Sources of Sectoral Fluctuations in Business 
Fixed Investment

Paul R. Blackley

A model of macroeconomic complementarity is used to assess causes of comovement in investment spending across nine sectors of the U.S. economy. It is hypothesized that the irreversibility and uncertainty of investment spending imply a greater role for investment linkages and aggregate factors in investment fluctuations compared with estimates for employment and output. For the average sector, past investment growth across all sectors, changes in aggregate demand, and a common factor account for two-thirds of the variance of investment growth. After accounting for aggregate demand, sectoral shocks explain 70% of the average sector’s innovations to investment growth. © 2000 Elsevier Science Inc.

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I. Introduction

Changes in the rate of investment are a major component of the fluctuations in aggregate spending that characterize U.S. business cycles. As in the case of comovement among sectoral output growth rates in Long and Plosser (1987), high correlations in investment growth rates across different sectors of the economy have been used to support an emphasis upon aggregate shocks as the main cause of fluctuations in investment spending. This emphasis underlies the assumption that countercyclical monetary and fiscal policies can offset the spending effects of shocks that are common to the entire economy and the main cause of investment volatility.

In contrast, a central feature of multisector real business cycle models [e.g., Long and Plosser (1983)] is that random shocks specific to a subset of industries can generate the same comovement across sectors previously attributed to common shocks. As summarized

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by Cooper and Haltiwanger (1990) [C-H (1990) hereafter], a sector-specific shock can be transmitted to other sectors by means of factor demand linkages due to technological complementarities in production. For example, a productivity improvement in one sector may result in a greater supply of an input to a second sector, with the latter also raising its demand for complementary inputs from other suppliers. Over time, the original shock may raise output throughout the economy, yielding a change in aggregate spending mistakenly attributed to an aggregate or common shock.

Previous work assessing comovement among sectors that comprise industrial production in the U.S. economy has demonstrated roles for both common and sectoral shocks, with some evidence of a greater effect for the sectoral type. Using monthly data (1948:2–1981:12), Long and Plosser (1987) estimated that a common shock explained 20% of the variation in output innovations for the average sector, implying a major role for the propagation of sector-specific shocks across these industries. Cooper and Haltiwanger (1996) [C-H (1996) hereafter] estimated common shock effects of a similar magnitude for output (29%), employment (23%), and prices (13%) during 1969:1 through 1992:3.

C-H (1990) assessed employment comovements among industries classified at the one-digit level for 1947:1 through 1985:12. Unlike the results for the industrial production sectors, they found that innovations to employment were not highly correlated across these sectors and an average of only 15% of the variation in a sector’s innovations was explained by a common factor. These results supported a model of employment comovement within an economy that is imperfectly competitive and subject to underemployment equilibria. In this case, an adverse sector-specific shock leads to reduced demands for final goods and services on the part of the affected sector’s employees, causing employment reductions in other sectors that persist if firms attempt to maintain steady inventory levels. Based upon both of their analyses, C-H (1996) concluded that aggregate shocks are less relevant for comovements across broadly defined sectors of the economy. Instead, it is likely that shocks common to similar activities, such as those involving industrial production, have a more significant impact upon employment comovements in those industries.

The results for comovements in output and employment call into question the importance of common shocks in explanations of fluctuations in aggregate spending. The purpose of this paper is to measure the magnitude of sectoral comovements for innovations in investment spending and to determine the relative importance of aggregate versus sector-specific shocks as sources of the innovations. The empirical approaches of Long and Plosser (1987) and C-H (1990), 1996) are applied to new plant and equipment investments across broadly-defined sectors of the economy.

