Three Financing Constraint Hypotheses and Inventory Investment: New Tests With Time and Sectoral Heterogeneity

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Abstract:

Over the last decade, research has shown that financing constraints have an important impact on many aspects of firm behavior and aggregate fluctuations. This paper undertakes a critical comparison of the three main financing constraint hypotheses--the bank lending, collateral, and internal finance hypotheses. To discriminate between hypotheses, we extend existing methodology by focusing on time and sectoral heterogeneity in high-frequency (quarterly) firm data. We find evidence consistent with all three financing constraint channels, but the internal finance hypothesis appears to best explain the broad set of facts about the amplitude of inventory investment and its sectoral and time heterogeneity.

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In the last decade, there has been a dramatic revival of research on financing constraints and capital market imperfections. As the review by Hubbard (1995) indicates, the literature is vast, with literally hundreds of new studies that cover the U.S. and many other countries, and it examines a broad range of activities.[1] This research demonstrates the importance of financing constraints for firms' investment in plant and equipment, inventories, and R&D. In addition, recent studies link financing constraints to employment decisions, pricing under imperfect information, business formation and survival, risk management, and tax policy. Much attention focuses on the macroeconomic importance of financing constraints, and a large number of new studies examine the role of financial factors in the transmission of monetary policy.

There are three main hypotheses in the financing constraint literature: i) the collateral hypothesis, ii) the bank lending hypothesis, and iii) the internal finance hypothesis. These hypotheses have a long history: the collateral hypothesis dates back to Irving Fisher (1916), the bank lending hypothesis can be traced to the "availability doctrine," and the internal finance hypothesis can be found in the work of Tinbergen (1938) and Meyer and Kuh (1957). While the three hypotheses are complementary in many respects, there are important differences in the mechanisms through which they operate. The bank lending and collateral mechanisms are closely related in that both work through external debt. The former emphasizes shifts in banks' loan supply schedules which change the flow of credit to bank-dependent firms, while the latter focuses on how changes in collateral value affect the cost and quantity of debt available to firms. In contrast, historical discussions of the internal finance hypothesis emphasized that because of capital market imperfections, many firms have little or no access to debt. Consequently, "the actual investment rate will be restricted predominantly to gross profit levels" (Kuh, 1963, p. 7). In other words, an additional

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[1] Hubbard's survey covers more than 100 articles on financing constraints or closely related topics, most written since 1990, indicating the fast rate of growth of the literature. Other excellent surveys include Bernanke (1993) and Gertler (1988) and Schiantarelli (1995).

dollar of internal finance permits an additional dollar of investment even when external finance is prohibitively costly or rationed.

This paper has two major objectives. The first is to examine these three financing constraint hypotheses within a single study. This comparative effort has not yet been undertaken even though a full understanding of the relevance of financing constraints requires knowledge about the ability of each hypothesis to explain the salient facts. Moreover, each hypothesis has different implications for tax and monetary policy (as we discuss in section VII).[2] We explore how well each of the three financing constraint hypotheses can explain inventory investment over the business cycle. Several recent studies, each using one of the three hypotheses, examine whether financing constraints can explain an economically important part of the dramatic inventory cycle that accompanies most recessions.[3] This is a challenge for the financing constraint literature and the stakes are high, since inventory investment fluctuations account for a surprisingly large fraction of the aggregate business cycle.[4]

The second objective of the paper is to extend the methodology for testing financing constraint hypotheses introduced by Fazzari, Hubbard, and Petersen (1988a). It has become standard practice for empirical research in this area to examine heterogeneity across groups of firms (firm heterogeneity), where the groups differ in ways that are *a priori* associated with the cost of external finance and the presence of financing constraints. Our extended method adds two new dimensions of heterogeneity--sectoral and time. Sectoral

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[2] Kashyap (1994, p. 126) also argues that it is important to distinguish between different views of financing constraints because policy implications differ.

[3] See Calomiris, Himmelberg, and Wachtel (1994), Carpenter, Fazzari, and Petersen (1994), Gertler and Gilchrist (1994a) and Kashyap, Lamont, and Stein (1994).

[4] Blinder and Maccini (1991a) report that declines in inventory investment amounted to 87 percent of the drop in aggregate U.S. output during postwar recessions. Explaining this fact is an unresolved problem because it is at odds with microeconomic models that imply inventories should stabilize output and because the traditional financial channel for explaining inventory investment, the interest rate, has not received much empirical support.

heterogeneity refers to the fact that some sectors of the economy exhibit far greater investment cyclicality than others. Time heterogeneity is based on the fact that individual investment cycles are different in important ways, including the stance of monetary policy. Combining firm heterogeneity with sectoral and time heterogeneity provides more discriminating tests, as well as many more experiments to examine different hypotheses. In addition, it provides a basis for distinguishing between alternative hypotheses within the financing constraints literature that may have observationally equivalent implications if one looks at heterogeneity in the firm dimension alone.

