Inventory (Dis)Investment, Internal Finance Fluctuations, and the Business Cycle

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Abstract

A well-known but under-emphasized feature of the business cycle is that the flow of internal finance is highly procyclical. We argue that finance constraints lead firms to offset a large proportion of internal finance fluctuations through inventory (dis)investment. We construct three panels of *quarterly* firm data, each of which contains a large fraction of aggregate inventories and covers a major inventory cycle. Our findings show that the impact of internal finance on inventory investment is greater for small firms than large, consistent with the existence of finance constraints. Internal finance, however, is also economically important for large firms. These results explain part of the large cyclical amplitude of inventory investment. Furthermore, heterogeneity in our results across time, especially between the 1981-82 recession and the 1990-91 recession, helps explain differences in the composition of aggregate investment shortfalls during contractions.

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1. INTRODUCTION

It is a well-known fact that inventory disinvestment can account for a majority of the movement in output during recessions. Abramowitz (1950) finds that approximately one half of the average shortfall in GNP for the five interwar business cycles resulted from inventory disinvestment. Blinder and Maccini (1991a) report even larger effects for postwar recessions. A lesser known fact is that corporate profits, and therefore internal finance flows, are also extremely procyclical and tend to lead the cycle. Wesley Mitchell (1951, p. 286) finds that the amplitude of the percentage change in corporate income over the business cycle is several times greater than any other series in his study. Robert Lucas (1977, p. 9) lists the high conformity and large amplitude of corporate income as one of the seven main qualitative features of the business cycle. The volatility of internal finance continues to be a salient feature of postwar cycles.

This paper links these two stylized facts by examining whether internal finance fluctuations may be an important cause of changes in inventory investment. Our exploration is motivated by a rapidly growing body of theoretical work that argues that internal finance or net worth may have an impact on firm behavior if the markets for external finance are imperfect. Although previous empirical work has focused on fixed investment, the dramatic cyclical fluctuations in both inventory investment and internal finance suggest that efforts to examine their link are overdue.[1]

With imperfect capital markets, all investment should be affected by fluctuations in internal finance; we argue that inventories should be especially sensitive. In response to a negative shock to internal finance, financially constrained firms will reduce their accumulation of assets with the effect on each asset determined by its relative liquidation and adjustment costs. Because inventory investment has low adjustment costs, its share of a financed-induced decline in total investment will be large relative to fixed investment or other uses of funds (R&D, for example).

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[1] Recent papers that find a connection between inventories and capital markets include Gertler and Gilchrist (1992), Kashyap, Stein, and Wilcox (1993), and Kashyap, Lamont, and Stein (1993). Carpenter (1992), Fazzari and Petersen (1993), and Whited (1991) study working capital (which includes inventories) and its relation to firms' financial conditions.

The connection between internal finance and inventory investment may also help resolve some important empirical puzzles about inventory behavior. Numerous studies have found that production varies more than sales and inventory investment is positively correlated with sales (see Blinder, 1986). Both results are inconsistent with the production smoothing-buffer stock inventory model. These findings may arise from an omitted variable bias: the presence of finance constraints induces a positive correlation between inventory investment and sales that may overwhelm the negative correlation arising from production smoothing alone.

The 1980s and early 1990s are an excellent period in which to examine the linkage between internal finance and inventory investment. In addition to pronounced swings in inventory investment, there were large aggregate fluctuations in internal finance, with troughs in 1982, 1986, and 1991. To determine the impact of these fluctuations on inventory investment, we constructed three non-overlapping panels with manufacturing firm data from the COMPUSTAT quarterly files, each covering a major movement of aggregate inventory investment. Since each panel includes a large fraction of the economy's inventories, our data are well suited to investigate aggregate inventory fluctuations over the business cycle.

Quarterly panel data at the firm level provide several advantages for studying inventory investment. The disaggregated data allow us to examine the heterogeneity of results across groups of firms split by size. Exploiting the heterogeneity of firms has been a powerful technique for identifying finance constraints in previous empirical work on fixed investment. The panel data allow us to control for firm and time effects (e.g., cost shocks and interest rates), essential features of an inventory investment study. The use of quarterly data is vital to analyze a high-frequency phenomenon like inventory investment; to date, firm-level studies of finance constraints have relied on annual data. With quarterly data we can construct multiple panels of short calendar duration, which allow us to examine changes in the impact of finance constraints through time and to test the robustness of our results.

To our knowledge, our study is the first work on the microfoundations of firm behavior over the business cycle to employ data with all of these key features: i) firm level data, ii) quarterly data, and iii) coverage of a major fraction of the aggregate economy. The high frequency panel data provide enough observations in the time dimension to study time series behavior of firms during *individual* cycles. Therefore we can examine directly whether "business cycles are all alike," (Lucas, 1977, p. 10), or, as Zarnowitz (1992, p. 3) suggests, "although individual cycles share important family characteristics, they are by no means all alike."

The next section of the paper briefly surveys empirical issues raised in the inventory investment literature and describes the linkage between fluctuations in internal finance and inventory investment. Section 3 lays out the empirical models we use to test our hypothesis. Section 4 describes our data and provides a number of summary statistics.

Section 5 presents the empirical results. We estimate a standard production smoothing model of inventory behavior augmented by fixed firm and time effects and internal finance variables. We find that internal finance has a greater impact upon inventory investment for small firms than it does for large firms. However, the effect is economically important even for large firms, especially for the 1981-82 recession, a period characterized by both significant inventory fluctuations and turbulent financial conditions.

Section 6 discusses the macroeconomic implications of our results. We argue that internal finance movements are often responsible for an important part of inventory fluctuations over the business cycle. But if reductions in inventories are limited for some reason (say because firms enter a recession with unusually low inventory stocks), internal finance movements will be reflected to a greater degree in other firm activities, especially investment in fixed capital. We link our regression results to aggregate evidence that supports this prediction. This perspective helps to explain differences in the composition of investment shortfalls in previous contractions; in particular we compare the 1981-82 recession with the downturn in 1990-91. Section 7 summarizes and concludes.

2. Inventory Investment and Internal Finance

The connection between inventory fluctuations and the business cycle has been a major concern of macroeconomists for years, and for good reason. While inventory investment accounts for less than one percent of GNP on average (from 1959 to 1991), Blinder and Maccini (1991a) find, in a purely arithmetic sense, that reductions in inventory investment accounts for about 87 percent of the drop in real output in an average postwar recession. Their argument that "the inventory accelerator created cycles *that otherwise might not exist*" (emphasis added) reflects a central role for inventories in the theory of the business cycle dating back at least to Metzler (1941). The dramatic role played by inventories in macroeconomic downturns, however, poses a puzzle when viewed from a microeconomic perspective.

Standard theory predicts that optimizing firms with convex costs will smooth production relative to sales, and when demand is stochastic firms can use inventories as a buffer against temporary demand shocks. Most empirical evidence, however, rejects the production smoothing-buffer stock model, finding that production varies more than sales and that the covariance between inventory investment and sales is positive.[2] These empirical findings have generated research that explains the "excess volatility" of inventories from a variety of perspectives, including work emphasizing cost shocks, increasing returns, and stockout avoidance.[3]

We focus on an alternative and complementary explanation of the excess volatility of inventories. Capital market imperfections can limit firms' access to

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[2] There are several exceptions. See Ghali (1987), Fair (1989) and Krane and Braun (1991).

