investment to which this criterion cannot be applied; (*d*) the reduction of the role of uncertainty about the course of business via planning in terms of average demand over the cycle; and (*e*) the practicability of reliable predictions of rate of return on entirely new products.

Our company adopted the return-on-investment measurement in 1950. Today it is our basic working tool in planning and striving for the best results possible. All other working tools and controls in our business, such as those provided by production and inventory planning, engineering of all kinds, accounting, purchasing, and sales promotion, are designed to improve the return on investment. Since they are so designed, we would stand to lose a major part of their effectiveness if objectives were to be stated in terms of growth, share of markets, or well-rounded lines, or in any other terms rather than return on investment.

Since projects in this group [mere replacement of plant and equipment, investment in general plant improvement, and safety, health, and working conditions] do not add to our earning power they are held to a minimum consistent with good plant operation, so that the largest share of the available capital can be used for projects expected to improve the rate of earnings * * *.

The profit possibilities of quality improvement projects are more difficult to evaluate. Here we need an objective appraisal as to whether the project will assist in maintaining or improving the present rate of return.

Projects involving additional capacity of existing commodities are checked, first, as to the present profit level, and, second, as to whether profitable sale of the increased capacity is assured over a business cycle. Investments made to satisfy peak demand of a year or two can seldom be substantiated and threaten to leave us with heavy investment in excess capacity facilities.

Recommendations for investment to produce new products must be supported by thorough economic analysis based on adequate sales research to determine whether there will be a sustained demand for the product. Assurance that the projected rate of return can be achieved should be especially clear before the appropriation is made, as entrance into new fields of endeavor is usually accompanied by considerable risk.

We remain firmly convinced that it [rate of return] is the only measurement by which consistently sound decisions can be reached and by which we can gage the effectiveness of our management teams toward achieving an adequate return on the funds invested in our business.[1]

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[1] The passages cited are from, respectively, pp. 9, 12, 13, and 14 of F. J. Muth, "Return on Investment—Tool of Modern Management, I, Basic Theory and Application," Improved Tools of Financial Management, Financial Management Series No. 111, American Management Association (New York, 1956).

CAPITAL EXPENDITURE POLICIES AND PROCEDURES[1]

One of the key objectives of the Armstrong Cork Co. is to—

> Recognize a basic responsibility to the general public—community, State, and Nation—and to meet that responsibility by operating a business that contributes to the economic growth and strength of the economy; by providing tax support for necessary government service; by aiding worthy health, educational, and welfare institutions; by taking an active part in community affairs; and by participating in the formulation of sound public policy directed to the achievement of a social and economic climate favorable to business growth, prosperity, high employment, and national well-being. ("Beginning Our Second Century of Progress—Armstrong Cork Co."—1960.)

To achieve this objective, a good deal of attention necessarily must be given to the investment of funds in capital projects not only to maintain existing operations on a strong competitive basis but also to add new products and processes which will contribute to the profitable growth of the company and hence to the economy. Many different types of projects, of course, comprise the level of capital appropriations and expenditures at any given time. Projects range widely from immediately essential outlays for safety, health, and improved working conditions to longer range investments in land and tree farms. The bulk of the capital investments, however, falls in the category of those needed to reduce costs and produce new and improved products.

The timing of capital expenditures is influenced by conditions both within and outside of management's immediate control. Looking to external determinants of our company's operations, we key our plans closely to our best judgment of general business and Armstrong market prospects. Insofar as possible, we seek to avoid expenditures which will give us unduly excessive new facilities (we always want some extra capacity) when they are ready to be brought into production. At all times, however, we are anxious to have added facilities which will give new strength to our business, especially when we anticipate some general economic or market weakness. To some degree, therefore, we pursue a conscious contracyclical policy of capital expenditures with a salutary effect upon sales, employment, and profits.

Regularization of capital investment per se is extremely difficult to achieve, and in our judgment, cannot be an end in itself for an individual company. A healthy, profitable enterprise necessarily will have a growing trend of capital appropriations and expenditures. A good deal of variation in expenditures from time to time, however, is unavoidable because of the innumerable, often unpredictable forces impinging upon the myriad of investment decisions being made on a day-to-day basis.

Armstrong management's principal control over capital outlays involves the rigorous attention given before authorization to the ex-

[1] Submitted by executives of the Armstrong Cork Co. at the invitation of the Joint Economic Committee.

pected profit return (after tax) on the capital to be employed. The specific approach which we take to evaluate both capital appropriation requests and the eventual success of previously approved investment projects is outlined in some detail in a later section of this statement.

Our experience during the postwar years has shown that relentless attention to the expected return on the capital employed of individual projects, together with careful projections of future market and general business conditions, produces a healthy net result. This is true for our company and all those immediately associated with it, as well as for the communities in which we operate and the general economy.

Management, however, cannot exercise complete control over even the factors within the company which may influence capital expenditures. The highly unpredictable results of research and development may accelerate an appropriation well ahead of some planned schedule, or may defer or abruptly cancel a project. Competitive developments often necessitate a change in plans and expenditures. Changes in government policies at the local, State, and Federal levels can and do influence many aspects of decisions involving capital expenditures. International developments also loom as increasingly important determinants of capital investment decisions of private business organizations in this country. Finally, it is seldom possible to forecast accurately on a continuing basis precisely what will happen in a given market or to the general economy; and therefore, capital projects are always subject to some adjustment. As a result, planning seems much more to minimize surprise than to eliminate it.

In the final analysis, the success of our business, and hence the support which we can give to the economy, depends primarily upon (1) the ability of our people to generate new ideas at a sufficiently high rate to insure profitable growth as well as (2) the power of existing incentives which spurs all participants to make their greatest possible contribution. The most serious shortage affecting new capital investments always is new ideas. When such ideas are inadequate, capital expenditures inevitably lag or are vulnerable. Capital outlays which are made largely on a "me-too" basis, duplicating what is already in existence, all too often cause eventual economic maladjustments, including employment and profit reverses.

Our management is keenly conscious of the need to keep our equipment and processes at a top rate of efficiency, for in these days of highly competitive national and international markets, any other course would be disastrous. Some minimum level of capital expenditures at least equal to depreciation is inescapable. Profitable company growth, however, which makes the principal contribution to national economic growth, depends fundamentally upon the development and carrying out of innovations requiring new added capital investment. As a matter of good business policy, therefore, we strive always to push aggressively projects which are of the innovation type. The chief reason, therefore, why our capital expenditures are not higher at any given time is simply that we do not have more new ideas which in our judgment would produce a satisfactory return on the capital to be employed and, hence, justify larger outlays.

In short, we believe that the key to a high and a less fluctuating level of capital investments for Armstrong, other companies, and our national economy is to be found in constant attention to profitable

opportunities to modernize existing facilities, but far more important, in stimulating a greater flow of basically new and improved products and the means to manufacture and distribute them profitably.

The most appropriate public policies, therefore, are those which are designed to encourage greater innovation and risk-taking in capital expenditures. Moreover, such policies must not reduce the incentive to take greater risks by penalizing those whose pioneering efforts are successful.

In our judgment, there is danger in rigid public policies aimed at regularization of capital outlays. However desirable such policies may seem from the standpoint of the national economy, almost invariably they carry with them some rather static and restrictive implications for capital investment decisions within industries and individual companies. In contrast, public policies aimed at stimulating profitable innovations can only be dynamic and lead to unquestioned faster growth ahead for our economy.

Having outlined the general approach taken toward capital expenditure policies by the Armstrong Cork Co., now let us describe more specifically the procedures used to evaluate proposed capital appropriations on the basis of the expected return on investment.

Effective evaluation of capital appropriation requests is essential to maintaining a satisfactory return on investment, both short term and long term. Such evaluation should be planned to follow the concept and terminology in use for budgetary controls and operating reports; otherwise the evaluation will fail to answer the questions which arise in the minds of top management when considering the advisability of granting an appropriation request.

Faced with these considerations, a system for evaluating capital appropriation requests has been developed by the Armstrong Cork Co. which, we believe, gives management the information it needs to make sound decisions. This system is based on the same concept of costs used in reporting budgets and operating results.

The more important aspects of the Armstrong Cork Co. system can be summarized as follows:

(1) The economics of proposed capital appropriation requests are examined by the controller's office in consultation with the interested staffs such as central engineering, research, industrial engineering, economic and marketing research, purchasing, etc., before presentation to top management.

(2) The basic evaluation is made in return on investment terms.

(3) An evaluation of risk is made, based on the length of time required to recover the cash to be expended.

(4) Management relies on these valuations in making appropriation decisions.

(5) Followup reports of the in-process status and actual results of capital appropriations granted are made annually by the controller's office to top management, who, in turn, discuss the results with the accountable persons.