To implement sectoral heterogeneity tests, we examine inventory investment in the durable and nondurable goods sectors of manufacturing. Stanback (1962), and more recently Zarnowitz (1985), report that inventory investment is far more volatile in the durable goods sector of the economy than in the nondurable goods sector. Our study is the first to show that financial factors are partially responsible for this difference. To implement time heterogeneity tests, we examine three periods in the 1980s and early 1990s that contain three distinct inventory cycles in manufacturing as well as salient differences in monetary and financial environments.

Evidence from aggregate and micro data, presented in sections III and IV, also indicates that inventory investment is more volatile in the durable goods sector than in the nondurable goods sector. We argue that it is difficult to explain this fact with the collateral hypothesis, to the extent that it relies upon movements in interest rates, or the bank lending hypothesis. It is also difficult for any financing constraint hypothesis relying on monetary policy to explain the inventory cycle that is evident in aggregate and micro data during the mid 1980s, a widely recognized period of easy money.

We also present evidence from both aggregate and microeconomic data showing that the cyclical movements in short-term debt exhibit little sectoral heterogeneity and have a much smaller cyclical amplitude than that of inventory investment. In contrast, internal finance flows have about the same cyclical amplitude as inventory investment and are

more cyclical in the durable goods sector. Internal finance flows also dropped sharply during the inventory cycle of the mid 1980s.

We present micro evidence in sections V and VI based on high frequency, quarterly firm data covering a large portion of the manufacturing sector. Quarterly data allow us to capture the high-frequency movements of inventory investment and provide us with the degrees of freedom needed to run regressions in the time dimension of the panel for short calendar periods. We estimate within-firm regressions for a standard inventory stock adjustment equation augmented with variables chosen to capture the effect of financing constraints. The financial variables include cash flow, the stock of cash, and the interest coverage ratio, variables used by previous studies to examine one of the three financing constraint hypotheses. The internal finance hypothesis performs well along all three dimensions of heterogeneity. We also find evidence supporting an external finance channel; in particular, a model with both cash flow and the flow of debt finance performs well. The importance of the latter variable is consistent with the bank lending and collateral views. Yet, the robust performance of cash flow in regressions that control for the effect of debt flows on investment confirms the empirical importance of the internal finance hypothesis.

Our results strongly support the existence of financing constraints, and some aspects of the results are consistent with all three financial constraint hypotheses. The internal finance hypothesis, however, appears to be the most general in the sense that it explains more dimensions of heterogeneity in the data and it appears to be capable of explaining the greatest proportion of inventory fluctuations over the business cycle.

II. The Three Hypotheses

In this section, we summarize each of the three financing constraint hypotheses as well as empirical studies which have employed them to examine inventory fluctuations. Each hypothesis shares a common foundation: capital market imperfections create a wedge between the cost of retained earnings and external finance (debt and new share issues). The presence of such a wedge has been motivated in early literature by various kinds of explicit transaction costs, such as flotation costs, bankruptcy costs, and distortionary taxes. Contemporary research appeals to asymmetric information between firms and potential suppliers of external finance. This problem can lead to adverse selection and moral hazard in debt and equity markets that increase the cost of external finance, cause credit rationing, or lead to a breakdown in the market for new equity issues.[5]

In spite of the similar foundations for the three financing constraint hypotheses, there are substantial differences among the mechanisms through which they operate. The bank lending and collateral hypotheses both work through external finance. The bank lending hypothesis focuses on shifts in the supply of bank loans, usually in response to monetary policy. The collateral hypothesis is somewhat broader, emphasizing how the collateral value of firms' assets affects their access to external finance from bank or other sources. In contrast to the others, the internal finance hypothesis requires no debt mechanism. Very simply, an additional dollar of cash flow permits a firm to invest an additional dollar even if external finance is prohibitively costly or unavailable. In this section, we examine these hypotheses in more depth and survey recent evidence on the ability of each to explain aspects of the dramatic inventory cycles in the U.S. economy.

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[5] See the survey by Gertler (1988).

A. The Bank Lending Hypothesis

The bank lending hypothesis dates back to the "availability doctrine" which identifies a credit channel for monetary policy and attributes a decline of firm activity during recessions to an inward shift in the supply of bank loans.[6] More recently, Bernanke and Blinder (1988) construct a simple model incorporating a bank loan channel in a modified IS-LM framework. For this channel to exist, some firms must be bank dependent and monetary policy must shift the loan supply schedule. Bernanke and Blinder (1992) and Kashyap, Stein, and Wilcox (1993) present aggregate vector autoregressions to show that monetary policy works partly through a bank loan channel.[7] Kashyap, Stein, and Wilcox indicate that the bank loan channel may be particularly important for inventory investment.