[3] For example, Eichenbaum (1989) shows that cost shocks provide firms with incentives to "bunch" production in periods of low cost. Ramey (1991) finds evidence of declining marginal costs that would also motivate production bunching. Blinder and Maccini (1991a) argue that production may vary more than sales if firms follow (S,s) inventory rules. Kahn (1992) shows that uncertain demand combined with costly stockouts helps explain the behavior of inventories in the automobile industry.

external finance, forcing them to rely mainly on internal finance. As a result, fluctuations in internal finance should affect inventory investment. Many recent studies find a similar role for internal finance in studies of fixed capital investment.[4]

The existence of finance constraints can be explained by transaction and bankruptcy costs. But much recent work has emphasized asymmetric information that causes adverse selection and moral hazard problems, creating a wedge between the cost of internal and external finance, as well as credit rationing.[5] These problems are not expected to impact all firms equally or to be invariant over time. Because public information is less available for small firms and they have relatively low levels of collateralizable assets, small firms are more likely to face finance constraints. They rely more heavily on bank debt than large firms, and they rarely issue commercial paper, which is an important source of funds for large firms. Furthermore, other indicators of financial constraints, such as the lack of a bond rating (see Whited, 1992) or zero dividend payouts (see Fazzari, Hubbard, and Petersen, 1988), are correlated with firm size. However, even large firms may face short-run problems in obtaining credit at favorable terms, especially when credit is tight. If firms cannot obtain external finance, or can obtain it only by paying a premium over the opportunity cost of internal funds, their investment activities are likely to vary with their flow of internal funds.

The linkage between fluctuations of inventory investment and those of internal finance has been considered in an earlier literature. Paul Kuznets writes (1964, p.336), "[a] firm's ability to finance inventory investment without resorting to borrowing is determined, finally, by earnings and depreciation flows or what might be

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4 For example, see Fazzari, Hubbard, and Petersen (1988), Gilchrist (1990), Devereux and Schiantarelli (1990), Hoshi, Kashyap, and Scharfstein (1991), Whited (1992), and Oliner and Rudebusch (1992).

5 See the survey by Gertler (1988).

termed `internal' finance." His times-series evidence over the period 1947 to 1961 indicated that a one dollar increase in internal finance increased manufacturers' inventories by more than three dollars.

Two recent papers find a linkage between monetary policy, operating through firms' access to external finance, and inventory investment. Using aggregate time-series data from the Quarterly Financial Report (QFR) split by firm size, Gertler and Gilchrist (1993) estimate a significantly larger impact of monetary shocks on the inventory investment of small firms compared with that of large firms. Kashyap, Lamont, and Stein (1993) also find evidence for a link between monetary policy, finance, and inventories. They analyze three separate cross sections of annual manufacturing firm data using the stock of liquidity (cash plus marketable securities), a variable which measures firms' exposure to lending restrictions induced by tight monetary policy. This variable is significant in explaining the inventory growth of firms without bond ratings in the 1982 recession but is not significant for firms with bond ratings. They note (p. 6) that the 1982 recession was "an episode for which all the aggregate evidence suggests that tight monetary policy had a real effect on the economy, and on inventories in particular."

Our approach focuses directly on the link between fluctuations in *internal* finance and inventory investment. Of central importance to our argument is the fact that business income, and therefore internal finance, move a great deal over the business cycle. Business income is volatile primarily because most of firms' costs are fixed in the short run. This is particularly true of modern corporations in which labor hoarding is an important feature of the business cycle (see, for example, Bernanke and Parkinson, 1991). With high fixed costs, relatively small movements in demand cause large movements in business income.[6]

Mitchell (1951) documented the procyclical movements of internal finance, finding that the percentage change in business income had an amplitude several times greater than any other series in his study. Postwar data show that business income continues to be extremely volatile over the cycle. Consider the following evidence compiled from the QFR. Depreciation allowances make up 49 percent of cash flow, on average, and slowly rose throughout the 1980s, with no obvious cyclical pattern. In contrast, business income, the other major piece of internal finance, was extremely volatile. It fell 47 percent from 1981.3 to 1982.4 and then more than doubled in the early stages of the recovery. Income fell 39 percent from 1984.2 to 1986.1 as growth slowed and the economy narrowly avoided a recession. During the most recent recession, income fell almost 57 percent from its peak in 1988.2 to its trough in 1990.4.

Such extreme declines in internal finance during business downturns confront financially constrained firms with difficult choices, forcing them to curtail their accumulation of all assets. However, a firm in this situation will not cut investment proportionately across all assets. Fazzari and Petersen (1993) and Carpenter (1992) point out that all firms, including financially constrained firms, seek to equate the marginal returns on different investments, *net* of adjustment costs at each point in time. Therefore, assets with low adjustment costs (inventories, for example) will typically bear the brunt of temporary negative shocks to internal finance. Symmetrically, improvements in internal finance during economic recoveries should induce the fastest accumulation of assets with relatively low adjustment costs.

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[6] Demand reductions do appear to precede downturns in the economy. Perry and Schultze (1993, p. 148) state that "weakness in final sales over the four quarters leading up to recession comes close to being a feature of the economy that predicts recessions."

Several studies indicate that capital expenditures and research and development, the other main components of investment expenditures, have substantially greater adjustment costs than inventories.[7]

Unlike largely irreversible investments in R&D and fixed capital, firms can, and often do, dramatically cut their stocks of inventories. Reducing the portion of internal finance devoted to inventory accumulation releases liquidity, relaxing short-run finance constraints on other investment activities of firms. Most inventory studies focus on finished goods, and although firms can build liquidity by operating with a smaller finished goods to sales ratio, materials and work-in-process inventories are much more volatile. Firms can disinvest by drawing down their stocks of raw materials without reordering. Work-in-process inventories can be liquidated in a similar manner.

There is, however, a cost of reducing inventory stocks. Inventories can be viewed like any other input to production (see Ramey, 1989). Thus, as the level of stocks falls, their marginal product rises and it becomes more costly for firms to sacrifice inventories at the margin. The extent to which inventory investment responds to internal finance fluctuations depends on the initial stock of inventories. Differences in the stocks of inventories may therefore help to explain variations in the behavior of inventory investment across business cycles. We develop this point further in section 6, contrasting inventory investment in the 1981-82 recession with the 1990-91 recession.

In sum, inventories constitute a large and relatively flexible part of firms' assets which provide potential liquidity to offset shocks to internal finance. Therefore, if

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[7] Zarnowitz (1992, p. 41) writes that inventories can be adjusted more quickly than fixed capital. Himmelberg and Petersen (1994) analyze this issue for R&D. For further discussion, see the review of research on adjustment costs in Fazzari and Petersen (1993).

finance constraints are important we expect aggregate inventory investment to bear a disproportionate share of internal finance movements.

3. EMPIRICAL SPECIFICATION

To test the link between internal finance and inventory accumulation, we modify a widely used inventory investment equation. For firm j at time t (measured in quarters) let:

(3.1) $$\Delta N_{jt} = \kappa (N^*_{jt} - N_{jt-1}) - \alpha (S_{jt} - E_{t-1}S_{jt}) + \beta_0 CF_{jt} + \beta_1 CF_{jt-1} + \beta_2 CF_{jt-2} + e_{jt},$$

where ΔN is inventory investment, N and N* denote the actual and target stocks of inventories, S and $E_{t-1}S$ represent the actual and forecasted levels of sales, and CF represents cash flow, our measure of internal finance. The first two terms in 3.1 are very similar to a model in Blinder and Maccini (1991b) that captures basic production smoothing and buffer stock ideas.[8] The stochastic term e_{jt} may include aggregate and seasonal effects along with random errors, as discussed below.

