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PART IV

Producer Durables

Business Fixed Investment: A Marriage of Fact and Fancy

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Introduction

Several years ago Robert Eisner wrote a paper entitled, "Investment: Fact and Fancy."[1] Despite the author's explicit denial of such intent, there seemed little doubt that in his mind fact was to be equated with the acceleration principle and fancy with what is often called the "residual funds" theory of investment.[2] Eisner's provocative title is characteristic of the long-standing controversy between the accelerationists and the profiteers, which has so often been a source of enjoyable acrimony and occasionally even a source of enlightenment.

The basic position of the accelerationists is that capital goods must be loved to be worth purchasing. The basic position of the profiteers is that capital goods cannot be bought for love, alas, but only for money. Given the utter reasonableness of both of these propositions, it is not surprising that in recent years we have been treated to a number of

NOTE: This project was started when the author was on the staff of the Council of Economic Advisers and completed as a project of the Research Seminar in Quantitative Economics at Michigan, with support of the National Science Foundation.

[1] Robert Eisner, "Investment: Fact and Fancy," *American Economic Review*, May 1963, pp. 237–246.

[2] This theory is first clearly spelled out in John Meyer and Edwin Kuh, *The Investment Decision*, Cambridge, Mass., 1957, and further developed in James Duesenberry, *Business Cycles and Economic Growth*, New York, 1958.

econometric studies in which both capacity utilization and cost of funds variables have been shown to influence investment.[3]

In this study I have developed additional evidence in support of compromise. In brief, the equations which I shall present show investment expenditures to be functionally related to capacity utilization, retained earnings, net balance sheet positions, interest rates, and equity yields. The data, which are drawn from a variety of sources, have a much broader industrial coverage than that of most studies, embracing nearly all of producer durables and "other construction" in the national accounts.[4] Thus the results may be fairly directly incorporated into aggregative models for policy and prediction.

Before proceeding, I feel that I ought to say a few words on behalf of the much-maligned construction of highly aggregative models. I grant that because of collinearity, simultaneity, aggregation bias, and shortage of data points, variables as aggregative as those in the national accounts are not a very rich testing ground for economic hypotheses. Nonetheless, there are two good reasons for continuing to use them.

The first is that the less aggregative the approach to hypothesis testing is, the greater are the dangers that model building will degenerate into particular explanations for particular cases and that description will masquerade as theory. Broadly aggregative data provide a useful check on the generality of propositions established from less aggregative data.

The second reason is that policy formulation and forecasting often require quick and dirty estimates of economic parameters. If a policy maker needs to know the size of the accelerator, it is little help to him to be told that it is one value for manufacturing, another for public utilities, and some wholly unknown value for the remainder of industry which no one has yet bothered to investigate. Without a complete dis-

[3] See, for example: Frank de Leeuw, "The Demand for Capital Goods by Manufacturers," *Econometrica,* July 1962, pp. 407–423; Gary Fromm, "Inventories, Business Cycles, and Economic Stabilization," in *Inventory Fluctuations and Economic Stabilization,* U.S. Congress, Joint Economic Committee, 87th Congress, 2nd Session, Washington, 1962; John Meyer and Robert Glauber, *Economic Decisions, Economic Forecasting, and Public Policy,* Cambridge, Mass., 1964; W. H. Locke Anderson, *Corporate Finance and Fixed Investment,* Cambridge, Mass., 1964; Shirley Almon, "Investment Decisions: A Quarterly Time Series Analysis of Capital Appropriations in Manufacturing," unpublished; Robert Resek, "Investment by Manufacturing Firms: A Quarterly Time Series Analysis of Industry Data," unpublished.

[4] The coverage is approximately the same as that of Bert Hickman's study, *Investment Demand and U.S. Economic Growth* (Washington, 1965), to which the present study owes a considerable debt.

aggregative model which is set up to yield quick answers, aggregate models will continue to be very useful.

