Investment cyclicality in manufacturing industries

Industrial investment tracks the business cycle, in general; but, when you get down to particulars, the picture is more complicated and, for analysts, more meaningful

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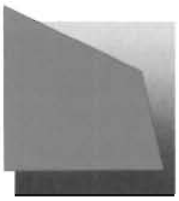

It is well known that investment fluctuates proportionately by much more than total output. The evidence on this is quite dramatic. Consider for example the ratio of net investment to GNP over the period 1946 to 1985. The lowest values of this ratio all occurred during recession years; while the mean of the ratio was 5.6 percent, the ratio was 2.9 percent in 1982, 3.3 percent in 1975, 3.7 percent in 1983, and 4.0 percent in 1976. In contrast, the ratio tends to be high in boom periods.[1]

In addition, investment closely tracks the business cycle. This procyclicality of investment is extremely important in accounting for the "shortfall" of GNP during downturns in the economy. Robert Barro's calculation of the difference between actual GNP and a smoothly growing "potential" GNP series over the period 1946 to 1985 shows that if all categories of investment are added together, fluctuations in investment account for 88 percent of the GNP shortfall during recessions. Barro concludes that "as a first approximation, explaining recessions amounts to explaining the sharp contractions in the investment components."[2]

There are many competing views explaining why investment is so procyclical. Among the most widely known hypotheses are the accelerator model; the neoclassical investment model, emphasizing the cost of capital and stock adjustments; and the cash flow model under conditions of imperfect capital markets. To date, there is no widespread agreement on which view of investment is most consistent with the facts concerning the cyclicality of investment.

In this article, we do not directly test any of the competing theories of investment. Rather, we explore the cyclicality of fixed investment at the industry level within the manufacturing sector. Very little attention has been given to examining investment at this level. The lack of information about industry behavior is probably due to the fact that investment studies employing firm data typically do not have enough data points to produce estimates of cyclicality across a wide range of industries.

There are some very basic questions concerning industry investment behavior that must be addressed. Do all broadly defined industries exhibit roughly the same degree of investment cyclicality over the business cycle? If not, is there some obvious pattern in the data that permits a useful organization of industries according to their degree of cyclicality? There is no obvious pattern in cyclicality predicted by investment models that focus only on the cost of capital. On the other hand, if industries do exhibit different investment patterns over the business cycle, then theories emphasizing either firm- or industry-specific determinants of investment may be required.

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To investigate industry cyclicality, we use a panel of 270 industries at the four-digit Standard Industrial Classification (SIC) level for the time period 1958 to 1986. For most of the issues explored in this study, we aggregate this panel to the two-digit SIC level of disaggregation. We find that most of the 20 two-digit industries do exhibit procyclical investment behavior over the period of our study. There are, however, marked differences across these industries both with respect to investment volatility and to investment cyclicality. Industries such as food products exhibit little or no investment cyclicality. Our main finding is that industries producing non-durable goods exhibit less cyclicality in investment than industries producing durable goods. Very often the difference is quite striking.

The remainder of the article proceeds as follows: The next section briefly reviews alternative views of investment cyclicality and some of the existing evidence. The following section describes the panel database employed in the study and the method used to construct "smoothed" industry investment series. Finally, we report our results on both the volatility and cyclicality of industry investment.

Theories of investment cyclicality

There are a number of investment theories that predict that investment should be a volatile component of GNP. Space permits only a cursory overview of three of the leading contenders; we describe here the predictions of the accelerator model, the neoclassical model, and the cash flow model.[3]

The accelerator model hypothesizes that the level of net investment depends on the change in expected demand for business output. According to this theory, a business's desired stock of capital varies directly with its level of output. Thus, when there is an "acceleration" in the economy and expected output increases, net investment is positive. The opposite occurs when there is a deceleration and net investment can actually become negative. Depending on the size of the capital–output ratio, investment can be several times more volatile and procyclical than output.

Neoclassical models have a theoretical advantage over the simple accelerator model in that they include the cost of capital as one of the determinants of the desired stock of capital and thus the level of investment. Some economists explain the volatility of investment through the cost-of-capital channel.[4] Their argument is essentially that when the real rate of interest changes, all firms experience a change in their desired stock of capital. Given that any year's investment amounts to a small portion of the total capital stock, even a relatively small percentage change in the desired stock of capital can result in large percentage changes in net investment. Shocks to the real interest rate can cause firm investment to be very volatile and industry investment to be procyclical.