The stock adjustment term in equation 3.1 relates the change of inventories to the gap between a target stock of inventories and the actual beginning-of-period stock. The speed of adjustment is given by the constant κ. The target stock is often related to expected sales. For finished goods inventories, this link comes from a stockout motive (see West, 1986 and Kahn, 1987). As expected sales rise, the probability of a costly stockout increases, inducing firms to hold more finished goods in inventory. To the extent that expected sales vary with recent actual sales, an inventory accelerator is generated that may explain part of inventory investment

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[8] Blanchard (1983) finds that an equation incorporating the first two terms of equation 3.1 performs about as well in explaining automobile inventory investment as an explicit structural model derived from a quadratic technology.

volatility. For work-in-process and raw materials inventories, similar accelerator effects arise through the target stock because these inventory components can be modeled as factors of production (see Ramey, 1989). The demand for these inputs also varies with actual and expected sales as well.

One common model for target inventories is:

$$N^*_{jt} = \gamma_j + \chi_1 E_{t-1} S_{jt} + w_{jt} \tag{3.2}$$

where w_{jt} is a random error term. In addition to expected sales, the target inventory level depends on a "fixed effect" (γ_j) that varies across firms. Blinder (1982, p.342) develops a formal model of inventory behavior that motivates including a fixed effect term. He writes that N* depends on firm-specific variables that "would not be expected to change very often or very quickly." Indeed, the fact that γ_j is constant for each firm is not very restrictive in our context since we estimate regressions over short panels (11 to 18 quarters). Since some between-firm determinants of N* are likely to be correlated with sales and cash flow (long-run firm demand and inventory storage costs identified by Blinder, for example), failing to control for unobservable fixed firm effects could lead to inconsistent parameter estimates in equation 3.1. Our panel data structure has the clear advantage that the fixed effects estimator is a general way to incorporate firm-specific factors impacting the target inventory stock.

The second term in equation 3.1 arises from the role of inventories as a buffer stock when firms smooth production. If actual and forecasted sales differ, inventory investment will reflect part of the difference, giving a negative effect of the sales forecast error on inventory investment. Equation (3.3) is an autoregressive forecast for sales similar to that used by Blinder (1986):

$$E_{t-1} S_{jt} = \lambda_j + \delta_1 S_{jt-1} + \delta_2 S_{jt-2} + v_{jt} \tag{3.3}$$

where λ_j is a firm fixed effect and v_{jt} is a random expectation error. This specification may appear restrictive since firms might anticipate some part of actual sales in period t based on information not contained in lags of sales. Because of the buffer stock term in equation 3.1, however, the estimating equation includes contemporaneous sales. Therefore, the model controls for any correlation between expected sales and actual contemporaneous sales not explained by lagged sales. This potential correlation affects our ability to identify the buffer stock coefficient α, but does not affect the estimation of the cash flow coefficients.

The cash flow terms in equation 3.1 are the main focus of our study. They reflect the impact of internal finance on inventory investment implied by the finance constraint literature. The approach here, directly linking a firm's asset accumulation to its cash flow, is analogous to that taken by many papers to test the impact of finance constraints on fixed capital investment (see, for example, Fazzari, Hubbard, and Petersen, 1988, and Hoshi, Kashyap, and Scharfstein, 1991). The timing of the cash flow effect is an important issue. Previous fixed investment studies use annual data and emphasize the contemporaneous effect of cash flow. Because inventory investment is a high frequency phenomenon, we use quarterly firm data in this study. With quarterly data, it is quite possible that finance constraints will be reflected in lags of cash flow.

Several recent papers appeal to cost shocks to explain fluctuations in inventory investment.[9] For example, if favorable temporary cost shocks increase the incentive to produce today relative to the future, optimizing firms might "bunch" production into low-cost periods rather than smooth production. Therefore, inventory investment (both finished goods and inventories that act as production inputs) will be positively correlated with output fluctuations induced by cost shocks. If the cost shocks are

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[9] Evidence on the importance of cost shocks is mixed. Eichenbaum (1989) finds that his "production-cost smoothing" model cannot be rejected, while the "production-level smoothing" model is rejected. Blinder (1986) finds some impact of raw materials costs on finished goods inventory investment, but virtually no effects of interest rates or wages. Nerlove et al. (1993) find that costs shocks are "rarely significant" in survey data. Miron and Zeldes (1988) also find little evidence for the importance of cost shocks.

correlated across firms, this kind of behavior could induce procyclical inventory investment. More important for our purposes, cost shocks might induce a positive correlation between cash flow and inventory investment. For example, a positive cost shock would raise business income as well as induce firms to bunch production, raising inventories.

We control for cost shocks in two ways. First, in some of our equations, we include time dummies disaggregated to the two-digit SIC industry level (denoted by η_{it} for industry i at time t). We also considered dummies at the four-digit level with no appreciable effect on the results. These dummies control for any industry technology shocks as well as industry-wide movements in labor, raw material, or capital costs. The ability to include these dummies is another major advantage of our firm panel data. Studies based on aggregate or industry data, which dominate the inventory investment literature, do not have the cross-sectional heterogeneity to control for these effects. In regressions that include time dummies, the cash flow results cannot be attributed to time-varying effects disaggregated to the two-digit SIC level. Our data structure therefore permits us to isolate internal finance effects from cost shocks. The disadvantage of controlling for cost shocks with time dummies, however, is that we get no explicit estimate of the impact of various kinds of cost shocks. Therefore, we also estimate equations with cost variables added to the regression (as in Blinder, 1986), including interest rates, wage costs, and energy costs.

Finally, because we use quarterly data to study inventory investment, we must address seasonality. Inventory investment has a strong seasonal component (see Miron and Zeldes, 1986). The two-digit SIC time dummies control for seasonality at the industry level.[10] Nerlove et al. (1993) argue that time dummies are the best way

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[10] Beaulieu, MacKie-Mason, and Miron (1992) report significant differences in the seasonal cycles of two-digit SIC manufacturing industries.

to control for seasonality in inventory studies. Nevertheless, we also ran regressions with the SAS X11 procedure to seasonally adjust all our regression variables. The results were similar to those reported in the next section.

Substituting equations (3.2), (3.3), and the firm and industry-time fixed effects into the inventory investment equation (3.1) yields the regression equation estimated here:

$$(3.4) \quad \Delta N_{jt} = -\kappa\, N_{jt-1} - \alpha\, S_{jt} + \delta_1\, (\alpha + \kappa\, \chi_1)\, S_{jt-1} + \delta_2\, (\alpha + \kappa\, \chi_1)\, S_{jt-2}$$
$$+ \beta_0\, CF_{jt} + \beta_1\, CF_{jt-1} + \beta_2\, CF_{jt-2} + \eta_j + \eta_{it} + u_{jt},$$

where η_j represents the linear combination of firm fixed effects, η_{it} is the time dummy coefficient for industry i at time t, and u_{jt} is the linear combination of stochastic error terms from equations (3.1) through (3.3). In the estimated regressions, all the independent variables are scaled by the firm's total assets (TA_{jt}) to control for heteroscedasticity. We now discuss the characteristics of the sample data used to estimate this equation.

4. DATA DESCRIPTION AND SUMMARY STATISTICS

A. Construction and Characteristics of the Panels

We collected our sample from the Compustat quarterly data tapes for the period 1981-1991. Like the annual data, the quarterly tapes contain income statement and balance sheet data for several thousand publicly traded companies. To date, Compustat's quarterly data have been virtually untapped by researchers examining the financial and investment behavior of firms.[11]

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[11] Quarterly data are available for total inventories but not for the separate components: finished goods, materials, or work-in-process.

We chose a set of easily reproducible selection rules for the construction of our three panels. All firms in our sample are domestically incorporated. We require that each of our panels be balanced, and we exclude the extreme lower tail of the size distribution because many of these firms are startup operations, often with zero inventories and negative cash flows.[12] To protect against results driven by a small number of extreme observations, we exclude observations in the one-percent tails for each regression variable.[13] Our sample covers a substantial portion of aggregate manufacturing inventories (54.5 percent over our sample period). Since manufacturing accounts for about half of aggregate inventories, our sample has clear relevance for explaining macroeconomic inventory behavior.