The motivating hypothesis for this analysis is that compared to changes in output and employment, changes in investment are less likely to be in response to sectoral shocks and instead are strongly influenced by aggregate shocks. Beneficial shocks to an industry’s demand or cost structure may elicit expansions in employment and output in that industry and related sectors that can be reversed at a comparatively low cost if the shock proves to

1 See Chirinko (1993) and Gordon and Veitch (1986) for a review of empirical results for models of aggregate investment spending which are consistent with the vector autoregressive models estimated in this paper. Examples include: (1) neoclassical models in which investment is a function of current and lagged changes in GDP (the flexible accelerator model) and the user cost of capital; (2) Q-Theory models in which the ratio of market value to replacement cost of capital is used to measure expectations of future output demands and capital costs; and (3) rational expectations models in which unexpected changes in variables such as the money supply and resource prices can affect spending decisions.
be transitory in duration. Conversely, given the higher incremental cost and irreversible nature of most investments, decision-makers are likely to require shifts in anticipated revenues and costs that are perceived to have multiple sources and be of considerable magnitude before increasing expenditures on new capital. Aggregate shocks may satisfy this requirement better than sectoral shocks that are more difficult to observe and quantify at time horizons typical of cyclical fluctuations in investment spending. Sectoral shocks such as changes in product demand or technology are more likely to affect longer run investment patterns and involve less comovement among all sectors of the economy.

Pindyck’s (1991) view is that investment spending includes an opportunity cost for exercising a call option on the decision to invest. Any increase in uncertainty regarding general economic conditions, such as future levels of aggregate demand or capital costs, raises this option cost of investment. Recent work by Evans et al. (1998) supports this conclusion. When there is complementarity among capital goods in monopolistically competitive markets, aggregate fluctuations in GDP growth and investment originate from shifts in expectations regarding future investment returns. Because expectations depend on forecasts of growth in aggregate sales and profits in their model, it suggests that common shocks are a major source of the fluctuations in aggregate investment that are observed as comovements among sectoral investments. Using plant-level data, Cooper et al. (1999) also found that aggregate shocks are the main cause of fluctuations in manufacturing investment in the U.S. economy.  

In some cases, persistent shocks that originate in one sector may affect many other sectors of the economy. Examples include changes in oil prices and advances in computing power. Empirically, these will be observed as aggregate or common shocks unless there are significant differences in the timing of the impacts across affected sectors. The investment effects of contemporaneous impacts are included in the measured influence of aggregate factors in the models estimated below.3

The next section presents a standard model of strategic complementarity applied to business investment. It documents the amount of comovement in investment spending among sectors and provides results for an initial assessment of the origins of fluctuations to this component of GDP. Section III extends the statistical analysis to quantify the impact of changes in aggregate demand upon sectoral investment growth rates, with the results confirming the initial conclusion that both common and sectoral shocks have important roles in business investment fluctuations in the U.S. economy. A final section summarizes the paper’s main conclusions.
II. A Model of Comovement in Business Investment

A general model of macroeconomic complementarity formulated by C-H (1996) is adapted here for assessing investment decisions under uncertainty. Assume firm i (i=1, ..., N) makes investment expenditures for the purpose of producing an output, the sale of which generates a profit as part of an overall strategy to maximize the expected value of its owners’ equity. The level of investment, $I_{it}$, varies directly with the present value of future returns, termed the expected payoff to firm i at time t, $\pi_{it}$.

Using the terminology of C-H (1996), the firm adopts a payoff function of the form:

$$\pi_{it} = f(e_{it}, E_t, E_{t-1}, \theta_{it})$$

where $e_{it}$ is a measure of the firm’s effort (e.g., an index of input quantities and utilization rates), $E$ is the aggregate performance of the economy observed for period t-1 and effort put forth in period t, and $\theta_{it}$ is the magnitude of any shock to firm i during period t. Each firm is small enough that it views $E_t$ as independent from $e_{it}$. Given the work of Evans et al. (1998) and Pindyck (1991), C-H’s assumptions that $\frac{\partial \pi}{\partial E_t} > 0$ and $\frac{\partial \pi}{\partial E_{t-1}} > 0$ are appropriate. They imply that investment is positively related to current and past increases in a variable such as aggregate output, that is, they imply contemporaneous and dynamic complementarity for investment decisions. The central issue here is an assessment of whether shocks that lead to innovations in investment spending are sector-specific or attributable to aggregate shocks to the entire economy (including any sectoral shocks with common impacts on investment in other sectors). Empirically, previous work has used a three step procedure to address this question for output [Long and Plosser (1987) and C-H (1996)] and employment [C-H (1990, 1996)]. The initial estimation process in this paper applies this approach to investment.