Theoretical Rationale

The starting premise of this investment model is the familiar profit-maximization assumption, whereby business carries its fixed investment to the point which equates the marginal rate of return to the marginal cost of funds. The operational problem in evaluating this premise is that neither the marginal rate of return (*mrr*) nor the marginal cost of funds (*mcf*) is directly observable. Hence it is necessary to evaluate the premise indirectly by conceptually specifying a model of the form:

$$mrr = f_1(I, Z_1), \tag{1}$$

$$mcf = f_2(I, Z_2), \tag{2}$$

$$mcf = mrr, \tag{3}$$

where Z_1 and Z_2 are the (vector) determinants of the positions of the *mrr* and *mcf* schedules as functions of investment (I). The two unobservables are eliminated from the system, which is solved for I, yielding:

$$I = g(Z_1, Z_2). \tag{4}$$

Measurements are made directly on (4), from which inferences about (1) and (2) are drawn.

As determinants of the position of the *mrr* schedule, I have used the level of output and the existing capital stock.

As Duesenberry has shown, one need not be a strict accelerationist to recognize the close link between utilization and investment.[5] If marginal costs rise with output along a schedule whose position is determined by the capital stock in existence, then the higher is output relative to the capital stock, the greater is the saving on variable cost to be obtained by shifting the marginal cost curve to the right through accumulating capital, and the higher is the rate of return on new capital.

As determinants of the position of the marginal cost of funds schedule, I have used the flow of retained earnings, the level of output, total outstanding liabilities, the value of assets other than fixed capital, the bond yield, and the dividend/price yield on equity.

The reason for including retained earnings is obvious. As for the balance sheet items, their inclusion is dictated by opportunity-cost

[5] Duesenberry, *Business Cycles,* Chap. 4.

considerations derived from the risks of illiquidity and indebtedness.[6] Other things equal, the higher noncapital assets are, the lower is the imputed cost of using funds for the accumulation of capital rather than noncapital assets, or the lower is the cost of decumulating noncapital assets to buy capital. The higher liabilities are, the higher is the cost of using funds for capital accumulation rather than debt retirement, or the higher is the cost of incurring further liabilities to finance capital expansion.

Along with the levels of liabilities and noncapital assets, some measure of businesses' ability to bear liabilities and its need to carry noncapital assets is required to determine the position of the imputed cost schedules. In both cases the level of output is probably a suitable variable, or in any case an adequate proxy which can be justified on grounds of simplicity.

The rate of interest is included to measure the market cost of raising funds through debt issue, and the dividend/share price ratio to measure the cost to existing stockholders of raising funds through equity issue.[7]

Taking these considerations together, we get relationships of the following sort (neglecting lags for the moment):

$$mrr = f_1(I, Q, K); \tag{5}$$

$$mcf = f_2(I, R, A, L, Q, s, r); \tag{6}$$

where I is investment, Q is output, K is capital stock, R is retained earnings, A is noncapital assets, L is liabilities, s is dividend/price ratio, and r is interest rate. If we normalize the dollar magnitudes for scale by taking them all as ratio to the capital stock and then make linear approximations, we get:

$$mrr = a_1 + a_2 \frac{I}{K} + a_3 \frac{Q}{K}; \tag{7}$$

$$mcf = b_1 + b_2 \frac{I}{K} + b_3 \frac{R}{K} + b_4 \frac{A}{K} + b_5 \frac{L}{K} + b_6 \frac{Q}{K} + b_7 s + b_8 r. \tag{8}$$

[6] For a further development of the rationale for including the state of the balance sheet, see Anderson, *Corporate Finance*, Chaps. 3 and 5.

[7] The cost to existing stockholders is actually some discounted earnings stream per share divided by the current price per share. Dividends are usually a better measure (except for scale) of normal earnings than current earnings are. Hence I use the dividend/price ratio rather than the earnings/price ratio.