It is apparent from figures 1 and 2 that our sample period contains three distinct inventory cycles, including the 1982 and the 1990 recessions. We split the data into three panels: 1981.1 - 1983.4, 1984.1 - 1988.3, and 1988.4 - 1991.4, where the splits are determined by the peaks in aggregate inventory investment. There are several advantages to analyzing multiple short panels as opposed to one long panel. First, we lose comparatively few firms from balancing each panel, an important consideration since Compustat greatly expanded its coverage during the 1980s. Second, short panels reduce the likelihood of introducing trends that might dominate cyclical movements in the data. Third, we can examine the heterogeneity of our results across different time periods, which is valuable because of differences in prevailing financial market conditions. Finally, a comparison of parameter estimates across panels tests the robustness of our findings.

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[12] We excluded firms with less than 10 million dollars in assets. Firms below this cutoff account for only a small fraction of inventory investment. Changing the cutoff value to $5 million had little impact on the results. Even though a firm is excluded from one panel, it may enter others if it reaches the $10 million asset figure.

[13] The results were not significantly affected by setting the outlier cutoff at either 2 percent or one-half percent.

If firms do not have equal access to external financial markets, the sensitivity of investment (of all types) to internal finance fluctuations will be greater for some firms than for others. A number of recent studies have used a strategy of dividing the sample to examine the heterogeneity of investment behavior. For example, Fazzari, Hubbard, and Petersen (1988) base their sample division on dividend-payout ratios. Gertler and Gilchrist (1992) split by the size of firms' gross assets. While there is no perfect indicator of the ease of access to external capital markets, these studies find that small firms rely more heavily on internal finance. In addition, Bernanke and Gertler (1989) provide formal justification for dividing firms into groups on the basis of their size by showing that firms' access to capital markets is related to the size of their net worth.

Our sample split is based on the size of the total assets of the firm in each panel. We place firms with less than $300 million in average total assets (in 1987 dollars) into the small size class.[14] This selection criterion gives an approximately equal number of firms in each class during the first period. For comparability across periods, we use the same total asset rule to separate firms into small and large classes. We experimented with several other size cutoffs around $300 million with little impact upon the results. Small firms comprise a significant fraction of manufacturing. Gertler and Gilchrist (1993) report QFR statistics showing that roughly 30 percent of manufacturing sales is accounted for by firms with less than $300 million in assets.

We report size statistics and sources of finances for all three panels in table 1. The pronounced differences in the size of firms produced by the splitting criterion are readily apparent. The median large firm is more than ten times larger than the median small firm in our panels. Median total assets for small firms in the first

[14] This cutoff is similar to the one chosen by Gertler and Gilchrist (1993).

period are $98 million versus $1.49 billion for large firms. Small firms employ a median of 1600 employees and have median sales of $37 million. In contrast, median employment for large firms is approximately 17 thousand and large firms have median sales of $488 million. The differences between firms in the two size classes become more significant in the second and third periods with the expansion of Compustat's coverage of small firms. The summary statistics also indicate that inventories constitute a considerable fraction of assets in both size categories and in all three time periods.

The second half of table 1 reports statistics on sources of finance. Small firms pay very few, if any, dividends. The median retention ratio, which we define as the ratio of income less dividends to income, is 0.79, 1.00 and 1.00 for small firms in each period, respectively, compared to 0.62, 0.68 and 0.67 for large firms. The higher retention ratios for small firms is consistent with the view that small firms are more likely to face binding finance constraints. Thus, dividing our sample by size roughly approximates a sample that is split on the basis of positive dividend payments. We define total net sources of finance as the sum of cash flow, funds raised from the net sale of common and preferred stock, and the change in total debt. The largest source of finance for both groups of firms in our sample is internal funds. The median cash flow to net sources ratio is 0.80 or greater for both size categories and for all periods. The least important source of finance in our sample is new equity. The median value of new shares to total sources show that small firms rely on new shares for less than one percent of their funds. (Note that the median ratios will not sum to unity.) Large firms also issue very few new shares. The proportion of funds raised by increases in debt are also relatively small for both groups of firms. Overall the numbers in the table suggest that the median firm makes modest use of external finance compared to internal finance.

B. Comovements of Inventories and Cash flow

Figures 1 and 2 show the seasonally adjusted time series plots of the quarterly means for inventory investment and cash flow for both small and large firms. Both variables are scaled by total assets. The left-hand scale refers to inventory investment; the right-hand scale refers to cash flow. Vertical lines represent panel boundaries.

The plots reveal a number of important features of the time-series characteristics of our data. First, when the plots of the inventory investment series are overlaid with the plot of aggregate manufacturing inventory investment (see Figure 1A in the appendix) it is apparent that there is a high time-series correlation between our data and aggregate inventory investment (the correlations are 0.72 for small firms and 0.76 for large firms). Second, the inventory investment series for small firms and large firms move together quite closely (the correlation between the two investment series is 0.73). Third, inventory investment appears to be more volatile over the business cycle for small firms than for large firms. Finally, and most importantly, for both plots, there is a striking correspondence between inventory investment and cash flow (the correlations are 0.76 for small firms and 0.68 for large firms).

Figures 1 and 2 also highlight several interesting macro episodes during the sample period. In the recovery from the 1982 recession, the trough-to-peak increase of inventory investment is one-third larger for the small firms even though their cash flow increased less than that of large firms. We might expect this pattern if small firms increased inventory investment not only to meet higher sales, but also to replenish stocks drawn down to release internal finance for higher valued uses during the previous recession. For both small and large firms, there is a sharp decline in cash flow and inventory investment in 1985-1986, which also occurs in U.S. aggregate data. Once again, the movement in inventory investment is greater for small firms than for large firms. Finally, in the last period, cash flow begins at a peak in late 1988 and then declines sharply for virtually the entire period. The decline is most pronounced for large firms. In contrast to the first two periods, the fall in inventory investment for large firms is modest compared to the decline in cash flow, a fact that is reflected in the regression results reported section 5.

C. Summary Statistics for the Regression Variables

Tables 2 and 3 report means and within-firm standard deviations for the key variables used in our regressions, by size and period. The construction of all variables, including the adjustment to inventories for LIFO and FIFO accounting, is described in the data appendix. All variables are quarterly flows, with the exception of the stock of inventories, and they are all scaled by total assets. In all periods, the mean inventory investment ratio reported in table 2 is greater for small firms than for large firms, which is consistent with the fact that small firms are growing faster. The cash flow ratio is somewhat greater for large firms than for small firms. Note that since our cash flow data are quarterly and we scale it by total assets, the ratios are smaller than those reported in work on fixed investment with annual data scaled by the fixed capital stock.

The summary statistics on the stock of inventories are of some interest. Inventory stocks are, on average, 26 percent of total assets for small firms and 19 percent of total assets for large firms. Since inventories are nearly ten times the size of quarterly average cash flows, there is considerable scope for firms to reduce inventory stocks, providing funds to offset negative shocks to cash flow. For example, for the typical firm, a one quarter decline of 50 percent in cash flow during a recession could be offset by only a five percent reduction in the stock of inventories. In addition, across the three time periods, the ratio of the stock of inventories to total assets has declined for both small and large firms.[15] Under our hypothesis, the role of inventories as a source of liquidity, and therefore as a potential shock absorber, has diminished.

