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CHAPTER 4

The Rate of Investment

THE rate of investment is a surpassingly important factor in economic life. The short-run fluctuations in investment are large in amplitude, and they are commonly credited with a dominant influence upon the state of business conditions. The secular growth of capital was long considered to be the basic determinant of the progress of an economy. In modern times there has been a growing tendency to place more emphasis upon the state of technological development as the prime source of progress, but no one has argued that the provision of adequate capital is an unimportant part of growth and, in one view, expenditures on research are simply investment in knowledge.

The main focus of our inquiry is upon the influence of the rate of return on investment. This emphasis is not due to the belief that *realized* rates of return are of decisive influence—indeed their relative unimportance will be argued. The emphasis is due rather to the fact that our data on rates of return and capital are comprehensive and comparable, whereas most other explanatory variables influencing investment—for example, shifts of consumer demands and advances in technology—involve such large and difficult problems of data collection and analysis as to be beyond our reach. Estimation of prospective profit rates receives some attention, and the effects of wages upon investment are treated in Chapter 5.

1. *The Rate of Return and Investment*

The rate of investment in an industry is governed by its expected rate of return, but the rate of return is itself a summary of all the forces impinging upon the industry. Any change in costs—whether due to raw-material prices, wage rates, taxes, or changes in technology—and any change in consumer demands will affect prospective costs, revenues, and therefore rates of return.

If one possessed direct and precise knowledge of (schedules of) prospective rates of return, he could by-pass all these other considerations in predicting investment, with one qualification. Since we are dealing with *industries*, not individual firms, it is probable that there will be no single amount of capital corresponding to the weighted average of the firms' rates of return. An increase in demand, for example, may lead to a given average prospective rate of return (with present capital), but the amount of investment will depend upon how the increased demand is

distributed among the firms. If the increase is directed primarily toward firms near capacity, it will have a different effect upon investment than if it is directed primarily toward firms with excess capacity.

But, of course, the prospective rates of profit are not known to an outside investigator, and even if anticipations of entrepreneurs are completely accurate, realized (ex post) rates of return will give only one point on the schedule of prospective rates. If it is correctly anticipated that without additional investment the rate of return next year will be 10 per cent, the long-run equilibrium rate being 7 per cent, then such an amount of investment may (and, if possible, will) be undertaken that the ex post rate will be only 7 per cent.

Realized rates of return will therefore be a clue to what they were previously and correctly anticipated to be (in the absence of additional investment) only to the extent that entrepreneurs were unable to make sufficient investment (or disinvestment) to bring the rate to the equilibrium level. If anticipations were in some degree incorrect, the ex post rate of return may be either higher or lower.

In an empirical study, therefore, we should not expect to find a high correlation between investment in year T and the realized rate of return in year T. If the anticipations were perfect and complete competitive adjustment could be made within a year (or other time period under study), the correlation would be zero. If anticipations were correct, but technological or other barriers prevented complete adjustment to the long-run competitive level, investment would be positively correlated with rates of return. Errors in anticipation, unless they were systematic, would presumably reduce any observed correlation. On the other hand, anticipations that were systematically conservative, in the sense of underestimating the departure of the anticipated rate of return from the competitive average, would increase the correlation between investment rates and realized rates of return: equilibrium would not be restored in the next time period, so ex post returns would be above average in expanding industries and below average in contracting industries.

To these possible reasons for a correlation between realized rates of return and investment, one must add a wholly different consideration. Profits fluctuate much more from year to year than dividends do, so unusually large profits lead to unusually large retained earnings, which are a substantial source of the increase in capital in manufacturing. In our postwar period, retained earnings were more than one-fourth of the increase in capital in every year, and were almost exactly one-half of the increase in capital for the period as a whole (Table 19). Hence one might argue

TABLE 19

INCOME, DIVIDENDS AND INTEREST PAID, RETAINED EARNINGS, AND INCREASE IN CAPITAL, ALL MANUFACTURING INDUSTRIES, 1947–58
(amounts in billions of dollars)

Year	Income	Dividends and Interest Paid	Retained Earnings	Increase in Capital	Retained Earnings as Per Cent of Increase in Capital
1947	10.5	4.4	6.2	13.6	45
1948	11.6	4.9	6.8	9.7	70
1949	9.0	5.0	4.0	2.1	190
1950	13.0	6.1	6.9	16.6	42
1951	10.9	5.9	5.0	18.5	27
1952	9.4	6.0	3.4	8.6	39
1953	9.9	6.3	3.6	6.6	55
1954	9.5	6.2	3.3	3.4	98
1955	13.8	7.3	6.5	17.1	38
1956	13.5	7.9	5.6	12.2	46
1957	12.8	8.3	4.5	6.9	65
1958	10.5	8.0	2.4	9.2	27

NOTE: Retained earnings and percentage calculated from unrounded data. Income excludes dividends received from other corporations, and dividends paid exclude a pro rata share of dividends received.

SOURCE: *Statistics of Income, Corporation Income Tax Returns*, for 1947 to 1958 (IRS).

that high profits automatically generated a large increase in capital in the same year.