Kashyap, Lamont, and Stein (1994, KLS hereafter) use firm-level data to examine the bank lending hypothesis' ability to explain inventory fluctuations in the U.S. economy, stressing that previous tests with aggregate data could not test the cross-sectional predictions of the hypothesis. They argue "[i]f the lending view is correct, one should expect the inventories of bank-dependent firms ... to fall *more sharply* in response to a monetary contraction than the inventories of those firms who have either plenty of internal funds or access to public debt markets and therefore do not need to rely on bank financing" (KLS, p. 567). Their tests are based on the idea that bank-dependent firms' stocks of cash and marketable securities should be positively correlated with inventory investment during periods of contracting bank loan supply (caused by tight monetary policy), since firms can use cash stocks to temporarily offset a decline in lending. KLS identify 1975 and 1982 as years of tight money, and find that cash stocks are significant and economically important in

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[6] Early references include Hodgman (1960), Kane and Malkiel (1965), Lindbeck (1959), Rosa (1951), and Smith (1956).

[7] Also see Bernanke (1983). Evidence against the importance of a credit channel for monetary policy may be found in King (1986), Romer and Romer (1990), Oliner and Rudebusch (1993), and Ramey (1993). Friedman and Kuttner (1993) find an important role for short-term credit markets in determining economic activity using a general model encapsulating bank loans and commercial paper flows.

cross-sectional inventory regressions for firms without corporate bond ratings during these years, but not for firms with ratings. KLS do not find significant effects in 1985-86, a period they argue is characterized by loose money.

B. The Collateral Hypothesis

Collateral models date back at least to Irving Fisher (1916) and Wesley Mitchell (1951). Like the bank lending hypothesis, the collateral hypothesis focuses on firms' access to debt finance. Rather than shifts in loan supply caused by factors independent of borrower characteristics, however, the collateral hypothesis emphasizes that access to external finance (both its quantity and cost) can vary with the amount of collateral firms offer for loans.[8] Collateral (or net worth), in this view, is largely a property of firms' balance sheets, and it includes tangible assets as well as the capitalized value of expected future cash flows. Gertler and Gilchrist (1994b, p. 49) conclude that tight monetary policy affects collateral because "[t]he rise in the interest rate reduces the discounted value of collateralizable net worth, thereby raising [the] premium of external finance." Gertler and Gilchrist (1994a, p. 311) also describe an indirect channel for monetary effects. Tight money reduces cash flows causing balance sheets to deteriorate and raises the premium lenders charge for external funds. This indirect channel, since it involves cash flow, complicates attempts to distinguish between the collateral and internal finance hypotheses, as we consider in more detail below.

Gertler and Gilchrist (1994a, hereafter GG) test the importance of the collateral hypothesis for inventory investment by examining the stance of monetary policy and its connection to inventory fluctuations of small and large firms using aggregate time-series data collected from the Quarterly Financial Reports (QFR). They find that inventory

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[8] For example, Bernanke and Gertler (1989) construct a model in which cyclical declines in net worth increase agency costs and lower borrowing and investment.

investment of small firms is more sensitive to monetary shocks than that of large firms. They also estimate time-series regressions for small and large firms' inventory investment and find that the coverage ratio (cash flow to interest expense), their proxy for collateral value, is significant for small but not large firms. They conclude that financial effects on small firms play a prominent role in the slowdown of inventory demand following a monetary tightening.

C. The Internal Finance Hypothesis

The internal finance hypothesis also has a long history, with earlier, more restrictive, versions sometimes referred to as the "cash flow hypothesis."[9] Early contributions include Tinbergen (1938), Kalecki (1949), Klein (1951), Meyer and Kuh (1957), and Minsky (1975). Kuh (1963, p. 7) summarizes this earlier literature stating: "Because of limited availability of funds either from capital market imperfections or self imposed restrictions on the business firm designed to avoid external financing, the actual investment rate will be restricted predominantly to gross profit levels."[10] This research predicts that investment depends primarily of internal funds because of limited availability of debt.

Recent literature on capital market imperfections shows that the cost of funds from external sources can exceed the opportunity cost of internal finance because of transactions costs and, especially, moral hazard and adverse selection problems arising from asymmetric information. Firms can use cash flow, however, to purchase new assets without incurring the higher costs of new debt or equity finance. If external finance is rationed, internal finance is the sole marginal source of funds for investment. Fluctuations of internal finance

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[9] More recent versions of this hypothesis recognize that while cash flow is the ultimate source of internal finance, firms can temporarily finance activities with internal funds by drawing down stocks of liquid assets. Indeed, financially constrained firms may hold buffer stocks of liquidity for these purposes, as discussed in Fazzari and Petersen (1993) and Calomiris, Himmelberg, and Wachtel (1994).

[10] See Kalecki (1949, p. 61) and Meyer and Kuh (1957, p. 204) for similar summary statements.

will lead to fluctuations in investment, particularly for assets with low adjustment costs (such as inventories) when internal finance shocks are perceived to be temporary.[11]

It is important to distinguish the role of cash flow according to the internal finance hypothesis from its potential role in the collateral hypothesis. Some authors have interpreted firms' cash flow as a proxy for access to external finance. The idea is that higher cash flows enhance collateral value, which improves the terms firms can obtain for new debt. In contrast, the internal finance hypothesis focuses on internal funds as a distinct source of finance for investment spending. According to this hypothesis, fluctuations in internal finance will have a major impact on investment *independent* of any effect they may have on the cost of debt finance.[12]

It is well known that cash flow is the principal source of financing for most businesses. Indeed, comparatively few companies have access to publicly traded debt and surprisingly many companies have no bank debt.[13] Between 1960 to 1989, the aggregate purchases of plant and equipment by nonfinancial corporations were roughly equivalent to available cash flows (see Kopcke, 1993 p. 16). Internal finance flows are also extremely cyclical, a fact documented at least as far back as Mitchell (1951) and listed by Lucas

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[11] See Carpenter (1992) and Fazzari and Petersen (1993) for elaboration on the role of adjustment costs and differences between temporary and permanent internal finance shocks. Chirinko (1993) and Himmelberg and Petersen (1994) present evidence consistent with the view that inventories have lower adjustment costs than other assets.