Table 3 presents the within-firm standard deviations of inventory investment, cash flow, and sales. Inventory investment is substantially more volatile for small firms (the standard deviation is about 50 percent larger), consistent with the findings in Gertler and Gilchrist (1992). The difference between the volatility of cash flow for small and large firms, however, is smaller. The fact that inventory investment is more volatile, relative to cash flow, for small firms is consistent with the financing constraint hypothesis: for any given fluctuation in internal finance, small firms should exhibit a greater inventory response.[16]

5. REGRESSION RESULTS

A. Basic Specification

Tables 4a and 4b report the main regression results for the specification given by equation 3.4. All regressions include fixed firm effects. The standard errors in parentheses are corrected for heteroscedasticity by White's method, and the degrees of freedom are adjusted to account for the implicit firm and time dummies in the regressions. Each table contains results for the three time periods (top to bottom) as well as separate regressions for small and large firms (left to right). The regressions in table 4a differ from those in table 4b only in their treatment of fixed time effects. In table 4a, the regressions include quarter dummies to control for seasonality at the

[15] This decline is consistent with "just-in-time" inventory management practices. It is mirrored in the QFR aggregate data for manufacturing firms. Similar trends are documented by Kopcke (1993)

[16] In contrast, the within-firm variation of cash flow is larger than that of fixed investment in other studies. See Fazzari and Petersen (1993) for further discussion.

two-digit SIC level. In table 4b, the regressions include a more general set of two-digit SIC dummies defined for each time period in the data (that is, a separate dummy for each possible year-quarter combination in each two-digit SIC industry). As discussed in section 3, these time dummies control for all time-varying effects, including cost shocks. But they also could remove much of the common cyclical component of inventory investment, cash flow, and sales. Therefore, the results in table 4b may be interpreted as an extreme test of our hypothesis when only idiosyncratic firm variation, independent of cyclical industry movements, is used to estimate the coefficients.

The stock adjustment-buffer stock terms perform as well as or better than they do in other inventory research. The coefficient on the beginning-of-period inventory stock variable is always negative and highly significant. The estimated adjustment speeds of the actual to the desired inventory stock, ranging from 14 to 26 percent per quarter, are consistent with other estimates in the literature.[17] As discussed in section 3, the contemporaneous sales coefficient is an amalgam of a negative buffer stock effect and a positive target stock-accelerator effect. We obtain negative and significant contemporaneous sales effects in all regressions except for large firms in period one. Previous studies often fail to find any negative effects of unanticipated sales movements on inventory investment (see, for example, Blinder, 1986). Virtually all of the lagged sales coefficients are positive and significant, consistent with a positive dependence of the target inventory stock on expected sales and a positive correlation of expected sales with lags of actual sales.

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[17] We estimate speeds of adjustment comparable to other studies despite two disadvantages of our data for this purpose. First, although time aggregation can lower adjustment speeds, we obtain estimates with quarterly data that are broadly consistent with those obtained from monthly data. Second, as Blinder (1986) finds, combining finished goods, work-in-process, and raw material inventories is likely to lower estimated adjustment speeds. But our results for total inventories are not much different from those obtained for finished goods stocks alone.

The main focus of our study is the cash flow effects. Consistent with the financial constraint hypothesis, the sum of the cash flow coefficients, and many of the individual coefficients, are positive and significant for both small and large firms over all three time periods. For the small firms, the sums of the cash flow coefficients are highly significant and economically important (sums ranging from 0.214 to 0.388) in all three periods. A substantial fraction of the quarter-to-quarter variation in cash flow is reflected in inventory changes, even though inventory accumulation is a very small net use of funds over a long horizon (see table 3). This finding is consistent with the view that inventory adjustment is a relatively low cost way for financially constrained firms to respond to temporary cash flow shocks.[18]

The differences in the cash flow effects across firm size support the view that they arise from finance constraints. In section 2, we noted that small firms face tighter finance constraints, and we therefore expect that the impact of cash flow shocks on inventory investment should be greater for small firms. This result occurs for the sum of the cash flow coefficients in all of our regressions, and the difference is statistically significant in periods 2 and 3. The difference in the contemporaneous cash flow coefficients is particularly striking across firm sizes.

The relative magnitudes of the cash flow coefficients over the three time periods are of interest and lend support to the financing constraint hypothesis. In the first panel, which covers the 1981-82 recession, the cash flow coefficients are large for both size classes. These results are consistent with the pronounced decline in aggregate inventory investment during the 1981-82 recession. Such a decline could occur only if large firms made major cuts in inventory investment. This was also a

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[18] The sums of the coefficients are in the same range as estimates of the impact of cash flow on fixed investment found in other studies (see Fazzari, Hubbard, and Petersen, 1988, for example) even though average inventory investment is much smaller than fixed investment for manufacturing firms. Therefore, the elasticity of inventory investment with respect to cash flow is very high, compared with fixed investment. Fazzari and Petersen (1993) obtain similar results.

period of very tight money, when even large firms may have faced temporary difficulties in securing external finance at reasonable terms. It is therefore quite possible that large firms sought liquidity to offset declines in cash flow by reducing their stock of inventories, consistent with our regression results.

In contrast to the first period, the cash flow coefficients for large firms in the third period are small. Again, this result is consistent with the historical record. Aggregate reductions in inventory investment, compared with the 1981-82 recession, were smaller and took place over a longer time in the 1990-91 recession covered by this period, although cash flow declined substantially. In addition, aggregate inventory stocks were lower entering the 1990-91 recession, which might reduce the extent to which optimizing firms cut inventories to respond to reductions in cash flow. The economic slowdown in 1985 and 1986 was not as dramatic as the recessions in our first and third periods. But the aggregate decline in inventory investment as a percentage of the aggregate decline in cash flow was about as large during this slowdown as it was during the 1982 recession. Thus, it is not surprising to find significant cash flow effects for this period. We discuss these macroeconomic issues in more depth in the next section.

It is interesting to compare our results with the findings of Kashyap, Lamont, and Stein (1993). In cross sections that overlapped with our data, their measure of liquidity was significant for inventory investment only in 1982, and only for firms without bond ratings (a sample with characteristics similar to our small firm sample).[19] While we also find that finance effects were strongest in the early 1980s, our results imply a more pervasive role for internal finance, both across firms and time. There are several possible reasons for this difference, consistent with the

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[19] Kashyap, Lamont, and Stein also report a significant liquidity effect, again only for their sample without bond ratings, for 1974.

different objectives of the two papers. First, our results are based on quarterly data rather than annual data. Because of the flexibility of inventories discussed previously, financial effects on inventory investment may occur quickly, and therefore they may appear relatively weak at annual frequencies even if they are significant at higher frequencies. Second, Kashyap, Lamont, and Stein estimate the "between" firm effect (in cross sections) of the *stock* of cash and marketable securities. This variable measures the extent to which firms may require debt financing, and therefore firms' exposure to lending restrictions induced by the tight monetary policy, which is their focus. In contrast, we examine the "within" firm variation of the *flow* of internal finance (using the time dimension of our panels). As we showed previously, since cash flow is quite volatile over the business cycle, its variation across time is the appropriate focus for our interest in the cyclical impact of internal finance on the time-series behavior of inventory investment.

The interpretation of our results is largely the same whether one looks at regressions that include only quarter dummies (table 4a) or regressions with a full set of time dummies (table 4b). Predictably, however, the size of the cash flow effects declines somewhat when the cyclical variation in cash flow common to firms in each two-digit industry is removed by including time dummies. The difference is most pronounced for period one, which contains the sharp cyclical episode in the early 1980s. The important point is that the cash flow effects remain strong, especially for small firms, even in the rather extreme experiment that attributes *all* of the time series variation at the industry level to factors other than cash flow.