The main defect in this argument is that it views the surplus of earnings over dividends and interest payments as an end-of-year residual which increases the firm's aggregate resources whether the firm wishes more capital or not. These earnings normally accrue over the year, not on December 31, and if the enterprise does not wish to increase (or decrease) dividends or investment commensurately, it can reduce its short-term (or, to some extent, long-term) liabilities. Only if the capital structure of the firm does not allow debt reduction (or increase) or if the capital markets are very imperfect (so retained earnings are a much cheaper source of capital than new borrowings or equity issues) will the current profits have a simple arithmetic effect upon total assets. The "arithmetic" influence of current profits upon current investment may therefore be quite small, and subsequent findings suggest that it is small.[1]

The preceding argument on the relationship between investment and ex post profits requires little modification if the industry is monopolized. There is less likelihood that the equilibrium rate of return will be stable

[1] See p. 76.

over time: this rate is set by the conditions of the particular industry, whereas the average rate in the competitive industries is set by the sum of their diverse conditions. But the equilibrium rate will be all that is observed ex post if the industry correctly anticipates and fully adjusts to changes in supply and demand conditions.[2]

Even if an industry were in long-run equilibrium each year so the rate of return was (approximately) constant, investment would be highly correlated with the factors that led to changes in the equilibrium position. If demand grew, the stock of capital would parallel the physical output of the industry. If changes in factor prices led to a substitution of capital for labor, the stock of capital would parallel increases in wages relative to the cost of capital. If technology advanced—and here we have no reliable quantitative measure—the stock of capital might either increase or decrease. Of course, to the extent that durable and specialized forms of capital were involved, long-run equilibrium could not be attained each year even with perfect foresight.[3]

Direct increases in demand (shifting of the industry's demand curve to the right) are measured approximately by receipts of the industry. If the increase in demand is not fully anticipated, prices will rise above their long-run equilibrium level, and receipts may increase in greater or less proportion than the horizontal shift of the demand schedule—normally a quantitatively minor complication.[4]

Reductions in cost are also measured, less perfectly, by changes in output. A reduction in costs will lead to a reduction in price and hence to an increase in output and, in general, the larger the reduction in costs, the greater the increase in output. If demand is elastic, increase in output will in turn be accompanied by an increase in receipts.

Since conditions of demand are usually less stable in the short run than those of cost, and since changes in receipts may measure changes in both demand and cost, receipts of the industry will be used as the primary index of the demand for capital.

[2] To the extent that monopoly declines over a period, investment and realized rates of return should be negatively related.

[3] For example, even if the future availability of an improved machine were known, an unimproved machine might have to be built this year.

[4] Let the industry have a constant long-run equilibrium price p_0, and let the demand shift to the right by a factor λ, i.e., the old demand curve is $q = f(p)$ and the new demand curve is $\lambda f(p)$. Then receipts will rise in the ratio

$$\frac{p\lambda f(p)}{p_0 f(p_0)} = \lambda + \lambda \frac{\Delta p(1 + \eta)}{p_0},$$

where Δp is the excess of price over p_0 and η is the elasticity of demand.

ANNUAL RELATIONSHIPS

Let us turn to the evidence. All the possible regressions of relative increase in capital on relative increase of receipts and either current or preceding year profit rates have been calculated for the period 1948 to 1957 (Table 20).[5] They agree almost too well with expectations! In every case, the overridingly important influence on the rate of investment is the change in receipts: this is the only consistently significant regression coefficient, and even its magnitude is remarkably stable. Except during the depression year, 1949, the relative change in capital was approximately six-tenths of the relative change in receipts. On average, somewhat over half the variance of relative changes in capital is explained by the relative change in receipts.

The current profit rate plays a negligible role in the regression equations: it is significantly different from zero only in 1950, 1951, and 1956, and in the former year it has a negative sign. The preceding year's profit rate is better behaved: it is almost consistently positive and is significant (at the 5 per cent level) in five (and almost so in 1957) of the nine years.[6] One possible interpretation of this finding is that this year's profit rate is used as predictor of next year's profit rate—which would be a sensible short-run rule, as our study of the stability of the industrial pattern of profit rates indicated. Investment in durable goods is, of course, less sensitive to short-run fluctuations in rates of return. There is another interpretation, however, which will be discussed shortly.

Our findings on the accelerator relation cannot readily be compared with those obtained (usually from data on individual companies) by others, because our capital concept (all assets except investments in other companies) is much broader than that usually employed. In fact, most investigations seek to relate gross investment in plant and equipment to changes in sales. This narrower concept is appropriate if it is believed that

[5] The considerable degree of direct control over investment during the war makes the earlier period less interesting; however, it is analyzed in the longer period regressions (see below). In the postwar period the aircraft industry, which underwent extreme fluctuations, was omitted, usually with little effect upon the regressions for three-digit industries.

[6] These two sets of regressions seem to support the argument (text accompanying Table 19) that the "arithmetic" effect of retained earnings on the increase of assets need not be of much importance. If it were, the relationship of investment to profit rates should not only be substantial but also larger for current than for preceding year profit rates.

As a further test of the arithmetic effect of retained earnings on investment, the residuals from the regressions of relative investment on current profits and relative change in receipts were correlated with the ratio of retained earnings to income, for 98 industries. In neither 1949 nor 1950 was there any correlation.