[12] Kuh and Meyer (1957, pp. 198-199) identify different collateral and internal finance channels. They recognize that high retentions provide firms with strong balance sheets and for them, "borrowing is cheaper and more feasible." However, they also argue that "insofar as short-run investment behavior is concerned, capital markets are of lesser importance than internal funds" and investment behavior will be "largely determined by the level of current liquidity inflows."

[13] Calomiris, Himmelberg, and Wachtel (1994) report that only 8 percent of Compustat firms have commercial paper programs and bond ratings. Another 12 percent of firms issue bonds but do not have commercial paper programs. Oliner (1995) reports that 25 percent of small firms and 40 percent of sole proprietorships have no debt from depository institutions.

(1977) as one of the seven main qualitative features of the business cycle.[14] The intuition for the great volatility is straightforward. First, sales and revenue fall just before and during recessions. Second, a large fraction of firms' labor and capital costs are fixed in the short run, so that relatively small movements in revenue cause large proportionate changes in profits and internal finance.[15]

In Carpenter, Fazzari and Petersen (1994, CFP hereafter) we test the importance of the internal finance hypothesis for inventory investment in regressions estimated from quarterly firm panel data. We find that cash flow coefficients for small firms exceed those for large firms, evidence that financing constraints are important. Further, we show that internal finance effects are economically important in three different time periods, explaining up to 50 percent of the aggregate shortfall of manufacturing inventory investment during recessions. Calomiris, Himmelberg, and Wachtel (1994) further support the importance of internal finance for inventory investment. In regressions similar to CFP, their cash flow variable has a much stronger effect for firms without commercial paper programs than for those with access to commercial paper.

III. Sectoral and Time Heterogeneity: Aggregate Evidence

A dominant theme in the empirical literature on financing constraints has been to exploit the heterogeneity in microeconomic data by examining groups of firms that are *a priori* likely to differ in their access to finance. Additional, tests can be constructed for the presence and economic importance of financing constraints by exploiting sectoral and time

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[14] Internal finance flows continue to be highly procyclical in recent data, declining dramatically in recessions. For example, business income fell 47 percent during the 1981-82 recession, 30 percent from 1984.2 to 1986.1 as the economy narrowly avoided a recession, and 53 percent from in the 1990-91 recession.

[15] It is widely recognized that capital costs are fixed or quasi-fixed in the short run, as indicated by the large literature emphasizing capital "adjustment costs." There is a parallel literature for labor costs, often emphasizing the importance of non-production workers, the need for which does not vary with output, and hiring costs. See Parsons (1986) for further discussion.

heterogeneity. These new tests also help to identify the ability of each of the three financing constraint views to explain salient facts about inventory investment. Sectoral heterogeneity refers to the fact that different sectors of the economy exhibit very different investment patterns, particularly over the business cycle. Like most studies, we examine manufacturing data, for which it is natural to exploit the pronounced differences between the durable and nondurable goods sectors. However, there are other cyclically sensitive sectors, such as retail and wholesale trade, for which sectoral heterogeneity could likely be used to develop additional tests of financing constraint hypotheses.[16]

Time heterogeneity refers to the fact that individual investment and business cycles are different in important ways. Business cycles provide obvious experiments for testing hypotheses about firm behavior, including models of financing constraints. This approach is consistent with Zarnowitz's observation that "although individual cycles share important family characteristics, they are by no means all alike" (1992, p. 3). Differences in the macro economy over time that are particularly relevant to the study of financing constraints include the stance of monetary policy and differences in the bank regulatory environment.

A. Sectoral Heterogeneity

Studies of the business cycle have identified major differences in cyclical volatility of inventory investment across the durable and nondurable sectors. Stanback (1962, p. 23) finds that for the first five postwar cycles "the change in the level of inventory investment was far greater for durables than for nondurables in all but one of the postwar phases." Zarnowitz (1985, p. 527) confirms this finding, identifying the much greater amplitude of cyclical movement in durable inventory investment as a main feature of the business cycle. Neither existing research on inventory investment behavior nor work on financing constraints, however, has made much of an attempt to explain this sectoral heterogeneity.

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[16] See Zakrajsek (1994) for a study of retail inventory investment and financing constraints.