Equating these and collecting terms with I/K on the left, we get:

$$\frac{I}{K} = c_1 + c_2\frac{Q}{K} + c_3\frac{R}{K} + c_4\frac{A}{K} + c_5\frac{L}{K} + c_6s + c_7r. \qquad (9)$$

This is the model whose measurement has been the principal task of this study.

The Data

The data used to fit regressions corresponding to equation (9) come from a variety of sources to be described below. All dollar magnitudes are in billion 1954 dollars. All flows are annual. All stocks are measured at the end of the year. Bond and stock yields are measured in percentage points.

First, K (capital stock) and I (investment): The data on stocks, depreciation, and net and gross investment are derived from those prepared by the Department of Commerce.[8] They cover all stocks of producer durable equipment and "other construction" corresponding to the national accounts investment data, except those of agriculture and nonprofit institutions. The series have been extended through 1963, taking account of the July 1964 revisions in the national accounts.[9]

The Commerce Department provides four stock series corresponding to four different depreciation methods: straight-line, *Bulletin F* lives; straight-line, *Bulletin F* lives shortened by 20 per cent; double declining-balance, *Bulletin F* lives; double declining-balance, *Bulletin F* lives shortened by 20 per cent. Since there is little a priori basis for choice among these,[10] I have used each in turn to see which one seems to give the best results.

If the rate of growth of the capital stock is poorly measured, it will have a serious distorting effect on the measured coefficients of equation (9). There are two likely sources of such measurement error. First, the depreciation rate may be either higher or lower than the rate at which capital wastage really occurs. Second, the investment deflator may not accurately reflect changes in the productivity of capital goods.[11]

[8] These series were originally published in the *Survey of Current Business,* November 1962.

[9] The author would like to thank Robert Wasson of the Commerce Department for assistance in updating the series and removing the investment of nonprofit institutions. The tedious calculations involved in this process were ably performed by Charles Bischoff, a summer intern at the Council of Economic Advisers.

[10] If there were, the Commerce Department presumably would not have hedged.

[11] This possibility is raised by Hickman in *Investment Demand,* which gives an interesting account of the interrelationships among depreciation, capital productivity, and embodiment on pages 39–41.

Since either of these is quite likely to be the case with the data at hand, I have added an explicit time trend to the variables already included in equation (9). Its coefficient can compensate for any systematic trend in the error of measurement of the capital stock.

Second, Q (output): These figures from the national accounts include GNP originating in nonfarm business less that originating in finance, insurance, and real estate.[12] Thus the coverage is quite close to that of the capital series.

Third, R (retained earnings), A (noncapital assets), L (liabilities): With the exception of inventory stocks (which are unpublished stock series corresponding to the national accounts nonfarm inventory investment), all these figures come from the flow-of-funds accounts for nonfarm, nonfinancial business.[13] The retained earnings include noncorporate depreciation and proprietors' net investment plus gross corporate saving. The assets include inventories plus noncorporate and corporate financial assets. The liabilities include all corporate and noncorporate liabilities except one- to four-family mortgages. All financial variables are deflated by the investment deflator.

Fourth, s (equity yield) and r (bond yield): These are annual averages of Moody's industrial dividend/price ratio and Moody's industrial bond yield.[14]

Specification

The specification of equation (9) is incomplete, for it fails to indicate the lag structure. Moreover, a constraint had to be placed on some of the coefficients because of collinearity and a shortage of degrees of freedom.

Two specifications were ultimately adopted for measurement:

$$i_t^n = d_1 + d_2\bar{u}_t + d_3f_t + d_4s_{t-1} + d_5r_{t-1}; \tag{10}$$

and

$$i_t^g = d'_1 + d'_2\bar{u}_t + d'_3f_t + d'_4s_{t-1} + d'_5r_{t-1}. \tag{10'}$$

[12] The GNP originating in nonfarm business comes from Table 10 of the July 1964 *Survey of Current Business* and earlier issues. That originating in finance, insurance, and real estate comes from the series prepared by Martin Marimont and published in the *Survey of Current Business,* October 1962 and September 1964.