"Return on investment" or, as we use the phrase, "return on capital employed," or ROCE, is nothing more than the ratio of net profit after tax to total book assets. In the Armstrong Cork Co., ROCE is accepted as the basis for measuring operating management performance. The success or failure of all of our individual and collective efforts to improve operations is reflected in our ROCE results.

Our internal ROCE concept is designed around our operations general managers. These men are responsible for the production and sale of all products within the major market areas assigned to them. They are expected to use the capital which they are allocated by the board to obtain the best possible return on it. Furthermore, and this is important, these line men are also responsible for recommending opportunities for the employment of additional capital to improve or expand existing businesses and to enter new businesses. The operations managers, therefore, occupy key positions in our company. The principal function of our staff departments is to help these line men fulfill their responsibilities; i.e., to obtain higher returns on more capital, or, in other words, to obtain superior performance as measured by ROCE, coupled with growth in and into businesses having high ROCE potentials.

All matters related to financing are reserved to a staff vice president. The determination of what shall be financed is reserved, depending upon the amounts involved, to the executive committee of our board of directors or to the board itself. In practice, the board of directors and its executive committee control "what shall be financed" almost entirely through our system of capital appropriation requests. This control of capital expenditures automatically controls the basic level of working capital. The general level of cash, accounts receivable, and inventories required by operations is determined basically by the types of businesses in which we operate. Since we are primarily a manufacturing company, the types of businesses we operate are established by the plant, property, and equipment we buy. Therefore, the board of directors and its executive committee, in controlling such purchases, indirectly but effectively control the types of businesses we operate and, consequently, the basic levels of cash, accounts receivable, and inventories.

Our procedures for reviewing capital appropriation requests are designed specifically to fit the needs of our organization. They do this by pointing up the probable effect of possible capital expenditures on future profit and loss statements expressed in terms of ROCE. We place our emphasis on accuracy of perspective rather than on accuracy of detail. Our aim is to discover the best of the many potential expenditures. We don't attempt to provide the figure which makes approval or disapproval of a request automatic. The figures we develop are relative, not absolute. One of the most valuable results of our system will never be measured since it is the elimination of projects of low ROCE potential from consideration before an undue amount of valuable technical and management effort is expended upon them.

We have two categories of reasons for capital requests. Category I, expenditures which are required to maintain ROCE on existing operations; and category II, expenditures which will improve ROCE for the company.

Our company policy is to hold expenditures for category I projects to a reasonable minimum, and to maximize ROCE improvement with category II expenditures. Therefore, when we find category I (rebuilding or replacement, or general plant improvement, or safety, health, and working conditions) given as the "reason for request," we do not calculate the ROCE advantage, since the benefits expected from them do not lend themselves to specific financial evaluation.

Category II requests, those which will improve ROCE for the company, are evaluated formally as follows:

1. Return on average total added capital employed (on an operating basis)

The calculation of the added profit after tax used in this ratio does not include charges for expense resulting from capital expenditures or for obsolescence since these are considered as startup costs. The "return on average total added capital employed" indicates the ratio of (*a*) the average added profit after tax on an operating basis to (*b*) the additional capital employed resulting from the requested expenditures. The added capital employed includes all components: cash, receivables, inventory, property, plant and equipment, and miscellaneous assets. The amount estimated for each component is the average to be employed during the projected period of years in which the facility is expected to give efficient operation.

2. Risk of loss of the cash expenditure requested

An indication of the risk of loss of the cash expenditure requested is obtained by comparing the "efficient productive period" with the "recovery period." If the efficient productive period does not exceed the recovery period, there is a distinct possibility that at least some of the cash to be invested would be lost.

3. Startup costs including obsolescence of existing facilities

The calculations for requests of $10,000 or more are summarized in routine ROCE reporting form. They are made primarily for the men responsible for operating results through the joint efforts of the operations' line and staff men assisted by top staff specialists. The controller for the operations involved is responsible for the coordination of all of these efforts, and for the direction of these efforts toward accuracy of perspective rather than of detail. The end result is a sound and easily understood basis for operations' recommendations, and for top management selections, of those capital appropriation requests which have the greatest possibility of improving ROCE for the company.

CONCLUDING OBSERVATION

It could be misleading to stop here, at the "end" of our capital appropriation evaluation system, without emphasizing two points: (1) the system described is not the system to displace all other systems; it is merely a system designed to meet our company's needs today, and (2) it is but one factor, albeit an important one, serving to help the company to obtain superior performance as measured by ROCE, coupled with growth in and into businesses having high ROCE potentials.

CAPITAL EXPENDITURES AND EXPECTATIONS

By Robert Eisner [1]

The execution of most business decisions takes time. Criteria for action therefore must relate to views as to the situation that will prevail during the period in which the action will take effect. This is true with regard to decisions to accumulate inventories, hire labor, advertise, or carry on research. It is emphatically true with regard to capital expenditures, the value of which can only be established over considerable periods of time. Hence no analysis of capital expenditures can be complete without explanation of the factors that shape expectations of the future.

Capital expenditures involve additions to and replacements of the stock of capital goods used in production. These imply changes in some underlying situations: existing capital goods have become worn out or economically or technologically obsolete, or additional capital goods have become needed, either to replace other factors of production or to expand output. The rate of capital expenditures at any time must depend upon expectations of changes in the underlying situation and the rate of adjustment to these expected changes.

Put simply, for a given rate and composition of output, a given technology and given relative prices of factors of production (including rates of interest or other measures of the cost of capital) a certain capital stock will be required. The only capital expenditures which will be generated will be those necessary to replace plant and equipment being worn out. A change in relative factor prices (or expected future relative factor prices) will generate a demand for more or less capital stock and, perhaps, a differently composed capital stock. Changes in technology may induce a demand for a different composition of capital stock and a greater or lesser total amount of capital stock. Changes in the composition of output may induce changes in the composition of capital stock as well as changes in the total amount of capital stock desired depending upon whether the new compositions of output call for more or less capital-intensive methods of production than the old. Changes in the overall rate of output will generate changes in the amount of capital stock desired by business; other things being equal, greater rates of output and expectations of greater rates of output will generate demand for greater amounts of capital stock.

At the root of business responses to various conditions and changes in conditions which they may face must be certain goals that they are attempting to achieve. Most important of these we believe to be the maximization of some function of expected profits. In the first

[1] The author is professor of economics, Northwestern University. Work on this project is continuing with interim reports made also at the annual meetings of American Economic Association, New York, December 1961, and Conference on Research in Income and Wealth, Chapel Hill, N.C., February 1962.

instance we may assume that businessmen try to maximize the mathematical expectation of expected profits. What we mean by this is that, in making decisions which will take effect in a future which can never be perceived precisely, firms take actions which they believe will on the average give them the greatest amount of profit. However, a secondary consideration of importance may well be a concern to minimize risk. Thus a firm may abstain from a capital expenditure that offers a 0.5 probability of a 30-percent profit and a 0.5 probability of a 10-percent loss—a probability weighted average profit of 10 percent—if the alternative is a relatively certain profit of, say, 8 percent.

With this view of business behavior we may indicate some of the measurable variables that we should expect to affect the rate of capital expenditures. These may include the rate of interest, as a measure of the relative price or cost of capital, actual and expected changes in demand, sales, or output, and, perhaps, profits and expected profits. Quantitative, empirical evaluations of the role of these variables in determining the amounts and variation of capital expenditures have proved difficult to obtain and have been dubiously interpreted.

Studies probing the role of the rate of interest have generally been negative in their results. But it is difficult for even one such as the present writer, who doubts that variations in the rate of interest have proved important in affecting the rate of capital expenditures, to be satisfied with the interpretations frequently made of these findings. For a correct analysis of the role of the rate of interest would have to recognize that its effects would frequently be indirect. Appropriate tests and measures would require a substantial subtlety of conception and execution. For example, the rate of interest is significant as a measure of the general cost and difficulty of obtaining capital. However, it is not a perfect measure. Businessmen sensitive to other terms of credit set by lenders or to problems of raising equity capital may answer negatively questions as to the role of the rate of interest as they sense it directly, when through its relations with these other parameters of the cost and availability of capital its effects may be substantial. Further, theoretical considerations would suggest that the rate of interest might have powerful direct effects only in regard to long-lived capital expenditures such as housing construction. But if a lower rate of interest were to induce a greater demand for new houses it might generate a demand for machinery to produce more furnaces or refrigerators which would have no obvious connection with the interest rate decline. And finally, serious statistical problems have developed in attempts to measure the role of the rate of interest because there is reason to believe that it operates as both cause and effect, and tends to move in different directions in these two capacities. Thus, given the investment demand schedule, the higher the rate of interest the less we should expect to be the rate of investment demand. However the investment demand schedule is notoriously unstable. Given the money supply, a higher investment demand schedule will mean a higher rate of interest. To the extent that the historical record has been dominated by fluctuations in the investment demand schedule we will find high rates of interest associated with high rates of investment and low rates of interest associated with low rates of investment, but to the extent that fluc-

tuations in the money supply have been dominant we would find in the historical record a negative relation between the rate of interest and investment.