The cash flow model also has a long tradition in the investment literature. In a world of perfect capital markets, sources of finance are irrelevant for the investment decision. However, when there are imperfections in capital markets, then internal finance generally has a cost advantage over external finance. When this is true, then sources of finance do matter. In particular, the quantity of internal finance, or cash flow, should be positively associated with the level of investment. Since firm profits and cash flows are very procyclical, the cash flow model of investment also predicts that investment will be procyclical. Furthermore, it predicts that investment will be more procyclical for industries which experience the most procyclicality in profits.

Evidence on the cyclicality of investment

There is no widespread agreement on which of these theories is most consistent with the facts concerning the cyclicality of investment. Over the last three decades, a large number of empirical studies have been undertaken, many of them with firm data. An excellent review of the literature before 1970 can be found in Kuh (1971). A review of some of the more recent literature can be found in Fazzari, Hubbard, and Petersen (1988).

Many of the earlier empirical studies such as Kuh (1971), Meyer and Kuh (1957), and Meyer and Glauber (1964) focused on accelerator and cash flow models of investment, typically finding some support for both explanations. In the last two decades, however, empirical research has shifted toward neoclassical models of investment. The impetus for this shift in direction came from the influential work of Modigliani and Miller (1958) who demonstrated that under certain conditions,

real investment decisions can be separated from purely financial factors; that is, that financial factors such as cash flow may be irrelevant to investment decisions. Whether this separation of real investment from financial considerations exists in practice is still being debated.[5]

A review of the empirical literature on the determinants of investment reveals that almost no studies systematically consider investment behavior at the industry level. Studies typically use either aggregate investment series for the whole economy or a sector of the economy or they use firm data. Firm data has many advantages over aggregate data for examining economic behavior. However, most studies that employ firm data do not have enough data points to permit estimates of differences in investment behavior across industries. This is probably the explanation for the paucity of studies that compare the investment behavior of a large number of industries for a substantial time period.

There are, however, some potentially interesting facts that can be learned by examining investment behavior at the industry level. It is well known that industries, even within manufacturing, do not respond alike to the business cycle. For example, some industries, such as those engaged in the processing of food, experience very little variation in demand for their output over the cycle. On the other hand, industries that produce durable goods experience considerable variation in demand and cash flow.

This raises an interesting test of models of business investment. Models which emphasize only the cost of capital do not predict systematic differences in investment cyclicality across industries. However, both the cash flow and the accelerator models clearly do. In the following sections of this article, we seek to set out some of the facts about differences in investment behavior at the industry level.

The data

The primary data sources utilized in this study are the *Census of Manufactures* and the *Annual Survey of Manufactures* (U.S. Bureau of the Census). There are several reasons why these data sources are the best available for examining the cyclicality of investment at the industry level. First, the Census reports investment data at the four-digit level, which is very disaggregated. Second, Census data assign individual plants, rather than whole companies, to their primary SIC industry. Since plants are typically much more specialized than companies, the problem of contamination is negligible. Finally, the data for most Census industries are available back to at least 1958, allowing for a panel of substantial length.

The *Census of Manufactures* currently contains approximately 455 four-digit industries, of which 270 are included in our panel. Since, it is either impossible or inconvenient to work with the entire population of Census industries, we excluded industries for any of three reasons. First, because we wished to examine a balanced panel of industries covering as many business cycles as possible, we excluded all industries for which the *Census of Manufactures* began gathering data later than 1958. Second, we excluded a number of industries having large gaps in the data. Finally, we excluded industries with inconsistencies in the industry classification or definition over time.[6]

Table 1 provides a summary of the breakdown of our sample of Census industries across the 20 two-digit manufacturing industries. The first column lists the identity of the 20 industries that make up the *Census of Manufactures*. The second column lists the total number of four-digit industries which made up each of the two-digit Census industries in 1986. The third column reports the breakdown of our sample of industries across the two-digit industries. The fourth column indicates the percentage of four-digit industries contained in our database. The fifth and sixth columns state what the average real investment (1982 dollars) was for each two-digit industry both for the Census population and our sample of four-digit industries.[7] The final column indicates the percentage of real investment accounted for by our set of industries.