Figure 1 extends Stanbeck's evidence to the present, showing quarterly growth rates of real inventory stocks for durable and nondurable manufacturing.[17] The durable series clearly displays greater cyclical volatility, with greater peaks and troughs. These differences are most pronounced in the 1960s and the 1980s. Part of the explanation for the intersectoral differences undoubtedly results from the "accelerator effect," i.e., sales and output are more volatile for durables. Our objective here is to explore whether the three financing constraint hypotheses can also explain part of this sectoral heterogeneity.

It is difficult for existing versions of the bank lending hypothesis to account for these durable/nondurable differences. This channel focuses on the supply side of financial markets, implicitly assuming homogeneity across bank-dependent firms. An inward shift of the supply curve of bank finance would likely affect all such firms equally, regardless of industry. One might expand the bank lending hypothesis to include heterogeneity across bank-dependent firms that could explain part of the durable/nondurable differences. For example, suppose some characteristic of durable firms made them more risky to lend to during a recession than nondurable firms. Then, a drop in loan supply might explain some of the durable/nondurable heterogeneity. This explanation, however, requires the flow of loans to durable firms be more cyclical than the flow to nondurables. Aggregate evidence reported below does not offer much support for this kind of difference.

For similar reasons, interest rate effects emphasized by the collateral hypothesis cannot explain intersectoral differences in inventory volatility as long as the discount rates used to compute the capitalized collateral value of future cash flows have similar cyclical patterns across sectors. We know of no evidence for such differences. Other aspects of the collateral hypothesis, however, may fare better in their ability to explain durable-nondurable heterogeneity. The collateral hypothesis allows variations in cash flow to affect firms'

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[17] Growth rates avoid possible biases due to differences in the sizes of the durable and nondurable sectors. Both series are three-quarter moving averages to make the cyclical patterns more obvious.

collateral values and their access to external funds. Cash flow is highly procyclical, and we will present evidence that its fluctuations are greater for durable than for nondurable industries. The collateral hypothesis should therefore predict that external finance flows will be more cyclical to durable firms if greater cash flow variation causes collateral values to vary more in the durable sector.

Figures 2 and 3 provides information on the cyclical behavior of short-term debt for both durable and non-durable industries. The cyclical movements in flows of short-term bank debt plotted in figure 2 are roughly similar across sectors. The trough for durables in the middle 1980s is deeper. The flows of non-bank debt plotted in figure 3 show greater cyclical movement in the non-durables sector in the first part of the period, but greater movement for durables toward the end of the sample period. Overall, there is little evidence of any large, systematic difference in the cyclicality of debt flows between durable and non-durable sectors.

Lending data, such as those presented in figures 2 and 3, reflect changes in both the supply and demand for funds. The supply shifts emphasized by the bank lending or collateral hypotheses may be masked by variations in the demand for funds. Because the output and sales of durable industries are much more procyclical than for nondurables, however, loan demand for durables is almost certainly more procyclical. Therefore, changes in the demand for funds would likely magnify intersectoral differences in loan flows induced by shifts in supply alone. Because the data provide no evidence of greater cyclicality of lending to durable versus nondurable firms, we would not likely find evidence of greater shifts of loan supply to durable firms even if we could separate such supply shifts from demand effects.

In contrast with the lack of sectoral differences we find for debt flows, there is strong evidence for important sectoral differences in the cyclical behavior of internal finance. Business income is far more cyclical in the durables sector during NBER defined recessions. The percentage decline in durable-sector business income during the last six

recessions averaged 60 percent, while the corresponding percentage decline for non-durables averaged only 13 percent.[18] Therefore, the direct positive link between inventory investment and cash flow, predicted by the internal finance hypothesis, has the potential to explain sectoral heterogeneity of inventory investment. It is important to note, however, that such an explanation requires econometric evidence that cash flow coefficients in an inventory investment model are at least as large for durable firms as they are for nondurable firms in specifications that control for the likely differences in the intersectoral accelerator effects. In this case, the greater volatility of durable firm cash flow would translate into greater volatility of durable inventory investment. The econometric evidence presented in section 6 supports this hypothesis.

B. Time Heterogeneity

Figure 1 shows that the well known cyclical fluctuation of inventory investment exists in both the durable and nondurable manufacturing sectors. We focus on its behavior during 1981-1992 because this is the period covered by the micro evidence presented in subsequent sections. During this period there are three distinct inventory investment cycles. We capture each in a separate panel of firms, using differences in the macroeconomic environment associated with each to assist in distinguishing between financing constraint hypotheses.[19]

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[18] Figures were taken from NIPA accounts. The comparison holds cycle by cycle as well; the percentage decline of durable business income was at least 2.9 times larger than that for non-durables in every recession from 1960 to 1991. These sectoral differences arise because sales and revenue in most durable goods industries are more cyclically volatile. One reason for this difference is the irreversibility of durable purchases, as emphasized by Bernanke (1983). Also, capital market imperfections can make household durable purchases volatile as explained by Mishkin (1976).