TABLE 20

ANNUAL REGRESSION OF RELATIVE CHANGE IN CORPORATE CAPITAL ON RELATIVE CHANGE IN RECEIPTS AND PROFIT RATE, NINETY-EIGHT INDUSTRIES, 1948–57

X_1 = log capital$_t$ − log capital$_{t-1}$
X_2 = log receipts$_t$ − log receipts$_{t-1}$
X_3 = profit rate, year t
X_4 = profit rate, year $(t - 1)$

Year	*Regression Coefficient, and Standard Error, of X_1 on:* X_2	X_3	Coefficient of Multiple Correlation
1948	.633	.000161	.776
	(.0556)	(.000724)	
1949	.402	.000602	.671
	(.0491)	(.000784)	
1950	.627	−.00371	.744
	(.0594)	(.00112)	
1951	.466	.00476	.794
	(.0572)	(.00111)	
1953	.654	−.000725	.837
	(.0473)	(.00144)	
1954	.583	−.00144	.726
	(.0570)	(.00104)	
1955	.471	.00272	.726
	(.0564)	(.00108)	
1956	.650	.00262	.778
	(.0636)	(.00108)	
1957	.772	−.000120	.744
	(.0775)	(.00118)	

Year	*Regression Coefficient, and Standard Error, of X_1 on:* X_2	X_4	Coefficient of Multiple Correlation
1948	.637	.000208	.776
	(.0530)	(.000583)	
1949	.438	.00149	.686
	(.0477)	(.000722)	
1950	.523	−.000988	.713
	(.0536)	(.000886)	
1951	.555	.00477	.820
	(.0470)	(.000835)	
1953	.627	.00269	.847
	(.0440)	(.00115)	
1954	.561	.00106	.722
	(.0556)	(.00112)	
1955	.515	.00418	.758
	(.0497)	(.000987)	
1956	.689	.00402	.812
	(.0554)	(.000851)	
1957	.739	.00239	.756
	(.0711)	(.00124)	

SOURCE: Tables A-36 to A-59; and *Statistics of Income*, for 1947 to 1957.

the technological ties between output and fixed capital are closer than those between output and total capital. But there is no presumption that this is true: it is almost certainly not true in the short run, when the relationship of fixed plant to output is highly variable; and it is not very plausible even in the long run. If fixed and working capital are substitutable, as of course they are, the presumption will in fact be that total capital has a more stable relationship than fixed capital has to output. The same presumption holds with respect to rates of return: we should expect net investment to be more sensitive than gross fixed investment is to changes in profit prospects. For gross investment will be influenced by replacement needs as well as by profits, and again the substitution between fixed and working capital enters to weaken the relationship, especially in the short run.

Eisner's estimates of the accelerator relation are based upon a distributed lag model, in which investment in durable goods this year is related to changes in sales in this and each of several previous years.[7] The sum of these coefficients for 1955 is .72, or .48 if firms making gross fixed investments of more than 40 per cent of their total fixed assets are excluded. Current and earlier profit rates had no systematic relationship to investment. The profit rates in this study are highly ambiguous, however: they are total earnings divided by fixed assets, which are a variable and minor fraction of total assets. The better performance of profits in the study of separate industries, where this profit measure is somewhat less dubious, suggests that the measure may have had an important effect on the results.

The well-known study of Meyer and Kuh is even more difficult to compare with our work. The net profit variable is again measured on gross fixed investment, and the change in sales enters into two of their variables—directly, and in a capacity measure.[8] Their finding that change in sales has no important effect on investment,[9] while the "capacity effect" is positive,[10] may arise in part from this multiple use of change in sales.

[7] Robert Eisner, "A Distributed Lag Investment Function," *Econometrica*, Jan. 1960, pp. 1–29.

[8] The change in sales relative to gross fixed investment is also measured. The capacity measure is defined as follows: let $(K/S)_m$ be the minimum ratio of fixed capital to sales during 1946–49. The capacity measure is then $(K/S)_m S_t$, where S_t is sales in the given year. If $(S_t - S_{t-1})/K_t$ is the direct measure of sales change, clearly this variable and $S_t K_t / S_{t-1}$ are not independent.

[9] The partial correlation coefficients are often negative, and significant in only 5 of 75 cases (John R. Meyer and Edwin Kuh, *The Investment Decision: An Empirical Study*, Harvard University Press, 1957).

[10] The correlation coefficients are generally significant and positive in 1946 and 1947, but not in the next three years (*ibid.*, p. 122).

Meyer and Kuh kindly supplied the simple correlations for their sample, and these were used to calculate for each of fifteen industries equations of the form,

$$\frac{\Delta F}{F} = a + b\frac{\pi}{F} + c\frac{\Delta S}{S},$$

where F is fixed investment, π is previous year's profits, and ΔS is change in sales in the given year. The lagged profit variable was much more influential than the change in sales, as shown below.