It can be easily ascertained from Table 1 that our sample contains some 59.3 percent of the total number of four-digit industries currently contained in the Census. This percentage varies across two-digit industries, the low being 25.3 percent in SIC 24. Our coverage of total manufacturing investment is considerably higher; over the 1958–1986 period, our sample includes 77.1 percent of all investment.

TABLE 1

FRB data base analysis: 1958 to 1986 real investment

	Total number of four digit industries in 1986	Number of four-didget industries in FRB data base	Percent of total	1958-1986 average investment	FRB data base, 1958-1986 average investment	Percent of total
Total manufacturing	455	270	59.3	57,453.6	44,322.1	77.1
SIC 20 - Food and kindred products	47	38	80.9	5,124.1	4,463.2	87.1
SIC 21 - Tobacco products	4	4	100.0	314.9	314.9	100.0
SIC 22 - Textile mill products	30	19	63.3	1,726.6	1,375.3	79.7
SIC 23 - Apparel and related products	33	15	45.5	602.8	305.0	50.6
SIC 24 - Lumber and wood products	17	4	23.5	1,618.5	984.7	60.8
SIC 25 - Furniture and fixtures	13	7	53.8	521.1	258.1	49.5
SIC 26 - Paper and allied products	17	11	64.7	3,938.3	3,602.9	91.5
SIC 27 - Printing and publishing	17	8	47.1	2,363.2	1,348.8	57.1
SIC 28 - Chemicals and allied products	33	16	48.5	7,625.1	4,585.7	60.1
SIC 29 - Petroleum and coal products	6	5	83.3	2,994.3	2,994.3	100.0
SIC 30 - Rubber & plastic products	6	4	66.7	1,992.1	1,705.4	85.6
SIC 31 - Leather and leather products	11	3	27.3	142.7	47.4	33.2
SIC 32 - Stone, clay and glass products	27	23	85.2	2,389.5	2,281.8	95.5
SIC 33 - Primary metal industries	26	18	69.2	5,736.6	5,097.7	88.9
SIC 34 - Fabricated metal products	36	19	52.8	3,076.3	1,970.2	64.0
SIC 35 - Machinery, except electrical	44	29	65.9	5,287.8	4,187.1	79.2
SIC 36 - Electrical machinery	37	25	67.6	4,522.3	2,848.8	63.0
SIC 37 - Transportation equipment	18	8	44.4	5,607.5	4,919.5	87.7
SIC 38 - Instruments & related products	13	7	53.8	1,256.5	895.2	71.2
SIC 39 - Miscellaneous manufacturing	20	7	35.0	613.4	136.1	22.2

Again, this percentage varies somewhat across the two-digit categories.

Constructing the smoothed investment series

To examine investment cyclicality, we are going to compare in the next section each industry's actual investment series to a "smoothed" investment series, where the smoothed investment series is the average of recent investment levels. The logic of our approach is quite straightforward. If an industry's actual investment tends to be above its smoothed investment series in boom times and below during economic contractions then actual investment is clearly procyclical. The degree of cyclicality is measured by the extent to which actual investment deviates from "smoothed" investment during economic expansions and contractions.

For comparison, we indexed the actual (deflated) investment for all two-digit industries, setting the value in 1958 at 100. To construct the smoothed investment series, we chose the simplest possible technique that would accomplish our objective. The method used, known as a "centered moving average smoothing" procedure, is given in the equation below:

$$1) \qquad \tilde{I}_t = \frac{1}{n} \sum_{i=t-\frac{(n-1)}{2}}^{t+\frac{(n-1)}{2}} I_i$$

where I_t is actual indexed investment in year t; $\tilde{I}_t$ is the smoothed value of indexed investment in year t; and n is the number of years over which investment is averaged.[8] We experimented with alternative values for n, settling on a value of nine as a compromise for achieving the twin goals of producing a smoothed investment series which also responds reasonably quickly to changes in the growth rate or trend in industry investment.[9]

Graphs of the actual and smoothed investment series appear below for all manufacturing and selected two-digit industries. Figure 1 plots the investment series for all manufacturing over the time period 1958–1986. The actual investment series is indicated by the black line while the smoothed series is indicated by the color line. Figures 2–5 report the same information for selected two-digit industries.