[19] Other papers have used time heterogeneity to study financial constraints. For example, Gertler and Hubbard (1988) obtain larger cash flow coefficient in a fixed investment regression during recessions than in other periods. Similar results are obtained by Oliner and Rudebusch (1994). Hu and Schiantarelli (1994) estimate a switching regression model and find that the probability of being constrained rises for firms in recessions. KLS (1994) find that cash stocks are significant for the inventory investment of firms without bond ratings in periods of tight money, but not in periods of loose money.

Our initial panel encompasses the 1981-82 recession. This recession is widely thought to have been caused by tight monetary policy. Because tight monetary policy and an enormous decline of internal finance during the early 1980s (business income in the durables sector fell by over 100 percent) coincide during this period, the decline in inventory investment is potentially consistent with each of the financing constraint hypotheses.

Our second panel contains the inventory cycle associated with 1985-86 slowdown. During 1986, second quarter real GNP growth was negative and it averaged only 1.2 percent during the third and fourth quarters. KLS (figure II) show that manufacturers cut real inventory stocks during five of the eight quarters in 1985-86. They also identify this period as one of easy monetary policy, viewing 1985-86 as "the decade's cleanest example of loose policy" (p. 590). They note that the Fed funds rate and the prime-commercial paper spread were low, and that real money growth was healthy. Based on their reading of the monetary environment, and their empirical results, KLS conclude that the bank loan channel was inoperative during the middle 1980s. In contrast, during the same period there was a substantial decline of internal finance.

There is less agreement about the source of the 1990-91 recession contained in our third panel. Bernanke (1993) argues that the typical symptoms of tight monetary policy were not present during the 1990-91 recession. However, he also argues that the decline in loan growth during that period was worse than for a typical recession, possibly due to shocks to bank capital. Indeed, this period is widely thought to contain a "capital crunch."[20] Because a reduction in bank capital can be equivalent to a reduction in reserves in its effect on a bank's ability to make loans, the bank loan hypothesis would, therefore, predict that variables that proxy for access to external finance should have an economically

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[20] See the review, including empirical evidence, in Boyd and Gertler (1994, pp. 21-22).

important effect during the third period. Internal finance declined during this recession, but by a somewhat lesser amount than the early 1981-82 recession.

Each of these three periods is characterized by a different macroeconomic environment. We use these facts as the foundation for time heterogeneity tests which, in combination with the heterogeneity between the durable and nondurable sectors, help to distinguish between the explanatory power of the three financing constraint hypotheses. Specifically, the bank loan channel predicts important financial effects in periods one and three--periods when there were possible shifts in the supply of bank loans--but not in period 2, when monetary policy was "easy." While both the collateral and internal finance hypotheses can potentially explain finance-induced declines of inventory investment in all three periods, the collateral hypothesis must rely upon a non-monetary shock to collateral in period 2.

IV. Empirical Specification

This section introduces the baseline econometric specification we use to examine financing constraints and inventory investment. We estimate a widely used inventory investment model (see Blinder and Maccini, 1991b, for example) with firm-level, *quarterly* panel data, augmented by the financial variables that have been used in the literature to test each of the three financing constraint hypotheses.

For firm j at time t (measured in quarters) let:

(1) $$\Delta N_{jt} = \lambda (N^*_{jt} - N_{jt}) - \alpha (S_{jt} - E_{t-1}S_{jt})$$

where ΔN_{jt} is inventory investment in period t, N_{jt} and N^*_{jt} denote the actual and target stocks of inventories at the beginning of period t, S_{jt} and $E_{t-1}S_{jt}$ represent actual and forecasted levels of sales. The "stock adjustment," term in equation (1) relates the change in inventories to the gap between target inventory stocks and actual beginning-of-period stocks. The parameter λ represents the "speed of adjustment." Following the literature, we model target inventories as a linear function of expected sales and include a firm fixed

effect that controls for unobservable differences across firms. The second term in equation (1) arises from inventory's role as a buffer stock and the parameter α measures inventory's response to unanticipated sales shocks. As in Blinder (1986), we assume that expected sales follow a second-order autoregressive process, again including a firm fixed effect.

Using these assumptions and substituting the target inventory and sales forecast into equation 1 provides the motivation for our estimating equation for inventory investment:

$$(2) \qquad \Delta N_{jt} = -\lambda N_{jt} - \alpha S_{jt} + \delta_1 S_{jt-1} + \delta_1 S_{jt-2} + \theta_j + \theta_{it} + u_{jt}.$$

where θ_j is a firm fixed effect, θ_{it} is an industry-level quarter dummy variable, and u_{jt} is a stochastic error term.[21] In the estimated regressions, all variables are scaled by the firm's beginning-of-quarter total assets (TA_{jt}) to control for heteroscedasticity.

High frequency panel data is essential for examining heterogeneity across both firms and time. In addition, a well-known advantage of panel data is the ability to control for firm-specific or "between-firm" factors. The fixed firm effect, θ_j captures all time-invariant differences in the determinants of the target stock of inventories, such as the rate of obsolescence and storage costs. Since some of these factors are almost certainly correlated with financial factors, failure to control for them will lead to inconsistent parameter estimates.[22] The quarter dummies, θ_{it}, contained in equation (2) are defined at the four-digit SIC level to control for different industries' seasonal patterns of inventory investment. Nerlove, Ross, and Wilson (1993) argue that quarter dummies are the best way to control for seasonality in inventory studies.