	Number of Significant Regression Coefficients, .05 level	
Year	Profits	Sales
1947	6	2
1948	7	3
1949	7	2
1950	8	5

All significant regression coefficients were positive. The relatively poor performance of changes in sales suggests that the sales of individual firms contain random fluctuations which are large relative to changes in sales, so industry sales may be a better index, even for a firm, of changes in its demand.[11]

LONGER-PERIOD RELATIONSHIPS

One source of ambiguity in the interpretation of annual rates of investment is that they are subject to large errors of measurement. We have no direct measure of their magnitude, but the instability of the year-to-year industrial pattern of rates of investment, and the greater stability of this pattern over longer periods, suggest that the errors are not negligible.[12] What should we expect when the period of investment is lengthened?

[11] The correlations of successive profit rates of individual firms are very high:

Pairs of Years	*Average Correlations of Profit Rates* (15 industries)
1945 and 1946	.59
1946 and 1947	.78
1947 and 1948	.81
1948 and 1949	.78
1949 and 1950	.72

[12] Note that the errors in measurement of capital should be at least in part positively correlated with the errors in measurement of receipts. When companies are reclassified, both their assets and receipts are allocated to the same industry.

On our previous argument, lengthening the period over which investment is measured should reduce the correlation between investment rates and profit rates. The presence of correlation in the short run is presumably due to one of two factors: either the expectations of future profit rates were systematically biased—the strength of the forces making for high or low rates was underestimated—or technological or other limitations on the firm's ability to adapt to new conditions prevented a complete elimination of unusual profits or losses. And both of these causes of correlation are surely weaker in a longer period: errors in expectations can be corrected; and any limitations on the firm's freedom to adjust investment diminish with time.

This argument assumes that a misjudgment of the demand for capital next year cannot be fully corrected next year, that it will require more than a year to recognize the error in expectations or to make the appropriate investment or disinvestment to restore the industry's profit rate to equilibrium, or both.[13] This is perhaps a plausible assumption, but its plausibility (which rests on the most casual empirical observation) surely varies from industry to industry.

This is of course an ex ante view: we are asking why the equilibirium amount of investment may not be attained next year. To the extent that the entrepreneurs misjudge the new demand for capital (the shifts of which we roughly measure by receipts), of course, profit rates will in actual fact not be at equilibrium next year. They will be higher or lower, but (in the absence of systematic errors of expectation) they will not be correlated with investment.

When the period is lengthened to several years, however, surely it will embrace both unanticipated changes in profit rates and the investment adjustments they in turn call forth. An unanticipated high profit rate next year will lead to larger investment the year (or two or three) thereafter and, conversely, an unexpectedly low profit rate will lead to smaller investment thereafter. This effect will be realized even if, on average, expectations are correct—it can be the result of unsystematic errors in anticipation.

The finding that investment in a year is correlated positively with the previous year's rate of return could be interpreted to support this view. In year t, the firm invested I_t expecting a realized rate of return, π^*_t. If in the event the realized rate was π_t, investment was too large or too small, and the excess or deficiency was larger, the larger the difference

[13] Recall that in our interindustry universe, equilibrium is defined by the profit rate in an industry relative to that of other industries.

between expected and realized rates of return. Say the deficiency or excess was $\Delta I_t = \lambda(\pi^*_t - \pi_t)$, with $\lambda > 0$. Then this amount of investment should be added to or subtracted from that amount called for by next year's shift in the demand for capital, and $\lambda(\pi_t^* - \pi_t)$ becomes one of the determinants of next year's total investment. This interpretation is not independent of that given in the previous subsection, for unexpectedly high profits this year are a relevant basis for predicting larger profits (with given capital) next year.

In sum, either larger or smaller correlations between investment and profit rates are therefore possible as the period of time is lengthened.

The regression equations for the two periods used in our study are given in Table 21. They display the usual strong relationship between invest-

TABLE 21

REGRESSION OF PERCENTAGE CHANGE IN CAPITAL ON PERCENTAGE CHANGE IN RECEIPTS AND ON PROFIT RATE, 1938–56

X_1 = percentage change in total capital
X_2 = percentage change in corporate receipts
X_3 = average profit rate

1938–47 ($n = 82$)	
$X_1 = -54.86 + \underset{(.051)}{.527X_2} + \underset{(3.26)}{6.12X_3}$	$R = .765$
1947–54 ($n = 98$)	
$X_1 = .242 + \underset{(.037)}{.808X_2} + \underset{(.732)}{2.12X_3}$	$R = .924$
1947–56 ($n = 98$)	
$X_1 = -31.70 + \underset{(.029)}{.858X_2} + \underset{(.816)}{6.64X_3}$	$R = .957$

SOURCE: Data employed from Tables A-14 to A-59; and from *Statistics of Income*, for 1938, 1947, 1954, and 1956.

ment and receipts,[14] and they also give substantially more weight to the profit rate. Even in the earlier period the regression of relative investment on profit rates was significant, and in the postwar period it was highly significant. In both periods, however, introduction of profit rates does not add appreciably to the "explanation" of the variance of investment

[14] The relative changes in capital and receipts for the longer period were calculated with relative changes expressed as percentages; in the annual regressions (which were calculated subsequently), the differences in successive logarithms were used.

rates.[15] The elasticity of relative investment with respect to relative receipts was .6 in the annual postwar regressions; it was .9 in the corresponding long-period regression. The difference between the annual and long-term elasticities is in keeping with expectations:[16] entrepreneurs will make a fuller adjustment of capital to a permanent than to a transitory change in demand.