Figures 2–5 all have the same vertical scale to facilitate cross-industry comparisons. The industries are as follows: food and kindred products (SIC 20); chemicals and allied products (SIC 28); industrial machinery and equipment (SIC 35); and transportation equipment (SIC 37). These industries have a large share of total investment in manufacturing, and as will become apparent, they illustrate different types of industry investment behavior.[10]

An inspection of Figures 1–5 below indicates that the procedure outlined in Equation (1) appears to do a satisfactory job of creating a smoothed investment series for each industry. To see this, compare the actual investment series for each industry with its smoothed investment series. The smoothed investment series picks up the trend in each industry's investment series without being unduly affected by the fluctuations in the actual investment series around its trend.

In Figures 1–5, the differences between the actual investment series (black line) and the smoothed investment series (color line) illustrate the cyclical behavior of industrial investment. In Figure 1, for total manufacturing, the peaks and valleys in investment over the business cycles between 1958 and 1986 are quite evident. In addition, an inspection of Figures 2–5 indicates that there is a wide range of cyclical investment behavior for SIC 20, 28, 35, and 37.

TABLE 2

Coefficient of variation of the investment ratio

	Coefficient of variation
Total manufacturing	**9.9**
SIC 20 - Food and kindred products	4.8
SIC 21 - Tobacco products	22.2
SIC 22 - Textile mill products	14.2
SIC 23 - Apparel and related products	11.7
SIC 24 - Lumber and wood products	18.0
SIC 25 - Furniture and fixtures	15.7
SIC 26 - Paper and allied products	13.3
SIC 27 - Printing and publishing	11.3
SIC 28 - Chemicals and allied products	12.9
SIC 29 - Petroleum and coal products	22.5
SIC 30 - Rubber and plastic products	18.0
SIC 31 - Leather and leather products	22.2
SIC 32 - Stone, clay and glass products	14.7
SIC 33 - Primary metal industries	18.1
SIC 34 - Fabricated metal products	11.8
SIC 35 - Machinery, except electrical	13.6
SIC 36 - Electrical machinery	12.3
SIC 37 - Transportation equipment	23.2
SIC 38 - Instruments and related products	16.2
SIC 39 - Miscellaneous manufacturing	12.5

Volatility of industry investment

Before turning to the statistical results on the cyclicality of industry investment, it is of interest to report the differences in the volatility of industry investment. It is quite apparent from Figures 2–5 that some industries exhibit more volatile investment than others. To quantify this, we form the ratio of actual to smoothed investment ($I_t / \tilde{I}_t$) for each year for each industry and compute the coefficient of variation, reported in Table 2.[11]

Judging by the size of the coefficients, the industry with the most volatile investment series is the transportation industry (SIC 37), closely followed by the petroleum (SIC 29) and tobacco (SIC 21) industries. At the other end of the scale, the food industry (SIC 20) has a coefficient of variation about five times smaller than that of the transportation industry. When volatility is measured by

FIGURE 1

Indexed real investment
(Total manufacturing)