The first step is to estimate comovement by means of contemporaneous correlations for growth rates in investment spending across nine sectors of the economy. A lack of significant correlations for sector i implies that its pattern of investment is not consistent with fluctuations in aggregate investment. Next, innovations to investment spending are measured as the residuals, $e_{it}$, from a vector autoregressive (VAR) model in which the equation for sector i is estimated as:

$$I_{it} = \alpha_i + \sum_{j=1}^{9} \sum_{j=1}^{J} \beta_{ij} I_{i,j-1} + e_{it}$$

where $I_{it}$ corresponds to the annual growth rate in investment spending in sector i and J is the number of lags in the VAR. This assumes that lagged investment growth rates contain the information used by decision-makers before the effects of any current period shocks occur. This specification also captures any noncontemporaneous input-output investment linkages of the sort identified by Horvath (1998). If the correlations among investment innovations are significantly lower than the original correlations for spending growth, there is evidence against the influence of common shocks as an important explanation of investment comovements.

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4 C-H (1996) reviewed the various areas in which models with complementarities have been employed. For macroeconomics, the major implications are the existence of multiple equilibria and a multiplier mechanism that can generate comovements and magnify a shock’s aggregate impact over time.
The third step is a factor analysis of the residual time series because, as noted by C-H (1996), significant correlations among sectoral innovations indicate only the possible existence of a common shock. If a factor that explains a significant portion of the variation in innovations is found, a common shock, though unidentified, is likely responsible for at least a portion of the comovement. This interpretation implies that any contemporaneous correlations among sectoral shocks are small in comparison to the common shocks that initiate responses consistent with strategic complementarity. If the common factor leaves unexplained a large portion of the innovation variance, according to C-H (1996) this provides indirect evidence for the existence of complementarities such as factor demand linkages that are separate from the role of common shocks.5

Table 1 identifies the nine business sectors used in the estimation of the investment model along with a noninvestment demand variable (AD) used in section III as a possible source of aggregate shocks. The sample covers the nonagricultural private economy and consists of annual data for 1947 through 1996.6 All variables are expressed as first differences of natural logs.7 The means and standard deviations in Table 1 indicate that the financial, service, and trade sectors increased their investment spending at rates considerably above those for sectors associated with industrial production (MINE, DUR, CON, DUR, NDU, TCP, WHOL, RET, FIRE, SERV).

Table 1. Variable Definitions and Sample Statistics, 1947–1996

<table>
<thead>
<tr>
<th>Investment Series</th>
<th>Mean</th>
<th>SD</th>
<th>Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINE</td>
<td>2.11</td>
<td>13.14</td>
<td>Mining</td>
</tr>
<tr>
<td>CON</td>
<td>1.08</td>
<td>17.95</td>
<td>Construction</td>
</tr>
<tr>
<td>DUR</td>
<td>3.44</td>
<td>15.86</td>
<td>Durable goods manufacturing</td>
</tr>
<tr>
<td>NDU</td>
<td>2.40</td>
<td>9.94</td>
<td>Nondurable goods manufacturing</td>
</tr>
<tr>
<td>TCP</td>
<td>3.13</td>
<td>7.77</td>
<td>Transportation, communications, and public utilities</td>
</tr>
<tr>
<td>WHOL</td>
<td>7.26</td>
<td>14.17</td>
<td>Wholesale trade</td>
</tr>
<tr>
<td>RET</td>
<td>6.94</td>
<td>10.09</td>
<td>Retail trade</td>
</tr>
<tr>
<td>FIRE</td>
<td>4.40</td>
<td>11.05</td>
<td>Finance, insurance, and real estate</td>
</tr>
<tr>
<td>SERV</td>
<td>7.79</td>
<td>10.09</td>
<td>Services</td>
</tr>
<tr>
<td>Aggregate Demand</td>
<td>3.17</td>
<td>2.06</td>
<td>Real private spending, excluding business investment</td>
</tr>
</tbody>
</table>

Note: All variables are first differences of natural logs, that is, continuous growth rates (n = 48).