[13] Board of Governors of the Federal Reserve System, *Flow of Funds Accounts, 1945–62, 1963 Supplement,* updated with more recent estimates from the *Federal Reserve Bulletin.*

[14] These are available in *Business Statistics.*

The following is an explanation of the new notation employed:

$$i_j^n = \frac{I_t^N}{K_{t-1}} \text{ is the net investment rate;}$$

$$i_t^g = \frac{I_t^G}{K_{t-1}} \text{ is the gross investment rate;}$$

$$\bar{u}_t = 0.5\,\frac{Q_t + Q_{t-1}}{K_{t-1}} \text{ is the output-capital ratio;}$$

$$f_t = \frac{A_{t-1}}{K_{t-1}} - \frac{L_{t-1}}{K_{t-1}} + 0.5\,\frac{R_t + R_{t-1}}{K_{t-1}} \text{ is the financial position.}$$

The following are the justifications for the particular specifications adopted.

First, if the average effective depreciation rate on existing capital were a constant, the choice of i^n or i^g as the dependent variable would affect only the intercept of the equation. Since it is not constant (even for the declining-balance stock versions) because of variations in the useful-life mix of the stock, I initially tried using the depreciation rate as an independent variable. Its measured coefficients were implausible and insignificant. Yet when no account is taken of depreciation, neither (10) nor (10′) is wholly satisfactory. Other things equal, higher depreciation ought to increase gross investment since it shifts the rate of return schedule, but it should lower net investment, since the supply of funds schedule is not infinitely elastic. Omitting the depreciation rate seemed the lesser of two evils, since its inclusion raised substantially the standard errors of the coefficients of other variables without contributing much to compensate for this.

Second, by averaging the output figures to approximate $Q_{t-1/2}$, the locus of final investment decision making is implicitly placed at the end of the year preceding the investment. Given that annual capital spending intentions surveys which are made before the preceding year's end are typically much poorer than those made soon after the beginning of the year, this seems like a good rough approximation.

Third, although the collapsing of the three internal cost of funds variables into a single variable was in part dictated by a shortage of data points and by the considerable collinearity which would otherwise occur, there are certainly analytical bases of justification. There is no reason to suppose that equal increments to noncapital assets (which are liquid) and liabilities should raise the imputed cost of funds for investment; if it did, firms could lower the cost by selling assets and buying back their liabilities. Hence the net position is what matters. Averaging R_t and R_{t-1} gives an approximation to the retained earnings flow at the end of $t-1$. This is used as a proxy for the expected flow during t. When this is added to $A_{t-1} - L_{t-1}$, it gives a variable which can be interpreted as the potential net position at the end of t if no investment is undertaken during t and no shares are issued. Apart from any equity issue, then, the further that investment is carried, the worse will be the end-of-year net position, and the higher will be the cost of funds.

Fourth, the bond and stock yields are lagged by a full year rather than the half year by which the other variables were lagged. This was done in the belief that decisions and arrangements to issue shares or long-term debt to finance capital spending are usually worked out quite far in advance of the spending undertaken.

It would be quite possible, of course, to quibble with the details of this specification. One might, for instance, prefer to have a nonadditive equation. I experimented with a log-linear form and got results which were not appreciably different from those of the linear form. Since a linear model lends itself to such ready economic interpretation and application, I preferred to stick with it. I also experimented with minor variations in the lag pattern, but these had little effect on the general characteristics of the results.

Results

The investment models given by equations (10) and (10′) were first fitted to data for which the dependent variable ranged from 1948 through 1963.[15] The fits were not especially impressive; and the standard errors of most of the coefficient were quite large. However, about half of the unexplained sum of squares was attributable to a very large residual for 1957. Since I firmly believe that the continuation of the mid-1950's investment boom into 1957 was collective madness *ex ante,* not to mention *ex post,* I had little compunction about pulling the 1957 observation and refitting the equations without it. The object of this was to increase the accuracy of the parameter estimates and not, of course, to raise the R^2. Anyone who feels that it is reprehensible to throw out maverick data points may feel free to double $1 - R^2$ in his own copy of Tables 1 and 2. All of the numbers in the tables as printed are based on calculations omitting 1957.