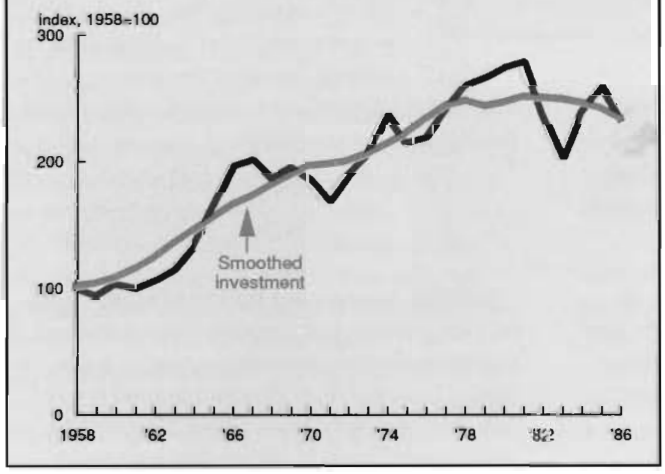


FIGURE 2

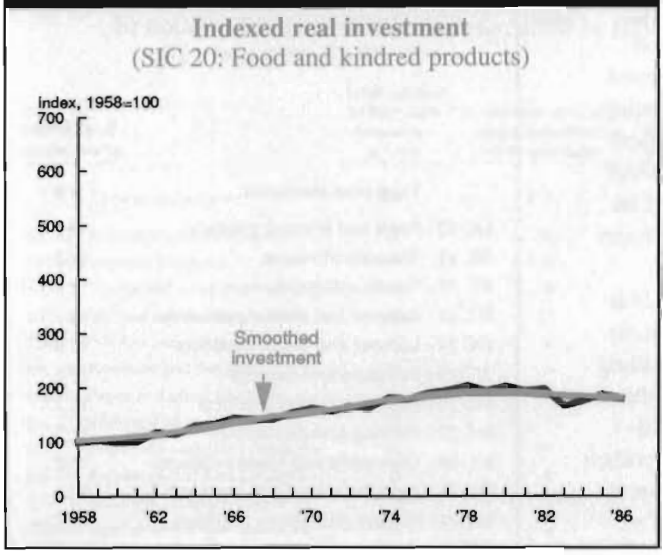
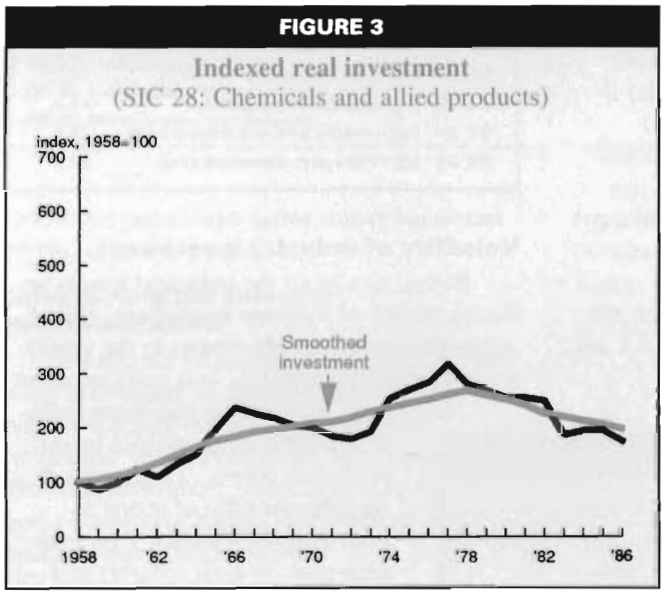


FIGURE 3



output or sales, it is well known that transportation is one of the most volatile industries and that food is one of the least volatile industries. It is apparent from Table 2 that this is also true with respect to their investment.

But, high volatility is not necessarily linked to high cyclicality, as we shall see in the next section. While the two conditions are linked in the case of the transportation industry, they definitely are not in the petroleum and tobacco industries.

The cyclicality of industry investment

We turn now to the descriptive statistics on the cyclicality of industry investment. We fit the following relationship to each industry's investment series:

$$2) \qquad \frac{I_t}{\tilde{I}_t} = a + b A_{t-1} + \epsilon_t$$

where I_t is actual investment in year t; $\tilde{I}_t$ is the smoothed investment series discussed above; A is a measure of the state of the aggregate economy; and ϵ is the error term. The measure of aggregate economic activity is lagged by one period because the peaks and troughs of the aggregate investment cycle typically lag slightly the peaks and troughs of aggregate GNP.[12]

We considered three alternative measures of A. One measure was the ratio of actual to potential GNP as measured by the Federal Reserve Board.[13] A second measure was the ratio of current capacity utilization in manufacturing to average capacity utilization. The final measure was the ratio of the actual rate of unemployment to the natural rate of unemployment. All three measures have potential shortcomings. Fortunately, the results were qualitatively the same for all three measures. Therefore we report results for only the first measure and briefly summarize the results for the other two measures; that is, for each industry, we report results for the following regression:

$$2A) \qquad \frac{I_t}{\tilde{I}_t} = a + b\frac{GNP_{t-1}}{POTGNP_{t-1}} + \epsilon_t$$

Table 3 shows our findings for the manufacturing sector and its component two-digit industries for the regression given in Equation (2A). To economize on space, we do not report the intercept terms, which were statistically insignificant in all but one regression. For each industry, we report three statistics:

the slope coefficient for the state of the economy variable, the standard error of the variable, and the adjusted r-square of the regression.