Sources: The industry investment series are chain-type quantity indexes for investment in fixed private capital, 1947 through 1996. Except for new electric light and power structures that are included when completed, the value of structures is included on a “put in place” basis. The data are from the diskette file 6ICQ.TXT of Estimates of Fixed Reproducible Tangible Wealth in the U.S.: 1925 through 1996 produced by the U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Wealth Division, Washington, DC, 1997. AD is formed as real personal consumption + real residential investment + real net exports taken from the Basic Economics Database maintained by Standard and Poor’s DRI division of The McGraw–Hill Companies. It is an annual average of quarterly data.

The third step is a factor analysis of the residual time series because, as noted by C-H (1996), significant correlations among sectoral innovations indicate only the possible existence of a common shock. If a factor that explains a significant portion of the variation in innovations is found, a common shock, though unidentified, is likely responsible for at least a portion of the comovement. This interpretation implies that any contemporaneous correlations among sectoral shocks are small in comparison to the common shocks that initiate responses consistent with strategic complementarity. If the common factor leaves unexplained a large portion of the innovation variance, according to C-H (1996) this provides indirect evidence for the existence of complementarities such as factor demand linkages that are separate from the role of common shocks.5

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5The factor analysis also assumes that the impact of all common shocks is upon contemporaneous investment innovations, although the various sectors may exhibit different lags in their responses to common shocks. This potential shortcoming is addressed for fluctuations in aggregate demand in the model extension contained in the next section.

6Public sector investment is omitted because the underlying motivation is not profit-maximization. Whether measured as a single aggregate of government investment or disaggregated into military, federal domestic, and state and local investment, in only one case out of 36 was there a significant positive correlation between changes in public and private investment.

7Augmented Dickey–Fuller tests, including a constant and trend term where significant, indicated the presence of a unit root for the logarithm of each investment and aggregate variable, with the exception of retail trade investment.
NDUR), construction, and infrastructure (TCPU). Standard deviation estimates confirm the previously mentioned high volatility of investment spending across all sectors when compared to noninvestment spending (AD).

Entries above the diagonal in Table 2 indicate substantial evidence of comovement in investment spending during this period. There are significant positive correlations among more than half of the total number of sector pairs, with seven of nine sectors having a majority of significant coefficients. Durable manufacturing, typically a highly cyclical sector, is correlated with both goods (MINE, CON, NDUR) and nongoods (TCPU, WHOL) sectors, whereas in every case there is a significant correlation among the nongoods sectors (TCPU, WHOL, RET, FIRE, SERV). During every postwar recession, except 1953 through 1954, a majority of sectors experienced declines in investment for at least one year of the recession, with construction and durable manufacturing declining during every recession.  

Estimates of Equation (2) using lag lengths of one or two years resulted in smaller values of the Schwarz Information Criterion at $J=1$ for every sector in the model. Five of the nine F statistics are significant at the 0.10 level (see Model One in Table 3). $R^2$ statistics range from 0.21 for MINE to 0.48 for CON, with an average across all sectors of 0.31. A hypothesis of first order autocorrelation is rejected by a Lagrange multiplier test for each equation in the model. An assessment of dynamic bivariate correlations between current and lagged changes in investment growth indicated that there are few intertemporal linkages across these broadly defined sectors. At the 0.10 level, current period investment growth in durable and nondurable manufacturing is correlated with prior period investment growth in five other sectors. Lagged changes in spending for CON, WHOL, RET, and SERV are significant for both manufacturing sectors. No other sector has more than two significant positive correlations with lagged changes in investment spending in other sectors.

The estimated residuals from Equation (2) provide estimates of innovations or shocks to investment spending for each sector. The pattern of significant positive correlations among the innovations is nearly identical to that of the original time series, with only one correlation changing from significant to insignificant. This suggests that common shocks are a potential cause of comovement in investment spending growth.