[15] These computations were ably and quickly performed by Wayne Vroman, a research assistant in the Research Seminar in Quantitative Economics, University of Michigan.

TABLE 1

Regression Results: Net Investment Rate

Capital Stock Series	Intercept	Coefficient of $\bar{u}_t$	f_t	s_{t-1}	r_{t-1}	t	$\bar{R}^2$
A	−.1001	.1392	.1395	−.0068	−.0168		.9716
		(.0332)	(.0298)	(.0013)	(.0024)		
	−.1076	.1493	.1257	−.0070	−.0155	−.0003	.9692
		(.0394)	(.0420)	(.0014)	(.0037)	(.0007)	
B	−.1835	.1335	.1680	−.0078	−.0097		.9810
		(.0258)	(.0217)	(.0012)	(.0023)		
	−.1864	.1368	.1629	−.0079	−.0091	−.0002	.9790
		(.0301)	(.0303)	(.0013)	(.0034)	(.0006)	
C	−.0369	.0925	.1148	−.0091	−.0273		.9678
		(.0301)	(.0314)	(.0017)	(.0030)		
	−.0553	.1240	.0716	−.0096	−.0226	−.0013	.9714
		(.0352)	(.0412)	(.0016)	(.0042)	(.0009)	
D	−.0712	.0835	.1307	−.0115	−.0243		.9696
		(.0263)	(.0257)	(.0017)	(.0032)		
	−.1078	.1157	.0856	−.0122	−.0179	−.0017	.9781
		(.0266)	(.0299)	(.0015)	(.0040)	(.0008)	

TABLE 2

Regression Results: Gross Investment Rate

Capital Stock Series	Intercept	Coefficient of $\bar{u}_t$	f_t	s_{t-1}	r_{t-1}	t	$\bar{R}^2$
A	.0103	.1234	.1391	−.0077	−.0162		.9730
		(.0287)	(.0265)	(.0013)	(.0022)		
	.0036	.1323	.1268	−.0078	−.0151	−.0003	.9708
		(.0350)	(.0374)	(.0012)	(.0033)	(.0006)	
B	−.0072	.1379	.1261	−.0088	−.0184		.9748
		(.0323)	(.0273)	(.0015)	(.0029)		
	−.0126	.1439	.1169	−.0089	−.0174	−.0003	.9725
		(.0376)	(.0379)	(.0016)	(.0042)	(.0008)	
C	.0338	.1135	.1340	−.0093	−.0214		.9685
		(.0272)	(.0284)	(.0015)	(.0027)		
	.0230	.1255	.1176	−.0095	−.0197	−.0005	.9663
		(.0350)	(.0409)	(.0016)	(.0042)	(.0008)	
D	.0241	.1191	.1365	−.0114	−.0250		.9716
		(.0288)	(.0281)	(.0019)	(.0035)		
	.0092	.1322	.1181	−.0117	−.0224	−.0007	.9692
		(.0353)	(.0397)	(.0020)	(.0052)	(.0010)	

The results presented in Table 1 are those for equation (10), in which i^n is the dependent variable. Those in Table 2 are for equation (10′), in which i^g is the dependent variable. Each equation is estimated for each of the capital stock variants, and for each variant it is estimated with and without the trend variable.

There are very few noticeable differences between the coefficients in the two tables, except of course for the intercepts. The differences between the two columns of intercepts are not far from what one should expect from the average depreciation rates, which range from .085 for series A to .144 for series D. The pairs of corresponding slope coefficients rarely differ from each other by any amount which looks remarkable, given the standard errors. Neither set of equations seems to give fits that are systematically better than those of the other.