Quantitative research has frequently revealed a positive association between business profits and capital expenditures. This has led some to infer that higher profits of business firms would bring about higher rates of capital expenditures. If this were so, a reduction in the corporate profits tax, for example, might be expected to induce an increase in business investment. However, the analystical discussion above should caution us to treat such views with considerable reserve. To say that business firms will invest or make capital expenditures to the extent that this will increase their profits is not the same thing as to say that business firms will invest or make capital expenditures if they have been enjoying profits. It is true that firms which have been earning high profits and are earning high profits are likely to view prospective investment as profitable. It is perhaps even more true that, during periods when profits are high business as a whole will tend to view prospective investment as profitable. But the link in the logical chain must be that high profits are associated with situations, such as high levels of demand and pressure of demand on capacity, which are the real determinants of investment expenditures. If this is so any measures which affect the rate of profits but do not affect these other factors generally associated with profits, will not influence investment.

My own quantitative studies lend support to this view. In the January 1960 issue of Econometrica I reported upon the results of a study of capital expenditures in approximately 200 of the largest industrial corporations in the United States. I noted that in the years 1953, 1954, and 1955 those firms that enjoyed highest profits tended to invest the most. However, I also noted a positive relation between business capital expenditures and prior changes in sales. The more a firm's sales had been increasing the greater were its capital expenditures. When both profits and the previous trend in sales were included as independent variables in multiple regressions, it was found for these very large firms that differences in profits explained no differences in capital expenditures which were not already explained by differences in trend of sales. It should be added that further work, still in a preliminary stage, suggests that differences in current profits may still explain some of the differences in current investment among smaller firms. This may relate to imperfections in capital markets. Our largest firms may have relatively little difficulty in going to the capital markets to secure funds which they consider desirable for purposes of capital expenditures. Smaller firms may be more limited to their own retained earnings and favorable profit pictures which will induce investors or lenders to make funds available to them. It should of course be recognized that while smaller firms may perform an important function in preserving, at least to some extent, a competitive character to our economy, the determinants of capital expenditures by our very large firms are in very large part the determinants of the aggregate of capital expenditures and hence of the level of prosperity of the economy as a whole.

Analytical considerations and various bodies of empirical data carry us some distance in the explanation of the long-run determinants of investment. As indicated earlier, this explanation runs in terms of

the demand for replacement of existing capital stock that has become worn out, technological change or changes in the composition of final demand or in the relative prices of factors of production which may induce increases in the quantity of capital stock or changes in its composition, and the rate of increase in aggregate demand or output. Elucidation of the short-run influences in capital expenditures, however, which might enable us to predict the timing of capital expenditures, has proved particularly difficult. Yet it is this problem which is of critical importance to the explanation and possible control of cyclical fluctuations in economic activity.

The difficulty in explaining and predicting the timing of capital expenditures in terms of their basic economic determinants has led to substantial reliance in recent years on relatively newly developed surveys of business anticipations. Through most of the postwar period surveys of business anticipations of plant and equipment expenditures have been conducted jointly by the Department of Commerce and the Securities and Exchange Commission for the U.S. Government and by the Department of Economics of the McGraw-Hill Publishing Co. Both sets of surveys have proved of definite value for forecasting the level of aggregate capital expenditures. However, both have indicated substantial discrepancies between actual expenditures and anticipations of these expenditures revealed in responses of individual firms, and, to a certain extent, in the averages of all responses in individual industries.

I am currently engaged in analysis of the factors effecting differences between actual capital expenditures and the anticipated expenditures reported in these two sets of surveys. My essential frame of reference is a "realizations function" which relates the difference between actual and anticipated capital expenditures to changes in the business situation or in business expectations which occur between the period during which the anticipations are expressed and the period in which the anticipations are executed. In the case of the McGraw-Hill surveys, I have had the opportunity of working with responses of individual firms, made available to me with code numbers to preserve the confidential nature of business replies. With the Commerce-SEC surveys I have been working with data relating to broad industry groups but have had the advantage of figures on a quarterly rather than only an annual basis. In both cases I have been able to combine survey material with quantitative information derived from other sources.[2] Some of my earlier study of the realizations function has been reported on in published work.[3] I shall be reporting further on my current work in papers forthcoming shortly.

Of particular interest in my studies thus far is the finding in regard to capital expenditure realizations that differences between actual and anticipated capital expenditures are in fact affected positively by differences between actual values of variables and their expected values at the time the anticipations were expressed. And also, realizations have been affected by changes in the values of actual variables or in the expectations associated with them over the cor-

[2] I should gratefully acknowledge support, in various phases of my research in capital expenditures and expectations, from the Merrill Foundation, Social Science Research Council, Ford Foundation, Guggenheim Foundation, National Science Foundation, and Commission on Money and Credit, and the Graduate School of Northwestern University.

[3] See in particular the Social Science Research Council's "Expectations, Uncertainty and Business Behavior" edited by Mary Jean Bowman (New York 1958), and, specifically "Expectations, Plans, and Capital Expenditures: A Synthesis of Ex-Post and Ex-Ante Data", pp. 165–188, in that volume.

responding period. In regard to sales expectations there is evidence that those firms whose sales increased more than they had been expected to increase at the time capital expenditure anticipations were expressed were the firms whose actual capital expenditures tended to exceed anticipated capital expenditures most. In statistical language, positive correlation coefficients and positive regression coefficients were found between actual minus anticipated capital expenditures and actual minus expected sales changes in cross-section data of individual firms. Utilizing quarterly time series data in manufacturing for the postwar period. I find positive relations between capital expenditures realizations and both a sales change realization variable and previous changes in profits. These data indicate that capital expenditures of any quarter tend to exceed anticipations of those capital expenditures expressed early in the previous quarter (*a*) when sales in the quarter preceding the period in which capital expenditure anticipations were expressed had been larger than expected, and (*b*) when profits in the period in which anticipations were expressed turned out to be larger than profits in the previous period.

It is to be hoped that work of this kind will enable us to combine anticipatory data furnished in surveys of business intentions and use of econometric techniques to measure quantitative relations among economic variables in such a way as to make better forecasts of capital expenditures than could be made with the anticipatory data alone. For example, suppose capital expenditure anticipations for a certain period are reported as X billion dollars while the expected change in sales to which these capital expenditure anticipations were related was +3 percent. Now suppose that as the period begins it becomes clear that sales are increasing by only 1 percent. If we know how many billions of dollars of additional capital goods are demanded to go with the expanded output each generated by 1 percent increase in sales, or more precisely, if we know how many billions of dollars of capital expenditures are related to each 1 percent of expected sales increase, we can base our forecast of actual capital expenditures on the original anticipation minus an adjustment to account for the amount that sales increases are falling short of expectations.

A further important use of the realization function would relate to predicting the effects of contemplated governmental measures. For example, suppose the Government were considering some new action such as making certain additional expenditures or cutting certain taxes. Suppose further that we knew the effects of this action on variables, such as expected sales changes, on which previous capital expenditure anticipations had rested. We might then, admittedly to some degree of approximation, be able to indicate how much the contemplated governmental action would cause capital expenditures to exceed (or fall short of) anticipations. Ideally, such analysis should bring in all the varied ramifications in an interdependent economy. Thus a cut in personal income taxes might have no direct effect on capital expenditures but might have important indirect effects by generating increased consumer demand which would in turn place pressure upon existing capacity and thus make new capital expenditures appear more profitable. I may report that some of my current work is being integrated with the work of other econometricians who are attempting to estimate jointly in a set of simultaneous equations the key interrelations in our economy.

A final word of caution is probably in order. It is important to distinguish between associations or correlations in the movements of variables, which may be quite useful for forecasting purposes, and true structural (or causal) relations which we may need to know in contemplating policy measures. Very much to the point may be current discussion of measures to offer tax incentives to encourage capital expenditures. Returning to an earlier example we find that capital expenditures have generally been higher when net earnings were higher. We also find that capital expenditures have tended to exceed anticipations when net earnings increased. Yet net earnings may have been (and I believe, were in fact) merely a "proxy variable" for the expected profitability of capital expenditures. If this is so, then measures such as explicit cuts in corporate profits tax rates or even implicit cuts in the form of liberalized depreciation allowances, may not have the intended stimulatory effect on capital expenditures. For they would affect the proxy variable, net current earnings, without effecting any of the underlying determinants of capital expenditures related essentially to the expected profitability of the capital expenditures themselves, discussed above. As such they might perform no more useful function than asking a feverish patient to suck an ice cube before using an oral thermometer to take his temperature. The temperature reading usually found to have been related to the state of his health, would certainly be lower, but one should hardly expect this treatment to improve the patient's condition.