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Table 2. Correlation Matrices: Investment Growth and Innovations to Investment Growth

<table>
<thead>
<tr>
<th></th>
<th>MINE</th>
<th>CON</th>
<th>DUR</th>
<th>NDUR</th>
<th>TCPU</th>
<th>WHOL</th>
<th>RET</th>
<th>FIRE</th>
<th>SERV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINE</td>
<td>0.09</td>
<td>0.35*</td>
<td>0.27*</td>
<td>0.10</td>
<td>0.13</td>
<td>-0.07</td>
<td>0.20</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>CON</td>
<td>0.21</td>
<td>0.43*</td>
<td>0.16</td>
<td>0.47*</td>
<td>0.50*</td>
<td>0.41*</td>
<td>0.34*</td>
<td>0.54*</td>
<td></td>
</tr>
<tr>
<td>DUR</td>
<td>0.36*</td>
<td>0.45*</td>
<td>0.78*</td>
<td>0.59*</td>
<td>0.29*</td>
<td>-0.02</td>
<td>0.15</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>NDUR</td>
<td>0.21</td>
<td>0.18</td>
<td>0.65*</td>
<td>0.39*</td>
<td>0.10</td>
<td>-0.07</td>
<td>-0.03</td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td>TCPU</td>
<td>-0.15</td>
<td>0.15</td>
<td>0.30*</td>
<td>0.17</td>
<td>0.43*</td>
<td>0.31*</td>
<td>0.34*</td>
<td>0.46*</td>
<td></td>
</tr>
<tr>
<td>WHOL</td>
<td>0.11</td>
<td>0.20</td>
<td>0.33*</td>
<td>0.19</td>
<td>0.28†</td>
<td>0.63*</td>
<td>0.47*</td>
<td>0.72*</td>
<td></td>
</tr>
<tr>
<td>RET</td>
<td>-0.17</td>
<td>-0.12</td>
<td>-0.13</td>
<td>0.08</td>
<td>0.11</td>
<td>0.37*</td>
<td>0.62*</td>
<td>0.56*</td>
<td></td>
</tr>
<tr>
<td>FIRE</td>
<td>0.22</td>
<td>0.02</td>
<td>0.03</td>
<td>0.07</td>
<td>0.08</td>
<td>0.21</td>
<td>0.50*</td>
<td>0.42*</td>
<td></td>
</tr>
<tr>
<td>SERV</td>
<td>0.04</td>
<td>0.20</td>
<td>0.20</td>
<td>-0.08</td>
<td>0.25†</td>
<td>0.58*</td>
<td>0.25†</td>
<td>0.13</td>
<td></td>
</tr>
</tbody>
</table>

* † indicates coefficient is significant at the 0.05 (0.10) level for a two-tailed test, $n=48$.

Note: Correlations above the diagonal are for contemporaneous investment growth rates. Those below the diagonal are for contemporaneous innovations to investment growth from Model 2.
A factor analysis on these nine time series yielded three factors that explained 57.8% of the total unit variance when allowing 100% of the common variance to be accounted for by the model. The first factor accounts for 64.2% of the common variance and has positive factor coefficients (loadings) for all nine sectors. The second factor accounts for 27.7% of the common variance. Based upon factor coefficient magnitudes and signs, it differentiates between slower growing goods sectors (MINE, DUR, and NDUR) and faster growing service sectors (WHOL, RET, FIRE, and SERV). The coefficients for CON and TCPU are close to zero for the second factor. The final factor accounts for only 8% of the common variance and has a mix of five negative and four positive coefficients. Because factors 2 and 3 have varying impacts across sectors and account for relatively small portions of the common variance, it is possible to conclude that the first factor is the only economically meaningful one for measuring an aggregate shock that has the same qualitative impact on all nine sectors.