B. Alternative Specifications and Robustness

We conducted a variety of other empirical experiments that largely confirm our main results. In previous sections, we mentioned the possibility that the omitted variable bias, arising from excluding cash flow from inventory investment equations for financially constrained firms, may have been partially responsible for disappointing results with buffer stock models in other studies. The reason is straightforward. The buffer stock model predicts a negative coefficient on unexpected sales, but unexpected sales is likely to be positively correlated with cash flow. If cash flow is excluded from the model, then the buffer stock coefficient may be biased upward. Our results provide support for this view. When we exclude cash flow, the coefficient on contemporaneous sales, the proxy for unexpected sales, increases in all our regressions. This increase is substantial for small firms in all periods and for large firms in period 1. These are also the regressions for which the contemporaneous cash flow effects are most important. In these regressions, excluding cash flow increases the contemporaneous sales coefficient, on average, by about 0.02, roughly half its magnitude in the regressions including cash flow. (The results are similar whether or not time dummies are included.)

To account for possible endogeneity, we instrumented contemporaneous cash flow with its first two lags (and therefore excluded the lagged cash flow variables from the equation). The estimates for the lagged inventory stock and sales variables are similar to those from the OLS regressions. While the point estimates of the cash flow effects increase in every regression, compared with the results in table 4a, their standard errors are also higher.[20] Nevertheless, the cash flow effects remain significantly different from zero for all the regressions (asymptotic t-statistics ranging from 2.6 to 5.3), except for large firms in the third period. The pattern of coefficients across the three panels is similar to the OLS results: the largest effects for both small and large firms appear in the period that contains the 1981-82 recession. Due to higher standard errors, however, the difference between large and small firms is only

[20] The regressions with time dummies had a similar pattern of results, but even larger standard errors. This result is not surprising since the regression with time dummies sweeps out common cyclical variation in cash flow in each industry. This cyclical variation helps lags of cash flow act as effective instruments.

significant for the third period. Overall, the instrumental variable results strongly confirm the economic importance of cash flow for inventory investment across firms and time.

Finally, we considered the impact of adding explicit measures of input costs to the regressions. We included contemporaneous and two lagged values of real hourly wages, real energy costs, and real interest rates. The wage and energy cost data were disaggregated to the two-digit SIC level. While some individual coefficients were significant, they had no systematic sign pattern, except for a negative impact of energy prices in the first time period. The results for the other coefficients were similar to those reported in tables 4a and 4b, including the negative "buffer stock" effect of contemporaneous sales. Most importantly, the sums of the cash flow coefficients are between those reported in tables 4a and 4b. The sums remain significant, statistically and economically, and the cash flow effects were greater for small firms than for large firms.[21]

6. INTERNAL FINANCE AND THE AGGREGATE BUSINESS CYCLE

The results presented in the previous section show that inventory movements are linked to fluctuations in internal finance in panels covering a substantial fraction of total inventories in manufacturing. Three facts stand out: the economically important cash flow coefficients for large as well as small firms in all periods, the dominant share of cash flow as a source of funds, and the dramatic procyclical movements of cash flow. Collectively, these facts help explain why aggregate inventory investment is so volatile over the business cycle.

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[21] The sums of the cash flow coefficients for small firms in periods one, two, and three were 0.279, 0.256, and 0.208. For large firms the corresponding sums were 0.230, 0.175, and 0.040.

To this point, we have emphasized the connection between internal finance and inventory investment. In this section, we extend the analysis to include cyclical fluctuations of fixed investment. If finance constraints are important, then reductions in internal finance will be reflected, to a greater or lesser degree, in all components of total investment. But the composition of total investment shortfalls, between inventories and fixed capital, has varied a great deal across recessions. In accounting for these compositional differences, we provide an explanation for the fact that fixed investment tends to decline more relative to inventory investment in longer, more severe recessions. Our approach also suggests why the cash flow effects in our inventory investment regressions are larger in the panel that covers the 1981-82 recession than the one containing the 1990-91 recession. We conclude by noting that unless internal finance itself were to become more stable, reductions in inventory fluctuations need not result in a more stable macro economy.

As discussed in detail in section 2, the amount by which firms cut inventory investment compared to fixed investment when internal finance declines will depend on the relative marginal costs of reducing each component. In short recessions the low adjustment and liquidation costs of inventories induces firms to offset much of their shortfall in cash flow by inventory disinvestment. As inventories are depleted during a protracted recession, however, the opportunity cost of further liquidation rises as the marginal product of inventories rises. Similarly, if firms enter a recession with unusually low inventory stocks, it will be more costly to sacrifice inventories. In either of these cases, fixed investment will likely bear a larger burden of the shortfall in cash flow.[22]

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[22] This argument relates to research emphasizing the strength of firms' balance sheets as a determinant of investment. See Bernanke and Gertler (1989), Calomiris and Hubbard (1990), and Hubbard and Kashyap (1992).

Fazzari and Petersen (1993) and Carpenter (1992) analyze this kind of connection between fixed and working capital investment in annual firm data. They find that working capital investment is very sensitive to cash flow. Furthermore, declines in working capital investment increase fixed investment for low-dividend firms.[23] These facts imply that finance constrained firms "smooth" fixed investment relative to cash flow fluctuations by adjusting working capital investment, which includes inventory investment. The less that such firms are able to reduce working capital and inventory investment in a recession when cash flow falls, therefore, the more they will have to cut fixed investment.

Macroeconomic evidence supports this kind of interaction between internal finance, inventories, and other aspects of firm investment. In his classic work on business cycles, Abramowitz (1950) found an inverse relation between the length of cycles and the change in inventory investment. For cycles less than a year in duration, inventory investment accounted for 96 percent of the change in output. For cycles of moderate duration (1.5 to 2.5 years), changes of inventory investment were 47 percent of the GNP changes. For the two long cycles Abramowitz studied (exceeding 3.75 years), changes of inventory investment amounted to only 19 percent of the change in output. Blinder and Maccini (1991a) report statistics with similar implications for postwar recessions. For the two most severe recessions covered by their statistics (1974-75 and 1981-82), changes in inventory investment averaged 53 percent of the drop in output, while in the other recessions inventory changes averaged 98 percent of the output drop. Zarnowitz (1992, p. 27) reviews the historical record and confirms these facts, "[i]nventory investment plays a very important role in

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[23] Fazzari and Petersen (1993, p. 338) also split working capital investment into inventory and non-inventory components. They report that both components had a significant negative effect on fixed investment. We cannot jointly estimate fixed and inventory investment equations with our quarterly data because Compustat only recently began tracking quarterly fixed investment and many firms report fixed investment only at annual frequencies.

short and mild cycles, whereas fluctuations in fixed investment acquire a greater weight in the longer and larger cycles."

A more detailed look at the two most recent recessionary periods also provides an interesting perspective on this issue. The data in table 5 show the macroeconomic impact of recent recessions on output, cash flow, inventory investment, and fixed investment. The shortfall in aggregate cash flow (corporate profits plus capital consumption) during the two periods was substantial and of a roughly equivalent magnitude, yet the character of the recessions was quite different. The ratio of the shortfall of inventory investment to that of fixed investment was 0.95 in the early 1980s. In contrast, this ratio was only 0.58 in the early 1990s. Hall (1993) presents similar findings. He shows that the decline in fixed investment is about three times as large as the decline in inventory investment, measured as deviations from trend over 1989-91.

Table 5

Macroeconomic Shortfalls of Cash Flow, Inventory Investment, and Fixed Investment

	Early 1980s Recession	Early 1990s Recession
Cumulative Cash Flow Shortfall	334.8	297.2
Cumulative Inventory Investment Shortfall	198.7	164.5
Cumulative Fixed Investment Shortfall	209.0	284.1

Note: All data are in billions of dollars summed over quarters at annual rates. The shortfalls for cash flow and fixed investment are measured as the cumulative difference from peak values prior to the recession trough until the variable regains its pre-recession peak. Because the peaks are not as well-defined for aggregate inventory investment, the shortfall during recession periods is defined as the cumulative difference between inventory investment and its long-run average.