TAXES, CASH FLOWS, AND INVESTMENT

By Diran Bodenhorn[1]

I. BACKGROUND CONSIDERATIONS

Recent work in the theory of investment decisions of the firm suggests that the cash flow is a more important variable than profit. Furthermore, cash flow, unlike profit, is a fairly simple and unambiguous concept. It simply refers to the amount of cash which a firm has left over at the end of any time period (a month, a quarter, or a year) from its receipts during that time period after it has paid all the bills, including taxes, presented during the time period. This cash flow is available to the firm for use to pay dividends, to pay off debt which has been incurred in the past, or to increase its assets. Investment in plant, equipment, or inventories represent some of the ways in which assets can be increased.

This does not mean, of course, that all increases in assets must be financed by the cash flows to the firm, since firms can and frequently do obtain additional funds by borrowing from stockholders, bondholders, banks, and so on. Nevertheless, an increasingly large proportion of investments is financed by what are called internally generated funds. Internally generated funds means funds which are obtained from the sales receipts of the firm rather than by borrowing, so that internally generated funds are the same as the cash flow mentioned earlier less any dividend payments and debt reductions. That is, internally generated funds is that part of the cash flow which is used to increase assets, rather than to reduce debt or to pay dividends.[2]

Cash flows are important to investment decisions in two respects. Present cash flows are an important determinant of the firm's ability to increase assets. The availability of internally generated cash flows is important to the firm's investment decisions because the firm is more likely to undertake any particular investment project if the funds can be obtained internally than if the money must be borrowed from the outside. There are a number of reasons for this, some associated with the greater risk, difficulty, and cost involved in raising funds outside the firm; and others associated with the desire of most firms to grow as rapidly as possible, which means that most firms would prefer to use the cash flows to increase assets rather than to increase dividends or reduce debts if there are any reasonably profitable uses to which they can put the assets.

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[1] The author is associate professor, College of Commerce and Administration, Ohio State University.

[2] See, for example, Bodenhorn, "On the Problem of Capital Budgeting," Journal of Finance (December 1959), and the references in that paper.

The impact of an increase in the availability of internal funds on investment is greater during periods when business is slow than it is during more prosperous periods. This is because the firm is less likely to borrow money on the outside during a recession than it is during a boom. On the other hand, investment is smaller during recessions not only because it is more difficult to obtain funds, but also because the various investment projects do not look as profitable as they do in more prosperous times.

This brings us to the second way in which cash flows influence investment decisions. Future cash flows are important as well as present cash flows. The effect of any particular investment undertaking upon future cash flows is what determines the ultimate profitability of the undertaking (and of the firm). Investment projects which create larger cash flows, or create the cash flows sooner than other projects, are more profitable.

This means that any Government action which increases the cash flow to the firm stimulates investment in two ways: It increases the funds available for investment, and it also makes the investment undertakings more profitable.

The impact of these ideas as far as congressional action is concerned is that the important consideration is not the impact of any particular legislation upon profits, or upon depreciation, inventory valuation, or asset values in general, but upon cash flows. Legislation which reduces the tax burden of the firm increases its cash flow (if it continues to operate as before) and thereby stimulates investment. The reduction in the tax burden makes the firm more profitable than it would otherwise have been, gives the firm additional internal funds which can be used for investment purposes, and makes investment more profitable by increasing the future cash flow associated with investment projects. All this is true even though the reduction in the tax burden may be arranged in such a way that the impact on the firm's reported "profit" may be unfavorable.

For example, Congress may reduce tax burdens by increasing the amount by which firms can depreciate plant and equipment, or by increasing the costs which the firm is permitted to charge off when it withdraws goods from inventory. Such behavior permits the firm to increase the amount of cost appearing on its income tax return, and thereby reduces both its profit and its income rax liability. The reduction in profit, however, is purely fictitious, while the reduction in the income tax liability is real. The reduction in profit is fictitious because it results from an increase in cost which is fictitious. The cost increase resulting from larger depreciation charges, or from a higher cost of inventories sold, is fictitious because it has no influence on the cash flow. That is, the actual cash costs incurred by the firm in building the inventory or in purchasing the asset which is being depreciated are not influenced in any way by the number which the business firm enters on its tax return for cost of inventory or for depreciation These numbers on the income tax return influence only the income tax liability and not the real or actual cash cost of inventory or the use of capital equipment. The effect of permitting larger entries for these costs on the income tax return is therefore not to reduce the profitability of the firm in any way, but rather to increase its profitability by reducing its tax burden.

One important implication of this analysis is that it is highly undesirable for Congress to require that firms use the same cost statements in reporting to stockholders that they use on their tax returns. Such a requirement, which applies now to LIFO inventory accounting, means that firms which desire to take advantage of the reduction in the tax burden permitted by LIFO accounting must simultaneously tell their stockholders in their annual report that the profitability of the firm has been reduced. This is highly undesirable since the true impact of LIFO inventory accounting is to increase the profitability of the firm immediately by reducing the tax burden, and Congress should not require that business firms make misleading accounting statements. The effect of LIFO on business firms is similar to the effect of accelerated depreciation. Accelerated depreciation increases the profitability of the firm in the short run by reducing its tax liability, and does not reduce its profitability in the long run if the firm either maintains its size or grows.[3]

This means that Congress should concentrate on the cash flows rather than on the income reported for tax purposes when it is considering legislation involving either depreciation or inventory accounting, and more generally when it is considering any change in the income tax laws. This does not mean that Congress should ignore the impact on economic profit (as contrasted to profit reported on tax returns) and consider only cash flows. Congress may still be interested in profit in considering the equity of various tax proposals. That is, Congress may still quite reasonably feel that a more profitable firm should pay higher taxes than a less profitable firm. The potential error, however, is to confuse the income reported on the income tax statement with the profitability of the firm. The profitability of the firm is a very difficult economic concept about which accountants and economists have been arguing for many years.

Congress does not have the power to legislate economic profitability, even if it wanted to do so. Congress has the power only to legislate tax laws which influence economic profitability. The impact of the comments I have been making is that the cash flow to the firm is a very important index of profitability which should not be ignored by legislators in considering the equity of various tax proposals. In fact, the impact of these statements is that equity would probably be improved if the cash flow were to become the base for the "income" tax, and Congress did not concern itself with more refined measures of profitability.

II. ACCELERATED DEPRECIATION VERSUS STRAIGHT-LINE DEPRECIATION

These statements provide us with a background for analyzing the impact of various taxes upon investment, both over the business cycle and in the long run. In particular, this analysis can be used to show that laws permitting accelerated depreciation rather than straight-line depreciation reduce the tax burden of the growing firm relative to the stationary or declining firm, thereby stimulating longrun growth, but that they increase the tax burden at the business cycle trough relative to the business cycle peak, and thereby tend to aggravate the business

[3] This is shown clearly in the paper by S. Davidson, "Accelerated Depreciation and the Allocation of Income Taxes," the Accounting Review (April 1958), and is illustrated by the calculations in the table below p. 41.

cycle rather than to smooth it out. Much the same kind of thing can be said about the substitution of LIFO inventory accounting for FIFO inventory accounting, and for some current proposals to permit depreciation on a replacement cost basis, or to increase the depreciation basis in proportion to general price level increases, rather than to require depreciation on an original cost basis.

The important things to remember in this analysis are that we are interested only in the effects of the tax laws upon the tax burden of the firms and are not interested in the effects on accounting profits, and that our purpose is to compare the tax burden with accelerated depreciation to the tax burden with straight-line depreciation. It is, however, somewhat easier to concentrate on the depreciation charges and to remember that depreciation charges are subtracted in arriving at the income tax base so that higher depreciation is associated with a lower tax base and therefore a lower tax burden. The lower the tax burden, of course, the greater the incentive to invest, as we have seen.

The accompanying table shows the amount of depreciation which firms could legally charge if investment were to follow the pattern shown in the table, for two different depreciation methods. The straight-line method assumes that 10 percent of the original investment can be charged against any investment for each of 10 years, while the accelerated depreciation also uses the 10-year base, but assumes that the sum-of-the-digits method is used. The particular investment pattern chosen is one of 3 years growth followed by a single year of decline in investment, 3 more years of growth, a year of decline, and so on. The growth in investment in each prosperous year is 110, and the decline during the 1-year recession is also 110.