The second column under Model One in Table 3 shows that the single common factor explains, on average, 41% of the variation in innovations to investment spending growth. Excluding MINE, which is significantly less sensitive to the common shock, increases the average to 45%. These values are three times those obtained by C-H (1990) using a similar industry classification with employment data for 1947 through 1985. Based on these estimates, sectoral shocks appear to have a slightly greater impact than common shocks as a cause of innovations to growth in investment spending. However, a majority of innovation variance is explained by the common factor for DUR, TCPU, WHOL and SERV. In addition, the combined impact upon sectoral investment growth rates of investment linkages over time and the common factor (VAR-FA Share in Table 3) is 58%.

Table 3. Summary Measures for Vector Autoregressions and Factor Analyses

<table>
<thead>
<tr>
<th>Sector</th>
<th>Model One</th>
<th>Model Two</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VAR $R^2$</td>
<td>FA $R^2$</td>
</tr>
<tr>
<td>MINE</td>
<td>0.21</td>
<td>0.09*</td>
</tr>
<tr>
<td>CON</td>
<td>0.48*</td>
<td>0.38*</td>
</tr>
<tr>
<td>DUR</td>
<td>0.36*</td>
<td>0.55*</td>
</tr>
<tr>
<td>NDUR</td>
<td>0.25</td>
<td>0.25*</td>
</tr>
<tr>
<td>TCPU</td>
<td>0.22</td>
<td>0.55*</td>
</tr>
<tr>
<td>WHOL</td>
<td>0.33*</td>
<td>0.67*</td>
</tr>
<tr>
<td>RET</td>
<td>0.33*</td>
<td>0.32*</td>
</tr>
<tr>
<td>FIRE</td>
<td>0.23</td>
<td>0.29*</td>
</tr>
<tr>
<td>SERV</td>
<td>0.35*</td>
<td>0.59*</td>
</tr>
<tr>
<td>Unweighted Mean</td>
<td>0.31</td>
<td>0.41</td>
</tr>
</tbody>
</table>

*† indicated significance of corresponding $t$ or $F$ statistic at the 0.05 (0.10) level, $n = 48$.

Note: VAR $R^2$ is $R^2$ for the vector autoregressions. FA $R^2$ is the share of the innovation variance explained by the first factor. VAR-FA Share is VAR $R^2 + (1 - VAR R^2) FA R^2$.

9 The common variance is measured by the sum of the prior communalities estimated by the squared multiple correlations of each innovation with all of the other innovations.

10 The results for the annual investment and monthly employment time series are not strictly comparable because sectoral shocks transmitted to other sectors are more likely to be classified as common shocks with annual data. However, because adjustments to investment proceed more slowly than short-run changes in employment, the use of annual investment data are not likely to result in misclassifications of the same magnitude as would occur for employment.
for the average sector. For DUR, WHOL and SERV, the combined effect accounts for over 70% of their variation. Together, these results indicate that elements of both real business cycle (i.e., sectoral shocks) and aggregate explanations of investment fluctuations are relevant for business cycle analysis.

III. Extension of the Basic Model

The factor analysis model of the previous section is unable to identify the changes in specific variables that act as shocks that are common to all sectors of the economy. It also assumes that the unidentified common factor has only a contemporaneous impact on investment in all sectors, whereas some sectors may exhibit faster responses to common shocks than others. To address these shortcomings for aggregate demand, an accelerator model of investment is used to specify strategic complementarities. As specified in Equation (1), for each sector $i$, current and lagged values are used for this purpose:

$$I_{it} = \alpha_i + \sum_{j=1}^{9} \beta_{ij} I_{i,t-j} + \sum_{j=0}^{1} \gamma_{ij} AD_{t-j} + u_{it}$$

(3)

where $AD$ is the growth rate in real private spending excluding business investment. It is assumed that observations on $AD$ provide information on the spending patterns of consumers which in turn determine expectations regarding the investment and output plans of other firms and sectors.\(^{11}\)

Using U.S. quarterly data for 1954:1 through 1973:2, Clark (1979) found that nonresidential fixed investment is best explained by a simple accelerator model in which changes in aggregate output are positively related to investment. Fama (1992) identified an accelerator effect that was responsible for cyclical increases in quarterly aggregate U.S. investment (1947–1990) and transitory increases in GNP relative to a stochastic trend. Acemoglu (1993) estimated that quarterly business investment in the U.S. is Granger caused by output (1965:1–1990:3). Similar to the strategic complementarity assumption, he maintained that output effects work with a lag, because firms use past changes in output to make inferences about the recent investment behavior of other firms, which is more