These results lead to the question of why the composition of aggregate investment reductions in the early 1990s was so different from the early 1980s recession. The answer may be that both manufacturing and trade inventory-to-sales ratios fell substantially in the 1980s (see, for example, Morgan 1991). This phenomenon could be due to changes in inventory management procedures--adoption of the much publicized "just-in-time" approach, for example. Under these circumstances, firms may have had less flexibility to liquidate inventory stocks when cash flow weakened in the late 1980s and into the 1990s. The result was a smaller decline of inventory investment relative to the experience of the early 1980s, as our regression results show for large firms. But consistent with the data in table 5, smaller inventory investment reductions may not dampen the cycle if an important propagating mechanism in the downturn works through internal finance.

The data in table 5 are consistent with another difference in the character of the two recent recessions. The early 1980s downturn was sharp and the recovery beginning in 1983 was robust. In contrast, the recession that did not officially begin until 1990:3 was preceded by slow growth beginning in 1989 and the recovery remains anemic into 1993. Therefore, the early 1990s recession is consistent with Abramowitz's (1950) finding that fixed investment suffers more relative to inventories in relatively long downturns.

This perspective developed here is different from much of the conventional analysis of inventories in the business cycle which treats inventory changes as an isolated phenomenon. Many authors have concluded that macro fluctuations would be substantially less severe, indeed some cycles may cease to exist, if inventories were more stable. For example, Dornbusch and Fischer (1990, p. 307) write:

> If inventories could be kept more closely in line with sales, or aggregate demand, fluctuations in inventory investment and GNP would be reduced. As business methods are improving all the time, the hope is often expressed that new methods of management will enable firms to keep tighter control over their inventories and thus the prospects for steadier growth can be improved.

If internal finance flows are an important determinant of inventory fluctuations, however, this conventional view is incomplete. Firms that do not respond to reduced cash flow by cutting inventory investment must still satisfy finance constraints. Cash flow shocks will then have a larger impact on other firm activities, such as fixed investment, employment, and R&D.[24] Therefore, inventory fluctuations might be best viewed, at least in part, as symptoms of the deeper problem created by finance constraints.

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[24] Fazzari and Petersen (1993) present microeconomic evidence showing that if cash flow shocks do not affect working capital investment (which includes inventories), they will be reflected in fixed investment. Aggregate data provided by Kopcke (1993, figure 4) also support the idea that fixed investment and inventories compete with each other for cash flow. He finds that fixed investment nearly equals cash flow over a long horizon, which is not surprising since inventory investment is a small use of funds in the long term. Fixed investment rises about 30 percent above cash flow, however, in both the 1981-82 and 1990-91 recessions, just at the time of negative inventory investment.

7. CONCLUSION

A well known but under-emphasized feature of the business cycle is that the flow of internal finance is very procyclical, especially during contractionary phases. It is also well known that internal finance is the predominant source of funds for most firms in the U.S. economy. Recent research indicates that access to internal finance constrains firms' investment expenditures, suggesting that the dramatic fluctuations in internal finance in the U.S. economy may be important for explaining the pronounced cyclical movements in aggregate investment.

Internal finance is used to fund many different investment activities including fixed investment and R&D. However, we argue that because of relatively low adjustment costs, inventories will often bear a disproportionate share of internal finance fluctuations. Inventories are a large proportion of firms' assets and are readily reversible. For example, firms can obtain liquidity to support other activities by reducing the rate at which they replenish the stock of raw materials. Because the stock of inventories is so large relative to quarterly cash flow for the typical firm in our study, a comparatively small percentage decline in the stock of inventories would be sufficient to offset even the large percentage reductions in cash flow that occur in recessions.

Our results strongly support the view that firms absorb shocks to internal finance through changes in inventory investment. Bringing previously untapped, *quarterly* firm data to bear on the relationship between inventory investment and internal finance, we estimate a standard inventory investment model augmented with firm and time effects as well as internal finance. Our results, from three separate panels, indicate that internal finance had a stronger impact on inventory investment for small firms than for large firms. However, the effect was economically important even for large firms, particularly during the 1981-82 recession. That cash flow affects large firms' inventory investment is important for establishing the importance of internal finance fluctuations for aggregate movements in inventory investment.

Inventory fluctuations often account for a majority of the decline in GNP in recessions, and our results help explain this phenomenon. Our results, however, cast doubt upon claims that the damping of inventory movements will necessarily reduce cyclical fluctuation in the aggregate economy. Fluctuations in internal finance must be absorbed somewhere, and in many recessions, inventory disinvestment is the method firms choose. However, if inventory stocks are low going into a recession or if they are drawn down during a prolonged recession, finance constraints will begin to have a greater impact on other firm activities, particularly fixed investment. This observation helps to explain the major differences in the composition of investment shortfalls in previous business cycles.

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DATA APPENDIX

Compustat contains data compiled in a fiscal-year format. Compustat aligns the fiscal quarters in the data with calendar quarters as follows. If the company's fiscal-year ends in the same month as a calendar quarter, the adjustment is straightforward. In cases where the end of a firm's fiscal quarter does not coincide with the end of a calendar quarter, we adjust the data so that the majority of the fiscal quarter is placed into the appropriate calendar quarter.

Internal finance is represented by cash flow in the regression model. Cash flow is defined as income before extraordinary items plus the sum of non-cash charges against income. The bulk of these charges consist of depreciation and amortization expenses. The remaining charges are: extraordinary items and discontinued operations, equity in net loss, and deferred taxes. The sales variable reported by Compustat is net of cash and trade discounts and other allowances for which customers receive credit. To construct a real measure for sales, we divide sales by the implicit GNP price deflator. We use the implicit price deflator for non-residential investment to construct all other real variables.

Compustat reports book values for inventories as well as the method(s) that companies use to value their inventories. Firms may use more than one method to evaluate their inventories. If so, Compustat indicates the predominant method. We adjust both the lagged stock of inventories and the inventory investment variable in our regressions to minimize the bias introduced by historical cost accounting. The value of the stock of a firm's inventories will be understated in an inflationary environment when inventories are evaluated with LIFO methods. To adjust, we group firms into LIFO and non-LIFO categories. For LIFO firms, we apply an algorithm developed in Salinger and Summers (1983) to estimate a replacement value for the inventory stock. For FIFO firms, the change in inventories will be overstated if there is a positive inflation rate because the end-of-period value will include the nominal inflation of the stocks. To remove the inflation bias from FIFO firms' inventory investment variable, we compute the change of inventories after deflating the stocks. For LIFO firms, we construct the flow measure of inventory investment by differencing the stock, then deflating.

The seasonal adjustment procedure we described in section 3 generates an inventory investment series that closely resembles the seasonally adjusted change in nonfarm business manufacturing inventories compiled by the Census Bureau. Figure A1 shows the close correspondence between the aggregate manufacturing inventory series and the means of our inventory investment data, seasonally adjusted with two-digit SIC quarter dummies. Our data capture the major movements in aggregate inventory investment during the sample period very well. In addition, an examination of the partial autocorrelation function of our series after accounting for seasonal fluctuations with dummy variables indicated that no partial autocorrelation function was significant at seasonal frequencies, and their pattern closely resembled that of the aggregate series adjusted with the Census X11 procedure.