There is nothing special about the particular pattern of prosperity and recession which I have selected, nor about the 10-year depreciation period. Different choices of investment patterns and of depreciation periods would have led to different numbers for the depreciation charges in the various years; but the general properties of the movements of the depreciation charges, and the values of the charges using accelerated depreciation relative to those using straight-line depreciation, would not change providing only that the general assumption of a long-run uptrend in investment is maintained. Since a general uptrend in investment has characterized the U.S. economy for a long period of time, it does not seem worthwhile to analyze other situations, although this could be done.

I shall now discuss the various properties of the depreciation charges shown in the table.

Illustrative example of depreciation charges using accelerated [1] and straight-line depreciation

Year	Investment	Change in investment	Straight-line depreciation [2]		Accelerated depreciation [2]		Difference accelerated depreciation less straight-line depreciation [4]
			Amount	Change [3]	Amount	Change [3]	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	2,000	+110					
2	2,110	+110					
3	2,220	+110					
4	2,330	−110					
5	2,220	+110					
6	2,330	+110					
7	2,440	+110					
8	2,550	−110					
9	2,440	+110					
10	2,550	+110	2,319	+66	2,404	+62	85
11	2,660	+110	2,385	+66	2,466	+70	81
12	2,770	−110	2,451	+44	2,536	+38	85
13	2,660	+110	2,495	+44	2,574	+50	79
14	2,770	+110	2,539	+66	2,624	+62	85
15	2,880	+110	2,605	+66	2,686	+70	81
16	2,990	−110	2,671	+44	2,756	+38	85
17	2,880	+110	2,715	+44	2,794	+50	79
18	2,990	----------	2,759	----------	2,844	----------	85

[1] Accelerated depreciation is sum of the digits. For 10 years, this gives 10/55, 9/55, 8/55, and so on.
[2] All depreciation is calculated on a 10-year basis. No depreciation can be calculated for the 1st 9 years, since this depends upon earlier investments.
[3] The patterns of yearly changes in depreciation charges in columns (5) and (7) will be repeated identically in future business cycles, provided that future cycles follow the pattern of column (3).
[4] The pattern of differences between the depreciation charges using the 2 methods will be repeated identically in future business cycles, provided that future cycles follow the pattern of column (3).

In the first place, the depreciation charges using accelerated depreciation are consistently larger than those using straight-line depreciation. This property of the depreciation charges has nothing to do with the business cycle pattern, nor with the depreciation period chosen. It results only from the long-term upward trend in investments.[4]

This does not mean that accelerated depreciation is just a method of reducing the tax burden on corporations and thereby increasing the relative burden of taxation on other taxpayers. This of course may be the case, and indeed would be the case if no adjustments were made in the tax rate. That is, permitting accelerated depreciation without at the same time increasing the tax rate reduces the tax burden on corporations relative to other taxpayers. In analyzing the impact of accelerated depreciation relative to straight-line depreciation, however, I do not believe that this is relevant, since the relative burden on the various taxpayers ought to be decided independent of the depreciation accounting procedures which the corporate income tax law permits. The same relative tax burden can (and should) be placed on corporations no matter which depreciation methods are authorized.

[4] If investment were the same in each successive business cycle instead of being higher in later business cycles, the average depreciation over the cycle would be the same for both depreciation methods, although there would still be differences in timing. If the economy were declining, so that investment was smaller in later business cycles than in earlier cycles, then the accelerated depreciation would, on the average, have lower depreciation charges than the straight-line depreciation method.

However, the impact of permitting accelerated depreciation rather than straight-line depreciation is to reduce the relative tax burden of those corporations which are increasing their investment expenditures relative to the tax burden of those corporations whose investment expenditures are either stable or declining. This is true, at least, providing that all corporations pay the same rate of tax, as is true at the present time. This means that the impact of the shift from straight-line to accelerated depreciation is to place less of the tax burden on growing firms and therefore relatively more of the tax burden on stable and declining firms. This should have the effect of stimulating long-run growth.

It should also be observed that the depreciation charges of a firm which maintains a steady investment pattern will be the same (in the long run) whether it uses accelerated or straight-line depreciation. However, if the tax burden of corporations relative to other taxpayers is to be maintained in the presence of accelerated depreciation, the tax rates must be increased, as we have already seen. This increase in the tax rate would represent an increase in the tax burden of a stable or stationary firm.

The analysis of the cyclical pattern of the depreciation charges is also made more difficult by the fact that the depreciation charges are consistently lower using the accelerated depreciation method. Since we are still not interested in the problem of the tax burden of corporations relative to other taxpayers, we must analyze the cyclical pattern either by considering the difference between the depreciation charges using accelerated depreciation and straight-line depreciation (col. 8 of the table), or the way in which the depreciation charges change from year to year using the different depreciation methods (cols. 5 and 7). We shall use the latter method, although the former would lead to the same conclusions.

First, let us observe that the depreciation charge, using either depreciation method, increases by 220 over the business cycle. That is, a comparison of the depreciation at the peak of one business cycle with the depreciation charge at the peak of the next business cycle (or a trough-to-trough comparison, or for any 2 corresponding years) shows that the depreciation charge for the later cycle is 220 larger than the depreciation charge for the preceding cycle.

Furthermore, the depreciation charge increases from year to year for both of the depreciation methods. However, the increase from the peak to the trough is smaller (38) for the accelerated depreciation method than it is (44) for the straight-line depreciation method. Thus the depreciation charge is relatively higher at the trough for the straight-line method, and the tax burden is therefore relatively smaller. The reverse is true, of course, if we consider the 3-year movement from the trough to the peak. The depreciation charge using the accelerated method then increases more than the depreciation charge using the straight-line method, so that the tax burden at the peak is relatively smaller for the accelerated method.

It should be emphasized that none of these properties of the depreciation charges results from the particular cyclic pattern used, nor from the 10-year depreciation assumption. Accelerated depreciation, by definition, permits relatively more depreciation in the early years and less in the later years of the life of an asset. This means that the

total depreciation charge against all assets is more heavily dependent upon the current year's investment level if accelerated depreciation is used. Thus the swing in depreciation charges will be greater if accelerated depreciation is used, so that there will be more depreciation charged at the peak, and less at the trough. It also means that growing firms have larger depreciation charges relative to total depreciable assets, since a larger proportion of their depreciable assets is acquired in any year.

In summary, we draw the following conclusion in our comparison of straight-line and accelerated depreciation: First, accelerated depreciation increases the depreciation charges permitted in a growing economy. This means that it would shift the relative tax burden away from corporations and toward other taxpayers if the tax rate were not adjusted. Second, accelerated depreciation benefits (reduces the tax burden of) growing firms at the expense of stationary and declining firms. Third, accelerated depreciation reduces somewhat the countercyclic effectiveness of the corporate income tax by increasing the tax burden at the trough of the business cycle relative to the tax burden at the peak of the cycle, provided that the tax rate does not change over the business cycle. To this extent, it discourages somewhat investment at the trough of the cycle and encourages it at the peak of the cycle.

INVENTION, INNOVATION, AND BUSINESS CYCLES

By Jacob Schmookler [1]

This paper attempts to relate some of the author's recent research to the business cycle. Section I provides a highly condensed view of the theory that waves of innovation cause business cycles. Section II summarizes the author's work which bears on this theory. Section III interprets the results.

I

The proposition that economic fluctuations are the inevitable accompaniment of technical change and economic growth was advanced with great eloquence and erudition by the late Joseph A. Schumpeter.[2] It is of course plain that without the vast technical changes of, say, the past 200 years the range of phenomena to which men had to adjust would have been substantially narrower, for new occupations and investment opportunities would not have been created, and old ones would not have been destroyed. On the other hand, certain phenomena which affect mankind's economic activity would have remained: crop failures and gluts, weather disturbances, wars, etc. Fluctuations in the rate of population growth would probably remain, but the amplitude of the fluctuations might be smaller than has actually been the case.

Schumpeter, however, said much more than this. Specifically, it was his contention that innovation was the central cause of business cycles. He defined innovation as a change in the method of supplying commodities, e.g., the introduction into economic life of a new product, process, or method of business organization. However, in his discussion he referred almost exclusively to technical innovations. Of these he was concerned only with major innovations, that is, innovations so important that they required the establishment of new firms using new plants and run by "new" men. He regarded minor innovations as essentially adaptive in character. Whereas the major innovations required men of great insight, talent, and daring, the minor innovations required rather common business skills.