We start with the obvious. For the manufacturing sector as a whole, the estimated coefficient is positive and significant at a very high confidence level. In other words, investment in manufacturing is procyclical. This is not a very surprising result; we would be hard pressed to explain a different finding. What is more interesting is that our regression results indicate that investment in manufacturing is more cyclical than aggregate GNP: our estimated coefficient of 2.23 implies that investment is approximately 2 percent above trend following a period when GNP is 1 percent above potential GNP. In addition, it is interesting to note that our single regressor is explaining a considerable fraction (40 percent) of the variation of actual investment around trend investment.

We turn now to the two-digit industry results. A cursory look at the results indicates a considerable range of point estimates across the 20 industries. The smallest coefficient, −1.36, is for SIC 21 (tobacco products), while the second smallest is for SIC 20 (food products). At the other end of the scale, SIC 37 (transportation) has an estimated coefficient of 3.79, while the next largest coefficient is for SIC 33 (primary metals). For all but SIC 21 (tobacco) the point estimate for the slope coefficient is positive. Of these nineteen industries, all but three (SIC 20, SIC 29, and SIC 39) have estimated slope coefficients of greater than one.

We believe the most interesting finding of our research is the clean separation into two groups, with respect to cyclical investment behavior, of the 20 two-digit industries. The group consisting of SIC 20 through SIC 31 as well as SIC 39 (miscellaneous manufacturing) exhibits slope coefficients of less than the overall manufacturing average of 2.23. The other group, SIC 32 through SIC 38, exhibits slope coefficients greater than the manufacturing average; that is, they exhibit more procyclical investment than average.

The first group, SIC 20 through SIC 31, can be characterized approximately as the nondurable-goods sector of manufacturing. With one exception, every one of these industries has an estimated slope coefficient of less than the all-manufacturing coefficient of 2.23. For seven of these industries, the estimated standard error is large enough that one cannot