Table 1

Sample Medians

	Period 1: 1981:1-1984:1		*Period 2: 1984:2-1988:3*		*Period 3: 1988:4-1991.4*	
	Small Firms	**Large Firms**	**Small Firms**	**Large Firms**	**Small Firms**	**Large Firms**
Number of Firms	250	261	458	249	672	371
Total Assets (Millions $87)	98.1	1491.9	65.0	1348.5	64.0	1457.5
Inventories (Millions $87)	23.7	279.5	15.2	219.4	14.9	235.9
Employment (Thousands)	1.6	17.3	0.9	13.7	0.7	11.7
Sales (Millions $87)	36.8	488.7	21.0	388.4	19.9	388.0
Sales Growth (Annualized)	-0.4%	-2.8%	5.7%	5.3%	2.0%	1.6%
Cash Flow to Net Sources	85.9%	92.5%	86.9%	88.1%	88.6%	80.0%
Stock Issues to Net Sources	0.3%	7.4%	0.5%	1.1%	0.1%	0.5%
Debt Issues to Net Sources	3.8%	1.4%	4.9%	7.1%	2.7%	16.0%
Retention Ratio	79.1%	61.7%	100.0%	67.7%	100.0%	67.5%

Table 2

Sample Means for Regression Variables

	Period 1: 1981:1-1984:1		*Period 2: 1984:2-1988:3*		*Period 3: 1988:4-1991.4*	
	Small Firms	**Large Firms**	**Small Firms**	**Large Firms**	**Small Firms**	**Large Firms**
ΔN_t / TA_t	0.0029	-0.0009	0.0054	0.0027	0.0020	0.0017
N_t / TA_t	0.2866	0.2160	0.2631	0.1947	0.2563	0.1789
CF_t / TA_t	0.0223	0.0257	0.0227	0.0276	0.0198	0.0251
S_t / TA_t	0.4172	0.3606	0.3529	0.3246	0.3255	0.2874

Table 3

Within-Firm Standard Deviations

	Period 1: 1981:1-1984:1		*Period 2: 1984:2-1988:3*		*Period 3: 1988:4-1991.4*	
	Small Firms	**Large Firms**	**Small Firms**	**Large Firms**	**Small Firms**	**Large Firms**
ΔN_t / TA_t	0.0237	0.0159	0.0265	0.0174	0.0263	0.0154
CF_t / TA_t	0.0119	0.0109	0.0176	0.0144	0.0186	0.0139
S_t / TA_t	0.0554	0.0389	0.0614	0.0462	0.0499	0.0352

Table 4a
Regression Results: Basic Model with Quarter Dummies
Dependent Variable: ΔN_t / TA_t

Independent Variable	**Small Firms**		**Large Firms**	
Period 1: 1981:3 - 1984:1				
N_{t-1} / TA_t	-0.262	(0.023)	-0.253	(0.023)
S_t / TA_t	-0.062	(0.014)	0.007	(0.015)
S_{t-1} / TA_{t-1}	0.013	(0.013)	0.043	(0.014)
S_{t-2} / TA_{t-2}	0.055	(0.012)	0.046	(0.013)
CF_t / TA_t	0.195	(0.054)	0.135	(0.035)
CF_{t-1} / TA_{t-1}	0.168	(0.054)	0.072	(0.035)
CF_{t-2} / TA_{t-2}	0.025	(0.055)	0.060	(0.040)
Sum of CF Effects	0.388	(0.076)	0.267	(0.060)
Adjusted R^2	0.270		0.203	
Period 2: 1984:2 - 1988:3				
N_{t-1} / TA_t	-0.157	(0.010)	-0.136	(0.014)
S_t / TA_t	-0.042	(0.009)	-0.023	(0.012)
S_{t-1} / TA_{t-1}	0.051	(0.008)	0.064	(0.010)
S_{t-2} / TA_{t-2}	0.037	(0.008)	0.003	(0.009)
CF_t / TA_t	0.146	(0.024)	0.057	(0.025)
CF_{t-1} / TA_{t-1}	0.060	(0.023)	0.045	(0.022)
CF_{t-2} / TA_{t-2}	0.057	(0.021)	0.094	(0.020)
Sum of CF Effects	0.263	(0.033)	0.196	(0.035)
Adjusted R^2	0.128		0.121	
Period 3: 1988:4 - 1991:4				
N_{t-1} / TA_t	-0.222	(0.012)	-0.201	(0.020)
S_t / TA_t	-0.054	(0.010)	-0.037	(0.012)
S_{t-1} / TA_{t-1}	0.076	(0.009)	0.083	(0.011)
S_{t-2} / TA_{t-2}	0.029	(0.009)	0.021	(0.009)
CF_t / TA_t	0.164	(0.022)	0.045	(0.025)
CF_{t-1} / TA_{t-1}	0.034	(0.020)	0.001	(0.022)
CF_{t-2} / TA_{t-2}	0.016	(0.021)	0.019	(0.021)
Sum of CF Effects	0.214	(0.032)	0.065	(0.036)
Adjusted R^2	0.138		0.159	

All equations were estimated with fixed firm effects that are not reported. Time effects were included as described in the text and are also not reported. Standard errors are corrected for heteroscedasticity using White's method. Standard errors are also corrected for degrees of freedom lost due to fixed firm and time effects.

Table 4b
Regression Results: Basic Model with Time Dummies
Dependent Variable: ΔN_t / TA_t

Independent Variable	**Small Firms**		**Large Firms**	
Period 1: 1981:3 - 1984:1				
N_{t-1} / TA_t	-0.258	(0.023)	-0.240	(0.026)
S_t / TA_t	-0.054	(0.014)	-0.003	(0.016)
S_{t-1} / TA_{t-1}	0.023	(0.011)	0.034	(0.015)
S_{t-2} / TA_{t-2}	0.072	(0.013)	0.054	(0.014)
CF_t / TA_t	0.116	(0.057)	0.124	(0.037)
CF_{t-1} / TA_{t-1}	0.121	(0.055)	0.057	(0.037)
CF_{t-2} / TA_{t-2}	-0.003	(0.056)	0.035	(0.042)
Sum of CF Effects	0.234	(0.083)	0.216	(0.065)
Adjusted R^2	0.352		0.267	
Period 2: 1984:2 - 1988:3				
N_{t-1} / TA_t	-0.155	(0.011)	-0.137	(0.015)
S_t / TA_t	-0.044	(0.009)	-0.027	(0.013)
S_{t-1} / TA_{t-1}	0.049	(0.008)	0.063	(0.011)
S_{t-2} / TA_{t-2}	0.039	(0.008)	0.009	(0.009)
CF_t / TA_t	0.138	(0.025)	0.049	(0.026)
CF_{t-1} / TA_{t-1}	0.057	(0.023)	0.034	(0.023)
CF_{t-2} / TA_{t-2}	0.048	(0.022)	0.078	(0.020)
Sum of CF Effects	0.243	(0.034)	0.161	(0.037)
Adjusted R^2	0.173		0.205	
Period 3: 1988:4 - 1991:4				
N_{t-1} / TA_t	-0.227	(0.012)	-0.211	(0.020)
S_t / TA_t	-0.063	(0.010)	-0.046	(0.013)
S_{t-1} / TA_{t-1}	0.069	(0.009)	0.088	(0.011)
S_{t-2} / TA_{t-2}	0.027	(0.009)	0.022	(0.009)
CF_t / TA_t	0.165	(0.022)	0.036	(0.025)
CF_{t-1} / TA_{t-1}	0.033	(0.021)	-0.016	(0.023)
CF_{t-2} / TA_{t-2}	0.009	(0.021)	0.007	(0.022)
Sum of CF Effects	0.207	(0.033)	0.027	(0.039)
Adjusted R^2	0.172		0.219	

All equations were estimated with fixed firm effects that are not reported. Time effects were included as described in the text and are also not reported. Standard errors are corrected for heteroscedasticity using White's method. Standard errors are also corrected for degrees of freedom lost due to fixed firm and time effects.