EFFECTS OF PRICE CHANGES

Since our three-digit industry data were not deflated, it is necessary to turn to the two-digit industries for information on the effects of price

TABLE 22

REGRESSION OF PERCENTAGE CHANGE IN CAPITAL ON PERCENTAGE CHANGE IN OUTPUT AND ON PROFIT RATES, TWENTY-ONE MAJOR INDUSTRIES, 1947–54

X_1 = percentage change in total capital
X_2 = percentage change in output
X_3 = average profit rate

Book values		
$X_1 = -9.641 + .743X_2 + 4.03X_3$	(.098) (1.92)	$R = .937$
1947 prices		
$X_1 = -45.34 + .396X_2 + 7.55X_3$	(.158) (2.14)	$R = .811$

SOURCE: Tables A-36 to A-59; and *Census of Manufactures, 1954*, Vol. IV, Part 4.

changes on the relationships between investment, receipts, and profit rates. The basic equations for this set of major industry groups are given in Table 22.[17] Elimination of price changes has a radical effect upon the

[15] If X_1 and X_2 are relative changes in investment and receipts, respectively, and X_3 is profit rates, the correlation coefficients are:

	1938–47	1947–54	1947–56
r_{12}	.753	.917	.926
r_{13}	.181	.325	.393
r_{23}	.060	.234	.167
$r_{12.3}$	.756	.915	.949
$r_{13.2}$	.207	.285	.640
$R_{1.23}$	.765	.924	.957

[16] A minor difference arises because the long-term regression is based upon percentage changes, whereas the annual regressions are based upon differences in logarithms. The exclusion of a single, highly abnormal industry (aircraft) increased the long-term elasticity from .5 to .8 for the 1947–54 period.

[17] The output measure is a ("cross") weighted average of output indexes in the *Census of Manufactures, 1954*, Vol. IV, Part 4. The transportation sector is omitted because the extremely unusual behavior of aircraft greatly affects the regressions.

relative importance of the two independent variables. The dominant part previously played by changes in receipts no longer holds: in fact, the coefficient of determination of profit rates becomes larger than that of physical output.[18] Since investment and receipts are similarly influenced by movements of prices much more than profit rates are, it is of course natural that deflation of the data reduces the role of receipts.[19] On the whole, the regression fits the data remarkably well even after deflation.

EXPECTED PROFIT RATES

The role of *expected* profit rates is crucial in determining the direction and volume of investment, in the traditional theory. We should naturally like to observe this variable and introduce it into our analysis, less to test its relevance (for this can hardly be doubted) than to form a notion of the quantitative effect of expected rates on investment. Expectations, however, are fully as difficult to quantify here as elsewhere in economics and, in particular, the popular method of questionnaire, even were it possible in our context, would yield results difficult to interpret or to trust. So we are thrown back on methods of constructing what may be more or less plausible measures of expectations.

Yehuda Grunfeld proposed the use of the market value of securities of a firm as an index of expectations of its future earnings.[20] There are substantial forces working to bring the expectations of management and market together: outside investors will profit by a more accurate set of predictions of future demands and costs, and management will profit by sale or purchase of securities if its expectations are superior to and different from those of the market.

Only modest use can be made of this index of future profits because of the limitations of data. Market values are available only for large firms whose securities are listed on exchanges (Grunfeld's work is based on such companies), and this requirement excludes many industries and raises doubts concerning the representativeness of the data for others. The available industry indexes of stock-market values have two other deficiencies for

[18] The correlation coefficients, in the notation of Table 22, are:

	Book Value	1947 *Prices*
r_{12}	.921	.648
r_{13}	.697	.733
$r_{12.3}$	.873	.509
$r_{13.2}$	.444	.640

[19] The same price indexes, in fact, enter into output and inventory deflations.

[20] "The Determinants of Corporate Investment," in *The Demand for Durable Goods*, Arnold C. Harberger, Ed., University of Chicago Press, 1960.

our purposes: only market values of common stocks are reported; and yearly values are the means of high and low quotations (of variable date) rather than those at a fixed time of year.[21] Yet the variable is sufficiently promising to make even a crude application worthwhile.

The time periods involved in the use of market value as a measure of expected profits are not self-evident. A given movement of market value reflects a change in expected earnings sometime in the future, and all one can say in general is that a given expected change in earnings will have a larger effect on present market value, the nearer in the future it is to occur.[22] It is possible that profit expectations for the near future dominate *movements* of stock-market values, or that the whole level of expected future earnings is decisive. We use *differences* among industries in movements of market value to measure *differences* in expected future earnings, and to this extent remove the effects of changes in the general level of security prices. Both annual and longer-period regressions will be examined.

The predictions of relative investment in a year by the preceding year's change in market value turn out rather poorly: in only one year is the correlation coefficient significantly greater than zero, and it is negative in two recession years (Table 23).[23] The predictions provided by the rate of return in the preceding year are considerably better, although only in 1951 and 1954 are they significant. The introduction of the preceding year's relative change in receipts does not appreciably affect either relationship.