Likewise, there is little basis for choice among the various capital stock series to be found in comparisons of either over-all goodness of fit or significance of the output-capital ratio. The only place where one can detect any important differences is in the net investment rate equations. For the two declining-balance stock equations the coefficients of the output-capital ratios are noticeably increased by inclusion of the trend terms. This suggests that the declining-balance depreciation leads to an understatement of the growth in the capital stock, and hence to an understatement of the secular down-drift in u_t. When the time trend is explicitly included, the coefficients on u_t get larger and the trends have negative coefficients. The trend has the least effect on the coefficients of the equations using stock series B; this is the series with the highest growth rate of the four.

The output-capital ratio coefficients are all quite significant; in every case they are at least three times their standard errors. They give more explanatory contribution to the straight-line stock equations than to the declining-balance equations, which is what one should expect if these are in fact somewhat better stock series.

In almost all equations the financial position variable is also highly significant. Its significance level is reduced when the trend variable is included in the regression, however. Since both the profit rate and the net position have downward trends over the data period, the financial position is quite collinear with the trend.

The dividend yield variable is highly significant in every equation. Indeed, this consistent predictive contribution is something of a puzzle if the stock dividend yield measures only the cost of equity funds. Its effects are probably nonlinear (threshold) for individual firms and hence it ought not to be easily approximated in an aggregate linear equation. It seems likely therefore that it also measures expectational elements which influence both investment and stock prices, but are not adequately reflected in u_t.

The rate of interest is also highly significant in every equation. Since it has a marked upward trend over the data period, it is quite collinear with the trend variable. Nonetheless, its significance levels hold up well even when the trend is explicitly included.

The time trend itself is a positive explanatory nuisance in almost all cases. Except in capital stock variants C and D in the net investment equations, the inclusion of the time trend always reduces the adjusted R^2. In the two exceptions the adjusted R^2 is increased only slightly by the trend. These results give very little indication, therefore, that the Commerce Department's estimating procedures systematically and significantly distort the growth rate of the effective capital stock.

Incidentally, these results suggest that the recent findings of Hickman[16] may result in part from incomplete specification. He observes a significant negative trend in his flexible accelerator equations. This he attributes to a downtrend in the amount of capital desired per unit of output, as capital is conventionally measured. However, his specification does not include adequate accounting for the factors which have led to a secular uptrend in the position of the marginal cost of funds schedule. Lacking this accounting, he is forced to infer from an actual downtrend in the net investment rate at a constant output-capital ratio that there has been a decline in the desired amount of capital per unit of output. The data used in this study also show a significant negative trend if the variables standing for the marginal cost of funds are omitted. However, as soon as they are included, the trend ceases to be significant.

Conclusions

On the strength of the results given in Tables 1 and 2, it seems fairly clear that both capacity utilization and financial variables belong together in an adequate explanation of investment. If these were the only results to support this contention, one could justifiably be skeptical because of the formidable problems of drawing reliable inferences from time series aggregates. However, given the weight of evidence derived from less aggregative studies (see footnote 3) and the confirmation found in these aggregates, it is hard to see how one can remain a celibate accelerationist.

[16] Hickman, *Investment Demand.*

On the strength of the parameters of these equations, it is tempting to advance some conclusions about the effects of monetary and tax policies. At this writing I shall resist these temptations because of the dynamic complexities of the relationships among the variables involved. Quite apart from the macroeconomic feedbacks from investment to output and profits, one cannot change any of the variables in the equations without affecting most of the others. Not only are they linked together through accounting identities, but they are also interrelated through decision-making processes which determine borrowing and equity issue and through a technical relationship between the utilization rate and the retained earnings rate. Until these are adequately spelled out, it will not be possible to make even a partial equilibrium analysis of the effects of policy changes. Hence it seems best to close this tale with the wedding and leave the story of its progeny to a sequel volume.