The specification given by equation 2 includes variables that reflect both the firm's production smoothing and buffer stock motives for holding inventories. For most purposes in our paper, these variables can be thought of as controls. Our focus will be on the

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[21] The fixed firm effect here is a linear combination of the fixed effect terms in the sales forecast and the target inventory stock.

[22] See Blinder (1982, p, 342) for a formal argument that justifies including a firm fixed effect in inventory investment models.

financial variables we add to this model that are used in empirical tests of the three financing constraint hypotheses: the stock of cash (bank lending), the coverage ratio (collateral), and cash flow (internal finance). We also add the change in short-term debt, which is relevant for both the bank lending and collateral views.

A concern sometimes raised in the financing constraint literature is that statistically significant coefficients on financial variables may arise if these variables contain information about expected investment opportunities not captured by controls for investment demand.[23] Many approaches have been developed in the literature to address this point. We note that current sales is included in all our regressions and it should be a good control variable for short-run inventory demand. Nevertheless, we will examine the robustness of our basic specifications by including variables used in the literature, such as leads of sales, to address issues related to expectations.

V. Data Description

A. Construction of the Panels

Our data are taken from the Compustat quarterly tapes, a source which has been virtually untapped in earlier research, and they cover the period 1981 to 1992. All firms in the sample are domestically incorporated. Each of our three panels is balanced, and, to protect against results driven by extreme observations, we exclude data in the one-percent tails of the distribution of each regression variable. Further information about the data construction is given in the data appendix.

We use these data to examine the three dimensions of heterogeneity discussed in section III. For firm heterogeneity, researchers have used a variety of different measures to

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[23] Financial variables may also be correlated with investment as a result of agency problems. See Carpenter (1995) for a discussion of the underlying issues.

segregate financially constrained firms.[24] In our study, we utilize both firm size and the presence of a bond rating, measures employed in recent studies of financing constraints and inventory investment. Fortunately, the two classification variables are highly correlated, and our results are largely unaffected by which measure we use.

We define small firms as those with less than $300 million in average total assets (in 1987 dollars) This selection criterion puts an approximately equal number of firms in the small and large size classes for the first period we analyze. Similar cutoffs have been used elsewhere to distinguish small from large firms.[25] Firms are also divided into the durable and nondurable sectors of manufacturing, with the usual two-digit SIC categorization.[26] To examine time heterogeneity, we split the data into three panels along the time dimension. The period splits were determined by peaks in aggregate inventory investment so that each period contains a distinct inventory cycle. Period one runs from 1981.1 to 1983.4, period two from 1984.1 to 1988.3, and period three from 1988.4 to 1992.4. As noted in section III, these three periods allow us to examine the impact of financial factors on inventory investment in different monetary and financial environments.

B. Characteristics of the Panel

Table 1 reports size statistics for our sample of firms. For each statistic, there are twelve cells in the table which cover the three time periods, two size categories, and two sector categories. The sample is representative of the manufacturing sector in terms of

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[24] These measures include firm retention ratios (Fazzari, Hubbard, and Petersen, 1988a; Gertler and Hubbard. 1988; Gilchrist, 1991), firm size (CFP, 1994; Galeotti, Schiantarelli, and Jaramillo, 1994; Gertler and Gilchrist, 1994a), presence of a bond rating (Whited, 1992; KLS, 1994), presence of a commercial paper rating (Calomiris, Himmelberg, and Wachtel, 1994), and membership in an industrial group (Hoshi, Kashyap, and Scharfstein, 1991; Schiantarelli and Sembenelli, 1995). Oliner and Rudebusch (1992) and Schaller (1993) examine heterogeneity of financial effects over a variety of other criteria.

[25] See Scherer and Ross (1990, table 3.1) and Gertler and Gilchrist (1994a).

[26] Nondurable manufacturing consists of SIC codes 20-23, 26-31. Durable manufacturing consists of SIC codes 24, 25, 32-38. We deleted miscellaneous manufacturing, SIC 39, from the sample.

industry coverage.[27] It also contains approximately one half of aggregate sales and inventories in manufacturing. We also computed summary statistics for the sample split by the presence of bond ratings and obtained results similar to those reported in table 1.[28]

Table 1 shows that the median size of large durable and nondurable firms is over $1 billion, while the median size of small firms is at least an order of magnitude smaller, somewhere between $50 to $100 million in total assets. The median sizes of durable and nondurable firms do not differ greatly within the small and large classes.

Table 2 contains sample statistics for sources of finance. The median retention ratio (the ratio of income less dividends to income) is always larger for small firms than for large, even when comparisons are made across sectors. In all but one case the median small firm retains more than 80 percent of its income. For small durable firms, the median retention ratio is unity in periods two and three. In only one case does the median large firm retain more than 80 percent of its income. High retention ratios for small firms are consistent with the view that small firms are more likely to face binding financing constraints. Intersectorally, retention ratios are lower for nondurable firms. This fact is consistent with the smaller cyclical fluctuations in cash flow for the nondurable sector. Nondurable firms may choose to pay a larger proportion of their cash flow out as dividends because it is less likely that they will suffer a shortfall in internal finance that will force a costly reduction in dividends.