This is of course a severe test to impose, for the predictions are unconditional in the sense that no data from the year in which investment occurs are employed.[24] Even changes in receipts, which are so successful in all analyses in which they are simultaneous with investment, have no predictive power: the correlation coefficient is negative in the only year in which it is statistically significant.

To test the role of market-value changes over a longer period, the market values in 1947 and 1948 (averaged) were compared with those of 1949 and 1950 (averaged), and the relative change in market value over

[21] See S. Cottle and T. Whitman, *Corporate Earning Power and Market Valuation, 1935–1955*, Duke University Press, 1959, p. 12. We are indebted to Cottle and Whitman for supplying supplementary information.

[22] Grunfeld used successive annual time periods for both market value and gross investment, where the latter is the dependent variable in a regression on market value and beginning-of-year stock of capital.

[23] A larger sample of rates of change in industry stock price indexes compiled by Standard and Poor were also analyzed for 1948–49 and 1949–50 against the subsequent year's investment rate, without a significant change in the results. These stock indexes were taken at the end of year.

[24] But it should be noted that $r_{12.3}$, in the notation of Table 23, is not very different if the change of receipts in the year of investment is used.

TABLE 23

CORRELATION BETWEEN INVESTMENT AND PROFIT RATES, CHANGE IN MARKET VALUE AND RECEIPTS, TWENTY-ONE INDUSTRIES, SELECTED YEARS, 1949–54

X_1 = investment = log capital$_t$ − log capital$_{t-1}$
X_2 = change in market value = log value$_{t-1}$ − log value$_{t-2}$
X_3 = change in receipts = log receipts$_{t-1}$ − log receipts$_{t-2}$
X_4 = profit rate, year $(t-1)$

Year	r_{12}	r_{13}	r_{14}	r_{23}	r_{34}	$r_{12.3}$	$r_{14.3}$
1949	−.077	.107	−.010	.348	.273	−.123	−.033
1950	.351	−.006	.295	.351	.350	.377	.345
1951	.481	.269	.499	.600	.382	.414	.437
1953[a]	.118	−.412	.154	.398	.462	.337	.169
1954[b]	−.161	−.114	.476	.205	−.150	−.142	.464

[a] Because 1952 data are not available, X_1 for 1953 is ½ (log capital 1953 − log capital 1951).

[b] For the same reason, X_3 is ½ (log receipts 1953 − log receipts 1951).

SOURCE: For market value data, Cottle and Whitman, *Corporate Earning Power*; other figures from Tables A-36 to A-59 and *Statistics of Income*.

that period was correlated with relative investment from 1950 to 1954. The simple correlation coefficient was .315 (for twenty-one industries). This result is also less than impressive, but in the light of the deficiencies of the data it cannot be viewed as wholly unpromising. The performance of market value as a predictor of investment demand appears to be about as good in this four-year analysis as it is in the annual analyses.

An alternative method of predicting ex ante profit rates is the extrapolation of recent profit rates. If the industry had previously been in long-run equilibrium, there would be no basis in past experience for estimating future returns, which would presumably also be at the equilibrium level after appropriate investment. But this is only a simple instance of the general rule that only if a system gets out of equilibrium can one discover the forces that restore equilibrium. If recent profit rates have not been at the equilibrium level, they possess predictive value for future profit rates. If profit rates have been above the average, and rising, the industry will have rosy profit prospects; if profit rates have been below average, and falling, the industry's near future is unattractive.

In this interpretation, one might assume that relative investment $(\Delta C/C)$ will be some function such as

$$\frac{\Delta C_{t+1}}{C_t} = a + b\,(\pi_t - \bar{\pi}_t) + c(\pi_t - \pi_{t-1}) + d\left(\frac{\Delta R_t}{R_{t-1}}\right)$$

where π is the profit rate, $\bar{\pi}$ the average of industries, R is receipts, and the

subscripts refer to time. The coefficient b should be positive since a profit rate above average encourages investment, and c should be positive because rising profit rates should work the same way. Finally, d should be positive because rising sales also suggest a large investment demand. The equation can be written

$$\frac{\Delta C_{t+1}}{C_t} = (a - b\bar{\pi}_t) + (b + c)\pi_t - c\pi_{t-1} + d\left(\frac{\Delta R_t}{R_{t-1}}\right)$$
$$= A + B\pi_t + C\pi_{t-1} + d\left(\frac{\Delta R_t}{R_{t-1}}\right),$$

with the expectation that B and d are positive and C negative. In this form, the equation differs from a simple regression of the rate of investment on previous years' profit rate and increase in receipts only by the presence of the profit rate two years before. It is in this form that the regression equation has been calculated, with differences in logarithms replacing percentage changes in corporate capital and receipts.

The predictions are again unconditional, in the sense that no data from the predicted year enter as independent variables so, at best, only modest results can be expected, and even they are not forthcoming (see Table 24). In the one year (1950), in which the profit rate of the preceding year has a statistically significant regression coefficient, it has the wrong sign. The regression coefficients for the profit rate lagged two years are significant in 1950 and 1956, but in other years are statistically nonsignificant and erratic in sign.