Schumpeter purported to observe in the historical record the presence of three cycles, one superimposed on the other. The longest lasted about half a century, the next lasted about a decade, and the shortest ran its course over a period of about 3½ years. The two longer cycles were in his judgment certainly caused by major innovations. He was less certain about the causes of the 3½-year cycle.

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[1] The author is professor, Science and Public Policy Program, Graduate School of Public Administration, Harvard University.

For more extended discussions and a wider range of evidence, cf. his "Changes in Industry and in the State of Knowledge as Determinants of Industrial Invention," in the forthcoming volume of the proceedings of the conference on invention, held at the University of Minnesota, May 1960, sponsored by the Universities-National Bureau Committee of Economic Research and the Committee on Economic Growth of the Social Science Research Council; and "Economic Sources of Inventive Activity," in a forthcoming issue of the Journal of Economic History.

[2] Cf., his "Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process," vols. I and II (New York, 1939).

His analysis, however, is open to objection on two main counts. In the first place, the very existence of his two longer cycles is questioned by others who have examined the historical and statistical record. In the second place, and it is to this point that the author's research relates, he imparted to innovation a degree of autonomy which it does not seem to merit. For Schumpeter innovation stood on a par with weather cycles, wars, and population cycles as an independent variable. As such, innovation could be taken as a starting point for analysis of business cycles, not merely as a matter of convenience but, according to Schumpeter, as a matter of principle. While he was aware that the innovations of any given period have some connection with the economic and social conditions out of which those innovations grow, by minimizing the extent of this association [3] he was able to make innovation into a prime cause of the business cycle.

Yet, while the innovator's behavior is not completely determined, it is not completely undetermined. The environment, by the restraints it imposes and the opportunities it affords, may greatly affect which innovations are introduced, when they are made, and how much and what sort of impact they will have.

In Schumpeter's cycle theory major innovations are introduced when the economy is in equilibrium.[4] The investments of the innovators together with those of their imitators then move the economy away from equilibrium into prosperity by inducing other sectors, including the banking system, to expand in response to growth of demand induced by the innovator's and imitators' spending on plant. However, once the plants producing the new product have been built and begin to turn out their goods in volume, investment declines, and prices—both those of the new product and those of old products which are competitive with it—begin to fall. The recession is on. The responses of the business community at large, again including the banking system, carry the recession below the equilibrium level. Finally, for reasons which need not detain us here, business begins to revive, the economy returns to the new equilibrium, and the stage is set for another round of innovation-induced prosperity.

The curious thing about the Schumpeterian cycle mechanism is the independence of major innovations from it. Such innovations do not take place during any phase of the cycle. They do not begin during depression or early recovery. They do not occur in prosperity. They take place in "equilibrium". At least in Schumpeter's view, this is not a mere matter of words. For if the innovations occurred in response to a given phase of the business cycle, his cycle theory would be, like many other theories, a self-generating theory. His insistence on the reality of "equilibrium",[5] and on equilibrium as the period during which major innovations were introduced helped give Schumpeter's business cycle theory a distinctive character. Many other business cycle theorists emphasized (*a*) the stimulating effects on the whole economy of innovation begun in recovery and prosperity or (*b*) the drag exerted on the economy by older industries in process of displacement by newer ones. Some theorists have also noted the capacity of innovations to help bring about recovery. But for these theorists innovation has been, while often important, still only one of

[3] Ibid., pp. 84–87, and ch. 4.
[4] Ibid., p. 131.
[5] Cf. Ibid., chs. 1, 2, and 5, especially pp. 70–71, and 206.

several elements in the cycle. For them innovation affected the amplitude, timing and pattern of business cycles, but it was not the prime cause of business cycles. Even these writers, like Schumpeter, considered only the effect of innovations on the business cycle and paid little attention to the effect of the business cycle on innovation.

II

The evidence to be discussed below in no way denies that innovation affects the business cycle. What it does emphasize, however, is the apparently enormous influence of the business cycle on innovation, a factor ignored both by Schumpeter and by other cycle theorists. Very specifically the evidence presented here, together with that to be published elsewhere, suggests that business cycles cause cycles in innovation, and renders dubious the proposition that cycles in innovation cause business cycles.

At the outset, one qualification should be noted: the data used—statistics of patents granted in various fields of industry [6]—relate directly not to innovations but to inventions. It is possible, however, that this deficiency of the data may strengthen rather than weaken the argument advanced. Innovation is invariably a business activity, carried on by businessmen, for business reasons. By contrast, invention, especially in the past, was only partly a business activity, carried on often by nonbusinessmen, and often for nonbusiness reasons. This suggests that if business conditions strongly affect invention, they probably affect innovation even more. Moreover, since the studies of the Patent Foundation of George Washington University indicate that between 40 and 50 percent of inventions patented by independents and between 50 and 60 percent of those patented by corporations are used commercially, invention and innovation are often closely allied.

Finally, even though Schumpeter's theory deals only with major innovations, there is little reason to suppose (although Schumpeter seemed to feel otherwise) that economic factors influence minor innovations more than they do major ones. Precisely because major innovations typically entail greater outlays, look further into the future and therefore carry greater risk, one would expect economic conditions to have, if anything, a greater effect upon the timing of major innovations than upon the timing of minor ones. In short, if economic conditions affect the timing of inventions, it is even more probable that such conditions affect the timing of innovations. And if innovations in general are affected by economic conditions, major innovations are probably affected even more.

Against this background the relevant evidence may be summarized, with illustrations, as follows:

1. The levels of invention, as indicated by statistics of patents, in broad classes of economic activity, show a distinct tendency to fluctuate together. This statement is based primarily on figure 1, which shows the number of patents granted in (*a*) the railroad industry, (*b*) the building industry, and (*c*) all other fields. While some differences are evident in the behavior of the three series shown in the figure, on the whole they move similarly.

[6] The statistics used are for patents granted counted as of the time of granting up to 1873. Thereafter they are counted as of the time of application, except in the case of shoemaking patents which are on a when-granted basis throughout.

2. When the number of inventions in any given industry is split into various fields, the number of inventions in each field tends to vary directly with the number made in other fields within the same industry, especially when due allowance is made for the fact that some branches of an industry's technology may tend to become obsolete. This is illustrated in figures 2 and 3, which show such breakdowns for building and shoemaking.[7] Just as the comparison of patenting in different industries in figure 1 suggests the strong influence of common external forces operating on the level of inventive activity in different industries, so the comparisons presented in these two figures suggests that common influences affect the level of inventive activity within the different branches of a given industry's technology.

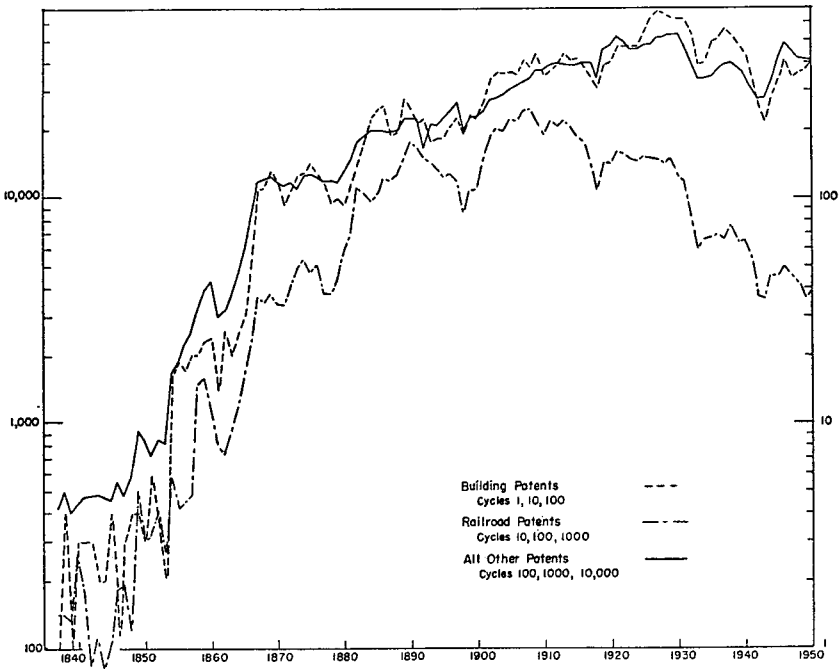

FIGURE 1. Patents in building, railroading, and all other fields, United States, 1837–1950, annual data.[8]

3. The variations in inventive activity respecting a given product usually seem to follow variations in the output of sales of the product itself. This association seems to hold equally well over the long run and the relatively short run.

This relationship is illustrated in figure 4, which shows the output and related patents of railroad freight cars. As shown in the graph output reaches an all-time peak just before patents, major troughs usually occur in output before similar ones do in patents, and major peaks in output also tend to occur before those in patents, although the leadership of output in this case is not as undisputed. Even the minor variations in patents and production are remarkably synchronized in this instance.