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\(^{11}\)This type of specification is similar to Chirinko’s (1993) implicit dynamic model of investment and is consistent with the approach of Gordon and Veitch (1986) that rejects the use of structural models to estimate investment parameters. It adopts the view of Caballero et al. (1995) who argue that investment nonconvexities and the imperfect synchronization of investment decisions across firms and sectors make the representative firm model inappropriate for estimation of aggregate investment equations. Support for the inclusion of lagged effects is provided by numerous studies which suggest that changes in factors that lead to adjustments in investment often precede actual spending on plant and equipment by time periods ranging from 4 to 8 quarters in length (Montgomery, 1995b; Hall 1977; Jorgenson and Stephenson, 1967; Mayer, 1960). To explain these lags, recent work by Montgomery (1995a) and Christiano and Todd (1996) cited the importance of dynamic complementarities between different types of investment (e.g., large investments occur before small investments, construction of structures occurs before the installation of equipment, etc.). Lags also occur due to time devoted to planning which includes items such as project design and considering the irreversibility of investment spending in the face of uncertain future payoffs.

\(^{12}\)Government purchases are omitted because they are largely input purchases (capital and labor) that are not related to cyclical fluctuations in aggregate demand (see Note 6 for further discussion on omitting public sector investment spending from the analysis). Other public sector purchases are not likely to elicit a strong investment response by the private sector because the former are influenced by political factors that are difficult to forecast and are less likely to be sustained. Inventories are omitted because they are an ambiguous indicator of investment conditions. Increases in inventories may be due to an anticipation of higher sales that stimulate new investment or a reflection of weak current sales that lead to less investment.
difficult to observe. Increases in output signal to the individual firm that aggregate investment spending is increasing, thereby raising the expected payoff to additional investment and introducing persistence to the effects of shocks. Recent work by Cooper et al. (1999) found that the frequency of cross-section spikes in investment spending across individual plants was correlated with aggregate investment and that aggregate shocks were the main source of changes in investment.

Results based upon estimates of Equation (3) are shown under Model Two in Table 3. With the exception of MINE, all sectors have significant F-statistics at the 0.05 level and large increases in VAR $R^2$. For these sectors, $\gamma_0$ and $\gamma_1$ have a positive and jointly significant impact upon investment spending growth. In the case of manufacturing, DUR and NDUR, only the lagged value is significant. In contrast, only the current change in real private noninvestment spending is significant for most of the nonmanufacturing sectors. Both $\gamma_0$ and $\gamma_1$ are significant for TCPU. A combination of factors may be at work in these results, which demonstrate the need to allow for staggered responses to aggregate shocks: (1) compared to manufacturing, nonmanufacturing sectors are closer in the distribution system to consumers who express final demands, (2) manufacturers wait for increased orders from nonmanufacturing sectors before making new investments, and (3) manufacturing investments are more structure-intensive and disruptive of the flow of work in the production environment whereas other sectors’ investments are more equipment-intensive and relatively easier to install. The magnitudes of the AD effects are considerable: the average sector, excluding MINE, has experienced a 3.7% point increase in its rate of investment growth for every one percentage point increase in AD over two consecutive years.

The correlations among the innovations estimated from Equation (3) are provided below the diagonal in Table 2. Compared to the original correlations for investment growth rates, there is a reduction in the mean correlation from 0.31 to 0.18, with the number of significant correlations declining from 22 to 11. All sectors experienced a reduction with the exception of DUR. These results imply that much of the original comovement in investment spending was due to a common response to changes in aggregate demand.