FIGURE 4

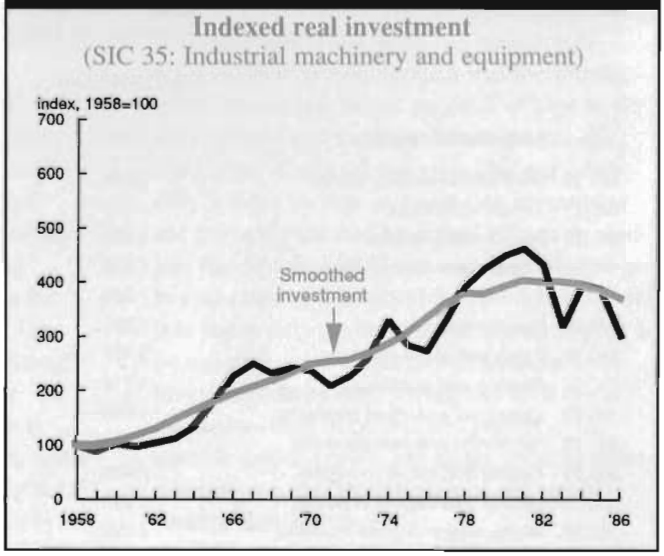


FIGURE 5

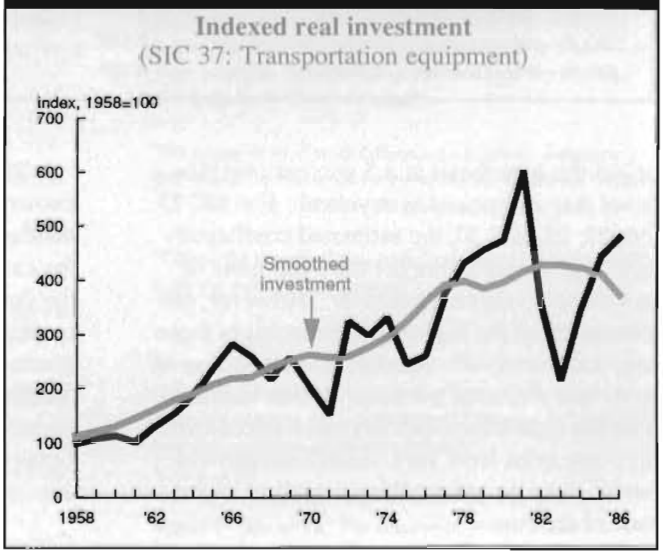


TABLE 3

Regression results: Investment ratio versus GNP ratio

	Slope coefficient	Standard error	R - Square (adjusted)
Total Manufacturing	**2.227**	**0.502**	**0.400**
SIC 20 - Food and kindred products	0.609	0.296	0.104
SIC 21 - Tobacco products	-1.361	1.450	-0.004
SIC 22 - Textile mill products	1.530	0.889	0.066
SIC 23 - Apparel and related products	1.825	0.687	0.178
SIC 24 - Lumber and wood products	1.928	1.138	0.063
SIC 25 - Furniture and fixtures	1.296	1.014	0.022
SIC 26 - Paper and allied products	2.129	0.786	0.185
SIC 27 - Printing and publishing	1.710	0.683	0.158
SIC 28 - Chemicals and allied products	1.903	0.769	0.155
SIC 29 - Petroleum and coal products	0.976	1.478	-0.021
SIC 30 - Rubber and plastic products	2.320	1.105	0.108
SIC 31 - Leather and leather products	1.228	1.448	-0.010
SIC 32 - Stone, clay and glass products	2.299	0.880	0.172
SIC 33 - Primary metal industries	3.368	1.008	0.266
SIC 34 - Fabricated metal products	2.389	0.635	0.320
SIC 35 - Machinery, except electrical	3.022	0.686	0.396
SIC 36 - Electrical machinery	2.248	0.691	0.255
SIC 37 - Transportation equipment	3.789	1.360	0.195
SIC 38 - Instruments and related products	2.528	0.959	0.175
SIC 39 - Miscellaneous manufacturing	0.760	0.813	-0.005

reject the hypothesis at a 5 percent confidence level that investment is acyclical. For SIC 23, 26, 27, 28, and 30, the estimated coefficients *are* large enough to reject the hypothesis of acyclical investment behavior. However, one cannot conclude that their investment is more cyclical than GNP. Finally, it is interesting to note that while the previous section indicated that the petroleum (SIC 29) and tobacco (SIC 21) industries have very volatile investment series, they do not exhibit procyclical investment behavior.

The other group, SIC 32 through SIC 38, consists of all durable-goods industries. All of these industries have slope coefficients greater than the manufacturing average, most noticeably for transportation (SIC 37), primary metals (SIC 33), and nonelectrical machinery (SIC 35). These three industries, along with fabricated metal products (SIC 34), have large enough coefficients relative to their standard errors such that one can reject the hypothesis that their slope coefficient is less than one. The transportation industry is particularly noteworthy, given the volatility of its investment series combined with its very high slope coefficient.

The durable-goods sector has long been known to have more cyclical output than the nondurable-goods sector. It also appears to be the case that investment across virtually all of the durable-goods two-digit industries is more cyclical than investment in the nondurable-goods industries. This pattern of results was confirmed for all measures of aggregate economic activity that were used as regressors in Equation 2, including capacity utilization and unemployment.

Conclusion

Studies of investment typically use either aggregate investment numbers or firm level data. We believe, however, that useful knowledge can be obtained by examining the investment behavior at the industry level. Using a panel database of 270 four-digit industries over the period 1958–1986, we have examined the volatility and cyclicality of investment for all 20 of the two-digit *Census of Manufactures* industries.

We find that there is a great deal of heterogeneity across these industries. Some industries, such as transportation, petroleum, and tobacco, exhibit considerable investment

volatility. We show, however, that industries which have the most volatile investment series do not necessarily exhibit the most cyclical investment series.

The major question that our article sought to answer is: Are there important differences in the cyclicality of investment across manufacturing industries? Our findings indicate that there are. With one exception, industries in SIC 20 through SIC 31 have estimated measures of cyclicality that are less than the manufacturing average for our sample. The remaining group of industries, SIC 32 through SIC 38, which consists of durable-goods manufacturers, appears to be more cyclical than the manufacturing average. The transportation industry leads the way followed by the primary metals and nonelectrical machinery.

While it has long been known that the durable-goods sector has larger cyclical swings in output and profits than the nondurable-goods sector, it also appears that the durable-goods sector has larger cyclical swings in the accumulation of capital. Thus, our results shed some doubt on the view that our economy's large swings in aggregate investment are primarily caused by firms' efforts to readjust their capital stocks in response to changes in real rates of interest. Models of investment that focus only on the cost of capital appear to be missing some important determinants of investment behavior. Given the well documented swings in output and profits in the durable-goods sector, the likely missing determinants are accelerator effects and internal finance considerations.