The results of both these profit expectation analyses are calculated to remind one that investment rates are among the most difficult of all economic magnitudes to predict. One must use very lenient standards of success in judging unconditional predictions, but even by these standards one can say only that both market value changes and lagged profit rates deserve further exploration.

2. *Other Possible Determinants of Investment Rates*

Although the level of demand (here measured by receipts) and profit rates are taken as the leading determinants of investment in the literature on the subject, there are a host of other variables which have been regarded as relevant. In general no strongly influential variables were found in this canvass, which was severely restricted by data limitations.

CONCENTRATION OF INDUSTRY

The effects of monopoly on the amount of capital invested in an industry are debated in an extensive literature. The most popular conclusions are

TABLE 24

REGRESSION OF RELATIVE INVESTMENT ON PREVIOUS RELATIVE CHANGE IN RECEIPTS AND PROFIT RATES, NINETY-EIGHT INDUSTRIES, 1949–57

X_1 = log capital$_t$ − log capital$_{t-1}$
X_2 = log receipts$_{t-1}$ − log receipts$_{t-2}$
X_3 = profit rate$_{t-1}$
X_4 = profit rate$_{t-2}$

1949		
$X_1 = .0085 + .149X_2 - .00035X_3 - .00052X_4$	(.081) (.0015) (.0012)	$R = .220$
1950		
$X_1 = .0629 + .124X_2 - .0044X_3 + .0036X_4$	(.099) (.0020) (.0018)	$R = .233$
1951		
$X_1 = -.0079 + .020X_2 + .0051X_3 + .0010X_4$	(.103) (.0026) (.0020)	$R = .437$
1953[a]		
$X_1 = -.0289 - .107X_2 + .0061X_3 + .0022X_4$	(.134) (.0041) (.0033)	$R = .364$
1954[b]		
$X_1 = -.00084 - .090X_2 + .0048X_3 - .0026X_4$	(.057) (.0025) (.0020)	$R = .223$
1955		
$X_1 = .0125 - .062X_2 + .0031X_3 + .0023X_4$	(.085) (.0028) (.0030)	$R = .331$
1956		
$X_1 = -.0118 + .072X_2 - .0041X_3 + .0103X_4$	(.084) (.0029) (.0028)	$R = .481$
1957		
$X_1 = -.0309 - .149X_2 + .0039X_3 + .0024X_4$	(.120) (.0035) (.0030)	$R = .343$

NOTE: 1952 data not available.
[a] 1951 substituted for $t - 1$; 1950 substituted for $t - 2$.
[b] 1951 substituted for $t - 2$.

SOURCE: Tables A-36 to A-59 and *Statistics of Income*.

that: (1) under monopoly proper or oligopoly there will be less capital, given demand and cost conditions, than there would be under competition; and (2) under most cartel systems there will be more capital per unit of output than under competition. But even if these conclusions are accepted, they do not settle the question of the effect of monopoly on investment. It would be quite possible for a monopoly to have 10 per cent less capital than a competitive industry would have, at each point in time, but clearly the percentage increase in capital (or investment relative to initial capital stock) would be identical in the two situations.

The long-term regressions of investment rates on profit rates and changes in receipts are given in Table 25. In the earlier period there is a considerable difference within both sets of regression coefficients, but

TABLE 25

REGRESSION OF RELATIVE CHANGE IN CAPITAL ON RELATIVE CHANGE IN RECEIPTS AND PROFIT RATE, BY INDUSTRY STRUCTURE, TWO PERIODS, 1938–56

X_1 = percentage increase in total capital
X_2 = percentage increase of corporate receipts
X_3 = average rate of return

Industry Structure	Number of Industries	Regression Coefficient of X_1 on:		Coefficient of Multiple Correlation
		X_2	X_3	
1938–47				
Unconcentrated	37	.313 (.105)	.41 (6.32)	.467
Ambiguous	34	.685 (.052)	12.14 (3.89)	.924
Concentrated	11	.294 (.125)	4.52 (5.77)	.651
1947–56				
Unconcentrated	54	.894 (.042)	2.89 (1.26)	.952
Ambiguous	30	.903 (.103)	−2.15 (2.83)	.905
Concentrated	14	.851 (.122)	8.62 (2.46)	.946

SOURCE: Tables A-14 to A-59; and C-1 and C-2.

there are no significant differences between the concentrated and unconcentrated industries. The impact of the war on that period, however, is such that its results are much less relevant than those of the later period. In the later period the relationships not only fit the data better, in the sense of higher coefficients of multiple correlation, but the parameters for the concentrated and unconcentrated industries seem much more stable.

In the later period, there appears to be one significant difference between the concentrated and unconcentrated industries. The unconcentrated industries' investment rates are considerably less responsive to changes in profit rates than the concentrated industries' rates are; the responsiveness to changes in receipts does not differ between the two classes. The lesser dependence, ex post, of investment on rates of return in unconcentrated industries may be due to the fact that investment adjusts more quickly to changes in demand under competition. This pattern may indeed be viewed as another aspect of the finding (in Chapter 3) that the industrial pattern of profit rates is more stable in concentrated than in

unconcentrated industries; given that fact, the differences in long-run average rates of return in unconcentrated industries will be much smaller and their observed effect on long-run investment rates also smaller.