[7] Because of the large number of series presented in the case of shoemaking the data are presented in the form of deviations of 5-year averages from trend.

[8] Patents are counted as of the year of grant through 1873. Thereafter they are counted as of the year of application.

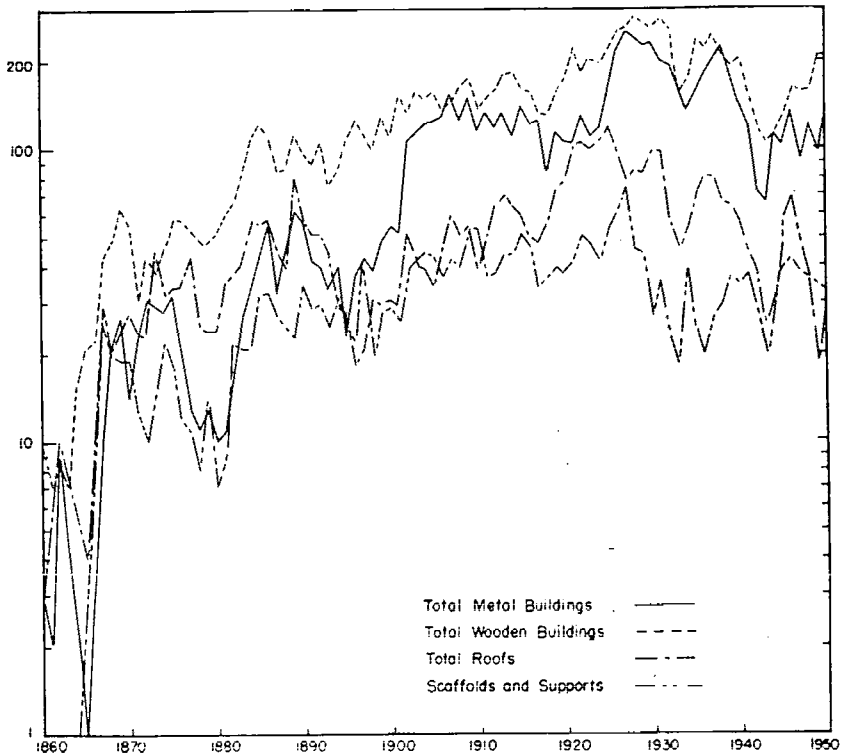

FIGURE 2. Patents in selected fields of building, United States, 1860–1950 annual data.

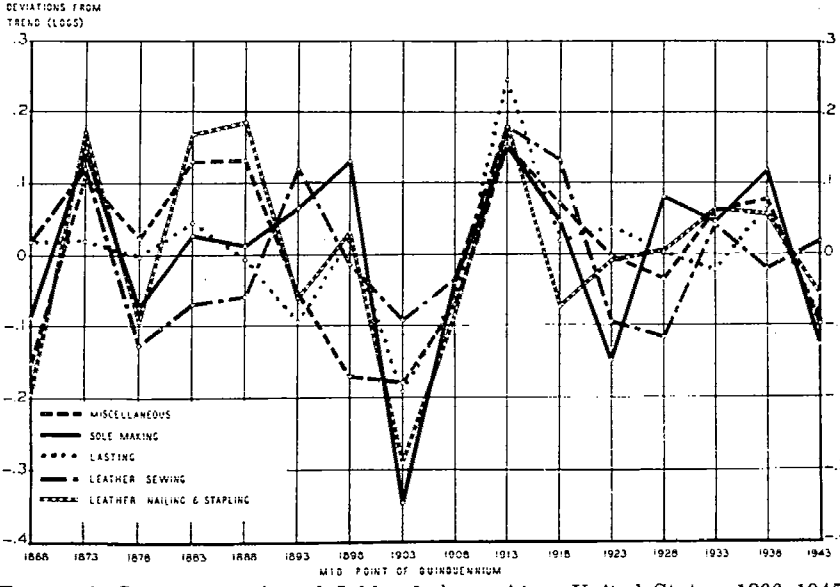

FIGURE 3. Patents in selected fields of shoemaking, United States, 1866–1945, deviations of 5-year averages from trend.[10]

[9] Patents are counted as of the year of grant through 1873. Thereafter they are counted as of the year of application.

[10] Patents are counted as of the year of grant throughout. Data based on date of application are not available.

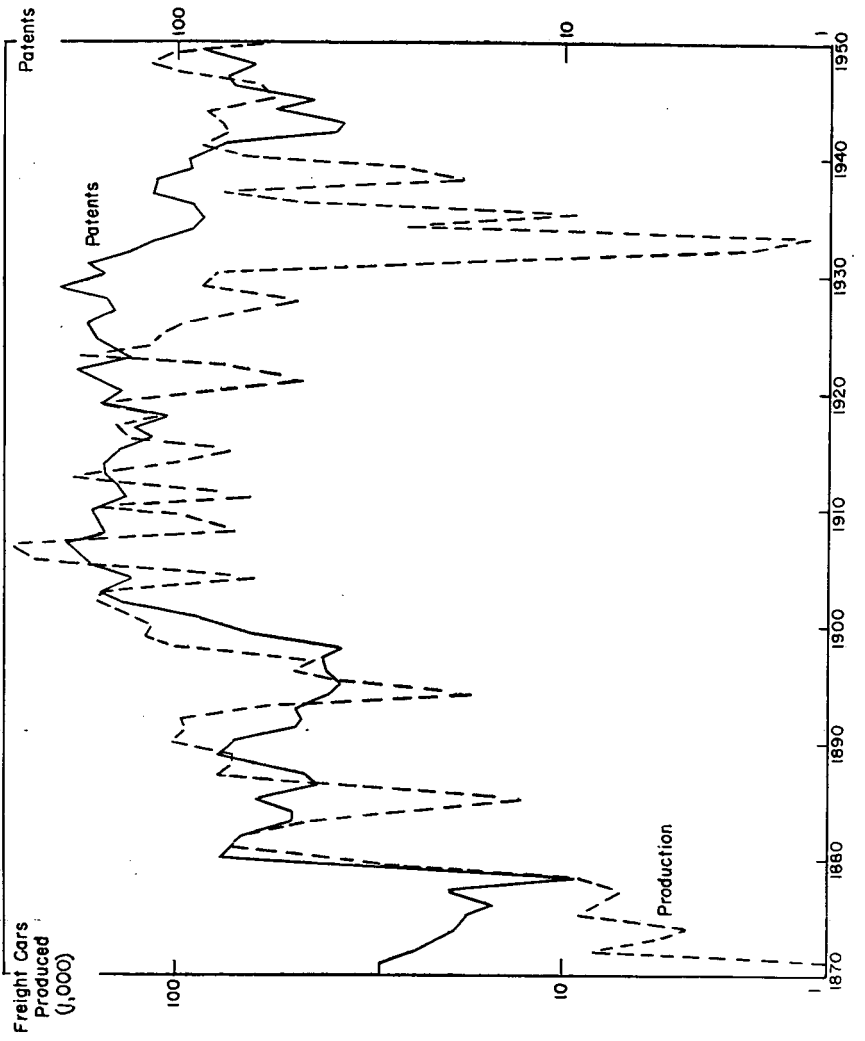

FIGURE 4. Railroad freight cars: Production and patents, United States, 1871–1950 annual data.[11]

[11] Patents are counted as of the year of grant through 1873. Thereafter they are counted as of the year of application.