FOOTNOTES

[1]These values are taken from Barro (1987, p. 226), which contains a more detailed discussion of the facts concerning the cyclicality of aggregate investment.

[2]See Barro (1987, p. 229).

[3]For a more detailed discussion of these models of investment, see Gordon (1984) or Kopcke (1985).

[4]See for example Barro (1987, p. 247).

[5]Recent papers which present evidence supporting the view that fluctuations in cash flow are an important source of fluctuation in investment include Fazzari, Hubbard, and Petersen (1988), Hoshi, Kashap, and Scharfstein (1989), and Kopcke (1985).

[6]It is well known that the Census periodically changes the definitions of some industries, often by merging portions of one industry with pieces of another. This provides the biggest challenge to utilizing the *Census of Manufactures*. Since we did not want our findings to be biased by changes in reported investment arising from industry reclassification, we thought it necessary to exclude all industries that underwent a significant reclassification. More details on the construction of the panel can be found in Domowitz, Hubbard, and Petersen (1986).

[7]The current dollar investment by two-digit SIC code industries were adjusted for inflation by dividing each of the series by the producer price index for capital goods.

[8]The centered moving average approach that we utilized averages the data for the previous four years, the data for the current year and the data for the next four years. Of course, for the years near our endpoints, fewer years of data were available for computing this average. See Pindyke and Rubinfeld (1981) for details.

[9]We experimented with different n values for Equation 1 and found that the results reported in the article are robust to a wide range of different values for n.

[10]Charts for the remaining two-digit industries are available from the authors upon request.

[11]The coefficient of variation is the ratio of the standard deviation to its mean. The standard deviation is an absolute measure of dispersion measured in units of the original data. By contrast, the coefficient of variation is dimensionless and measures relative dispersion.

[12]We also considered contemporaneous A as well as A lagged by two years. The regression results for total manufacturing, based on a considerably higher adjusted r-square, prefers A lagged by one period over contemporaneous A. At the two-digit industry level the results of contemporaneous versus one-year lag were roughly the same. However, for A with a two-year lag, there is no statistically significant relationship between investment and the two-year lagged state of the economy.

[13]Potential GNP is from estimates made by staff members of the Board of Governors. For the methodology underlying these estimates see Clark (1982).

REFERENCES

Barro, Robert J., *Macroeconomics*, New York: John Wiley & Sons, 1987.

Clark, Peter K., "Okun's Law and Potential GNP," *Board of Governors of the Federal Reserve System*, October 1982.

Domowitz, Ian, R. Glenn Hubbard, and Bruce C. Petersen, "Business Cycles and the Relationship Between Concentration and Price-Cost Margins," *Rand Journal of Economics*, Vol. 17, No. 1, Spring 1986, pp. 1-17.

Fazzari, Steven M., R. Glenn Hubbard, and Bruce C. Petersen, "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity*, Vol. 1, 1988, pp. 141-195.

Gordon, Robert J., *Macroeconomics*, Boston: Little, Brown and Company, 1984.

Hoshi, Takeo, Anil Kashap, and David Scharfstein, "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Panel Data," *Federal Reserve Board Working Paper*, June 1988.

Kopcke, Richard W., "The Determinants of Investment Spending," Federal Reserve Bank of Boston, *New England Economic Review*, July/August 1985, pp. 19-35.

Kuh, Edwin, *Capital Stock Growth: A Micro-Econometric Approach*, London: North-Holland Publishing Company, 1971.

Meyer, John R., and Robert R. Glauber, *Investment Decisions, Economic Forecasting, and Public Policy*, Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1964.

Meyer, John R., and Edwin Kuh, *The Investment Decision: An Empirical Study*, Boston: Harvard University Press, 1957.

Modigliani, Franco, and Merton H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review*, Vol 48 June 1958, pp. 261-297.

Pindyke, Robert S., and Daniel L. Rubinfeld, *Econometric Models and Economic Forecasts*, New York: McGraw-Hill Book Company, 1981.

U.S. Department of Commerce, *Census of Manufactures*, selected issues.

_____, *Annual Survey of Manufactures*, selected issues.