This view is reinforced by the factor analysis applied to the nine time series of innovations estimated from Equation (3). As in the first case three factors are identified, but only 44.0% of the total unit variance is accounted for compared to the 57.8% in the original analysis. Factor 1 is used to measure a common shock because it accounts for 51.8% of the common variance and has positive factor coefficients for all nine sectors. Factors 2 and 3 are not included for the same reasons as before: factor 2 distinguishes between the faster growing services sectors and slower growing goods sectors, and factor 3 accounts for only 15.7% of the common variance and has five negative and four positive coefficients.

Except for the mining and manufacturing sectors, the common shock explains less of the variation in sectoral innovations than before, with the average declining from 41 to 28%. The most notable change in the impact of the common factor upon investment innovations is the large decline for the nonmanufacturing sectors. For only durable manufacturing does the common shock still explain more than half of the innovation variance. As a result, much of the comovement in investment growth innovations attributed to the common factor in Model One is accounted for by similar sectoral responses to changes in aggregate demand.
The contribution to a sector’s investment growth of factors other than current period sector-specific shocks is estimated by VAR-FA Share, the sum of the explanatory effects of the VAR model (including $\Delta D_t$ and $\Delta D_{t-1}$) and the common factor. With an average value for VAR-FA Share of 0.65, only one-third of the variation in the typical sector’s investment growth is due to current-period, own-sector shocks to spending. The value of 0.88 for durable manufacturing is notable because this sector produces most of the physical capital purchased in the economy. Fluctuations in investment in this sector depend largely upon external forces and not on technological shocks or changes in demand specific to durable manufacturing production.

Overall, the results for Model Two suggest that the relative importance of aggregate versus sector-specific effects depends on the component of investment spending being considered. For the average sector, information contained in past investment growth rates across all sectors, changes in noninvestment aggregate demand, and the common unidentified factor account for nearly two-thirds of the variation in investment spending growth. For innovations to investment growth unrelated to aggregate demand, sectoral shocks account for 72% of the variation. Thus, fluctuations in investment spending growth are estimated to be strongly influenced by both aggregate factors and innovations specific to individual sectors.

IV. Summary and Conclusions

Multisector real business cycle models maintain that sectoral shocks to demand and productivity can result in correlated investment fluctuations across many sectors when significant production linkages exist. In contrast, the traditional focus upon macroeconomic determinants of investment spending has been supported by recent work emphasizing the role of expectations concerning future returns. Specifically, because investments typically involve large, irreversible expenditures based upon uncertain payoffs, signals from the performance of the aggregate economy are relied upon to guide investment decisions. Strategic complementarities across firms and sectors result in comovements that are observed as aggregate investment fluctuations.

This paper has used a VAR-factor analysis model to assess the relative importance of sectoral versus aggregate factors as causes of the high degree of comovement in investment spending. When including the impact of linkages to prior period investment spending, changes in aggregate demand and a common factor account for two-thirds of the variation in the average sector’s investment growth. The combined effects exert their strongest impact upon investment in the durable manufacturing sector. Both dynamic correlations of investment growth rates and temporal differences in responses to changes in aggregate demand indicate that manufacturing investment follows investment in the service-producing sectors of the economy. Because the common factor may contain multisector responses to a shock that originates in one sector, a lower bound estimate is that one-third of the average sector’s investment growth variation is due to sectoral shocks. For innovations to investment spending not caused by changes in aggregate demand, the lower bound impact rises to over 70%. Fluctuations in aggregate investment are therefore caused by a combination of sectoral and aggregate shocks to the economy.

When identifiable changes in consumer preferences or production technology occur in specific sectors, any change in aggregate investment is likely to be accompanied by sectoral reallocations of capital. Changes in aggregate policies are not needed in this case,
especially if the process leads to a more efficient pattern of resource allocation. Conversely, if economy-wide factors are negatively influencing expectations regarding future business conditions, cyclical downturns in investment across many sectors are likely to occur. The decline in exports to Asia during 1998 and the rapid increase in oil prices during 1990 are examples of recent events that affected many sectors. At other times there may be a general decline in business confidence even though no specific exogenous cause may be apparent. In each case, aggregate policies such as the lowering of short-term interest rates may work to offset the negative impact of strategic complementarities upon investment spending throughout the economy.

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