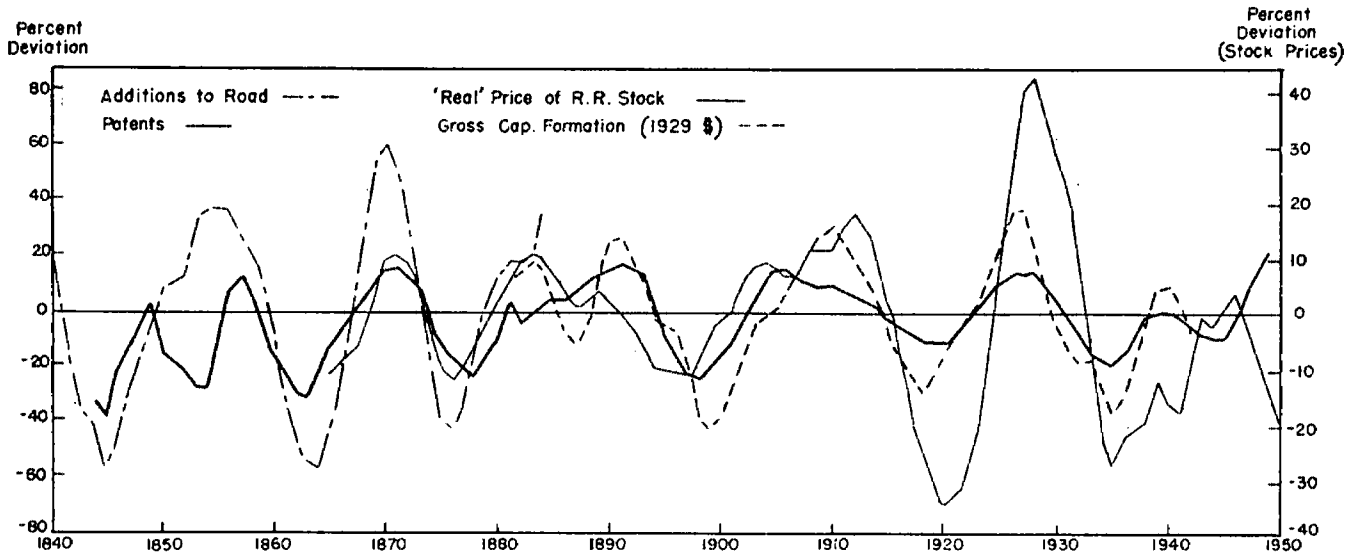

FIGURE 5. Long swings in railroad patents and investment: Percentage deviations 7- or 9-year moving averages from 17-year moving average.[12]

[12] Patents are counted as of the year of grant through 1873. Thereafter they are counted as of the year of application.

Figure 5 shows the deviations of 7-year from 17-year moving averages of four global railroad variables: the total number of railroad patents, net changes in miles of road, gross capital formation in 1929 prices, and the "real price" of railroad stocks. The latter represents an index of railroad stock prices adjusted for changes in the general level of wholesale prices. These measures bring out sharply the "long swings" in the railroad industry which have been subjected to considerable analysis by others.[13] The general pattern revealed by figure 5 suggests that investment moves up and down with railroad profits as reflected in stock prices, and invention moves up and down with both, with a tendency to lag.

Finally, figure 6 introduced less for the amusement which it may afford than for the clarity with which it points the lesson implied by the earlier graphs, depicts the number of patents in the field of horseshoes and horseshoe calks, i.e., devices attached to horseshoes to reduce slippage. It will be observed that the number of inventions in the field of horseshoes began to decline about the time when the horse began to give way to the automobile and truck, while inventing in the calk field continued to rise for a time, perhaps because the declining number of horses on the highways had increasing difficulty keeping their footing on roads more and more of which were being paved.[14]

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[13] Cf. M. J. Ulmer, "Capital in Transportation, Communications, and Public Utilities" (Princeton 1960); and Paul H. Cootner, "Transport Innovation and Economic Development" (MIT Ph. D. dissertation, 1953).

[14] Evidence of similar character for other fields will be published in the articles cited in footnote 1.

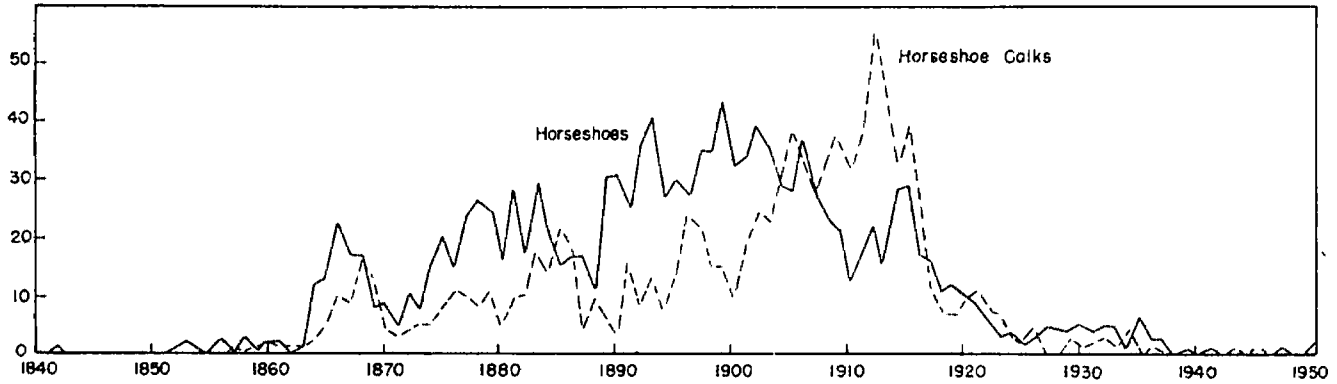

FIGURE 6. Horseshoe patents, United States, 1840–1950, annual data. [15]

[15] Patents are counted as of the year of grant through 1873. Thereafte they are counted as of the year of application.

III

In brief, as shown in figure 1, inventive activity in widely different fields tends to move in somewhat similar directions. Secondly, as shown in figures 2 and 3, the patterns of invention within the different branches of a given industry tend to exhibit considerable similarity. Finally, the evidence illustrated by figures 4, 5, and 6 suggests strongly that inventive activity in a field tends to follow the course of economic activity in that field. These patterns cast considerable doubt on the validity of the Schumpeterian theory of business cycles.

These relationships rather suggest the following hypotheses: (*a*) The level of economic activity in any given industry is typically governed by the general level of economic activity, probably because it is the rest of the economy which largely determines how much the industry must pay for inputs, how much it gets for its products, and what quantities it can profitably sell. (*b*) To a large extent, and this is the major concern of this paper, invention and innovation are the responses of creative men to much the same stimuli which influence the economic behavior of other men. This is suggested by the strong tendency of invention in a field to rise and fall with the volume of sales in the field, e.g., railroad equipment, to which the inventions relate.

(*c*) More specifically, and here we are clearly in the realm of conjecture, both the motive and the opportunity to invent in a field are likely to be positively correlated with sales in that field. On the side of motive, two factors may be suggested. First, when a commodity—a horseshoe or a freight car—is selling in volume, the profit which may be expected from an improvement in it would ordinarily be greater than when the sales of the commodity are small. Hence the expected profit from any given invention will tend to vary directly with the sales of the product in which the invention is to be embodied. Thus, the chances of selling an improved freight car, and therefore the chances of profiting from the invention which improves it, are presumably better if freight cars are selling better. Hence, insofar as economic motives affect invention, variations in sales will tend to induce similar variations in invention.

The second factor bearing on motive is more subtle but perhaps of critical importance, at least if one is to trust both the published and private accounts which inventors give of the events which trigger their activities. The common thread which seems to run through almost all of their accounts is that they encountered some unsatisfactory technical condition which they felt they could remedy. It seems plausible to believe that at least some factors related to sales volume will tend to cause dissatisfaction with an existing product to rise with its sales. Rising sales often mean new workers are producing and new customers are using the good in question, and workers and new customers may look at the product with fresh eyes and perhaps different standards. And increased sales may mean that the product is used under new conditions, conditions in which it may not perform as well as it did in its older uses. Thus, in terms of motive to invent, variations in sales of the product concerned may be correlated positively with both the expected profit from invention, and the dissatisfaction with the product which often provokes invention.

On the side of opportunity, two factors may be suggested. First, invention is often costly. When the sales of a commodity are high, one would ordinarily expect the firms and the workers producing the product, and those who buy it, to be better able to finance the costs of invention. In this connection it is worth noting that in the case of corporate invention the common business practice of setting research and development budgets at a fixed percentage of sales tends to produce the result we have observed.

Secondly, the larger the number of people making or using a product, the greater the probability that one of them will find it unsatisfactory and attempt to improve it. Obviously the number of workers producing the product and the number of individuals purchasing it are both positively correlated with the sales of the product. Hence, when the product is selling in larger volume the number of individuals intimately concerned with the details of the product is likely to be greater than when its sales are low.

Whether or not these tentative explanatory variables are the proper ones, we do not yet know. Nonetheless, in view of the timing relations between the fluctuations in output and inventive activity, with the tendency of the former to lead the latter, we can conclude with considerable assurance that economic fluctuations in some way induce corresponding fluctuations in inventive activity. If this conclusion is granted, it seems even more reasonable to suppose that economic fluctuations induce variations in innovative activity.

In the past economists, lacking a theory of invention or innovation but struck by their highly visible effects, were prone to assign to them more independence than now seems warranted. Inventions and innovations undoubtedly exert great economic influence. Unquestionably the behavior of inventors and innovators individually or collectively is less predictable than that of consumers or businessmen in the mass. Nonetheless, because inventors and innovators seek to solve society's technical problems—problems which change with changing conditions, and because they are subject to the same kinds of economic restraints and incentives as other men, their behavior is in some important respects as embedded in society's processes as is that of other men.

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