A closely related question is whether the number of firms in an industry exerts an independent influence on investment. The hypothesis runs as follows: the more numerous the firms in an industry, the greater the dispersion of their rates of operation relative to "capacity." Therefore, even if the industry on average is at (say) 80 per cent of capacity, a given increase in demand will lead those firms at higher rates of operation to expand investment to handle their share of the increase in demand. This is presumably a short-run phenomenon—indeed the very notion of capacity of a firm loses any meaning in the long run.

A rigorous testing of this argument cannot be made with our data. Only if firms are making the same products in the same geographical market does the conclusion follow, and we cannot isolate these complicating influences. A rough test was made by comparing the residuals from our regression equations (Table 20) relating relative investment to profit rates and relative changes in receipts, for the years 1949 and 1950, with the number of corporate tax returns in each industry. No relationship was found.[25]

IDLE CAPACITY

A permanent increase in demand for an industry's product will lead to increased investment if the industry has previously been in long-run equilibrium. For the "capacity"—meaning by this elusive term the rate of investment fully appropriate to the previous rate of output—must be enlarged: more intensive working of the existing plants will almost always be more expensive than making a suitable expansion of investment.

Our regression equations relating investment to percentage change in receipts are, in effect, estimates of this relationship for industries whose outputs are growing. But for industries whose demands are declining, the relationship will often be much looser. It may require more time to withdraw capital than expectations and events have allowed, and the question arises: do industries that have experienced more or less persistent declines in output display a different investment behavior?

In order to answer this question we have segregated those industries whose receipts in a given year were smaller than they were two or three years earlier. In 1950, for example, there were twenty-eight such

[25] The correlation coefficients between residuals and number of returns for 98 industries are −.091 for 1949 and .100 for 1950.

industries, and the declines from the previous peak receipts[26] are compared with the residuals from the regression equation relating 1950 investment to 1950 profit rates and to 1950 changes in receipts. This analysis is possible for four postwar years, and yields the correlation coefficients shown below.

Year	*Rank Correlation: Residuals and Idle Capacity*	*N*
1949	—.343	17
1950	—.297	28
1951	—.829	6
1954	—.026	29

None of these correlations is impressive, but their consistency suggests that delayed withdrawal of capital has been present in even the fairly broad industrial categories with which we had to deal. Apparently our

TABLE 26

TECHNICAL PROGRESS, INVESTMENT, AND RATE OF RETURN, 1947–54

Industry	Percentage Increase in Output per Unit of Input[a]	Average Rate of Return	Percentage Increase in Assets (book value)
Electric machinery and equipment	28.1	8.50	72.29
Fabricated metal products	28.0	8.68	62.14
Chemicals and allied products	22.5	8.92	65.64
Basic lumber	27.0	9.09	46.86
Petroleum and coal products	16.1	8.01	91.34
Textile mill products	14.4	7.13	27.83
Machinery, except transportation and electric	13.6	8.26	67.44
Stone, clay, and glass products	12.5	9.05	87.35
Food and kindred products	11.4	6.72	34.01
Rubber products	10.7	6.24	54.69
Furniture and finished lumber	8.8	7.23	54.70
Paper and allied products	8.5	9.93	81.10
Printing and publishing	7.7	7.51	45.34
Apparel and fabric products	6.9	4.51	19.49
Beverages	4.5	7.48	45.08
Tobacco products	3.5	6.46	35.84
Primary metal products	2.7	7.59	66.45
Leather products	0.1	5.52	4.40

[a] 1948–53.

SOURCE: Based on data from John W. Kendrick, *Productivity Trends in the United States*, Princeton for National Bureau of Economic Research, 1961, Appendix D, Table D-IV, pp. 468–475; and Tables A-36 to A-59, below.

[26] The decline in receipts is log receipts$_{49}$ − log receipts$_{48}$ or log receipts$_{49}$ − log receipts$_{47}$, whichever is numerically larger.

regressions would be somewhat improved by introducing a lagged as well as a current relative change in receipts.

OTHER INFLUENCES ON INVESTMENT

Some of the most widely discussed influences on investment are already implicitly recognized in our analysis.[27] Shifts in consumer demand, for example, are already reflected in our receipts measure.

One economic influence on investment, which lurks behind our summary variables, is technical progress—the reductions in real costs, or improvements in quality or kind of goods. This influence is of the highest interest to contemporary economists, and certain comparisons of Kendrick's measures—unfortunately available only at a fairly broad level—with investments and rates of return are given in Table 26. There are moderately strong relationships of this measure of progress with investment and rates of return.[28] The former of these results is wholly in keeping with expectations—large reductions in cost and price will induce large sales and investment. The relationship between this measure of progress and rates of return is equally strong, and rather less expected. The inference may be that the adjustment of investment has not kept pace with the technical progress in these industries, or that the write-off of research expenditures leads to an appreciable understatement of capital.

[27] The influence of wage rates is discussed in the next chapter.
[28] The respective rank correlation coefficients are +.46 and +.57.