Table 2 also shows that regardless of time period, size, or industrial sector, internal finance is overwhelmingly the largest source of funds for firms. The median share of cash flow in total sources of finance exceeds 80 percent in all but one instance, and is more than

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[27] The five two-digit SIC codes that contain the largest number of firms are: industrial equipment (17 percent of the sample firms), electrical equipment (13 percent), chemicals (11 percent), transportation equipment (6 percent). These five industries are also the ones with the largest weights in the aggregate production index.

[28] The median sizes of both rated and non-rated firms are slightly larger than the corresponding figures for large and small firms. This is due to the fact that some firms in our large firm category do not have a bond rating. Rated firms also have somewhat higher debt issues to net sources than large firms.

90 percent in a majority of cases.[29] In contrast, external finance comprises a relatively small proportion of total sources for the median firm. Debt finance accounts for a larger proportion of funds than new share issues. New debt, however, is a small proportion of net sources. In only one case does new debt account for more than ten percent of median net sources, and in four of twelve cases reported in table 2, the median ratio of new debt to net sources is zero.

C. Comovements of Inventories, Cash Flow and Debt Across Sectors

Figures 4 and 5 display the comovements of inventory investment, internal finance and debt finance for the firms in our sample. The figures show seasonally adjusted plots of the quarterly medians for inventory investment, cash flow, and the change in short-term debt for both small nondurable and durable firms (Figures 4a and 4b) and large nondurable and durable firms (Figures 5a and 5b). All variables are scaled by beginning-of-quarter total assets. While the intercepts are defined differently for each series, the vertical scaling is consistent for all three series plotted in the figures to facilitate comparison.

The four figures display several interesting patterns. Consistent with the aggregate evidence in Section III, inventory investment, for both small and large firms, is considerably more cyclical in the durable goods sector than in the nondurable goods sector. Also consistent with the aggregate evidence, there are three inventory investment cycles over the time period contained in our sample, including a cycle in mid the 1980s, which shows up mainly in the durable sector. Median inventory investment is frequently negative for both sectors in the first cycle and for durable firms in the third cycle.

It is also clear from the plots that cash flow is more cyclical in the durable goods sector. In addition, there is a close correspondence between inventory investment and cash

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[29] Total net sources of funds is defined as the sum of cash flow, the value of new stock issues and the change in total debt.

flow, particularly for small durable and nondurable firms as well as for large durable firms. (The correlation between the median inventory investment and cash flow ratios for these groups are between 0.51 and 0.73).

The pattern of debt finance is somewhat surprising. For both durable and nondurable firms, short-term debt finance is distinctly less cyclical and has a lower amplitude than cash flow fluctuations. For small durable firms the correlation of debt finance and inventory investment is 0.26. Debt finance is more volatile for small nondurable firms (its correlation with inventory investment is 0.42). The greater cyclicality of debt finance for nondurables is the opposite of what one would expect, given the greater cyclicality of inventory investment in the durable goods sector.

VI. Regression Results

We begin this section by presenting estimates of different versions of equation 2, where the specifications differ only in the choice of financial variable that augments the basic stock-adjustment model: cash flow, the stock of cash and equivalents, and the coverage ratio. These variables are used, respectively, by CFP (1994), KLS (1994), and GG (1994a), in their investigation of the internal finance, bank lending, and collateral hypotheses. The results for these specifications appear in tables 3-5. The regressions in tables 6 and 7 include both cash flow and the flow of short-term debt, measuring the impact and relative importance of internal and external finance flows for inventory investment. Finally, we report results for several different tests of robustness.

All regressions are estimated with fixed firm effects that eliminate the influence of differences in the average levels of the regressors across firms; in other words, all remaining variation is in the time dimension of the data. The standard errors are asymptotically consistent in the presence of heteroscedasticity (estimated with White's method). All regressions contain a set of quarter dummies, for each 4-digit SIC industry, to control for seasonality.

Before discussing the results for the different financial variables, it is important to note that the coefficients for the nonfinancial variables, in all regressions, are consistent with findings in the inventory literature.[30] The coefficients on the lagged inventory stock variable are always negative and highly significant. The quarterly speeds of adjustment range between 0.079 and 0.416 with most values between 0.14 and 0.27. Sales variables are statistically significant in all regressions, with some evidence of buffer stock effects for small firms (as indicated by a negative coefficient on contemporaneous sales). The estimated values of the control variables are largely consistent across the specifications presented in tables 3 through 7.

A. Internal Finance Regressions

The internal finance regressions are reported in table 3. As in CFP, we include contemporaneous and two lags of cash flow. For expediency, we discuss only the sums of the cash flow coefficients. Consider first the differences in the results across firm size (firm heterogeneity). For each sector, and in each time period, small firms have bigger cash flow sums than large firms. The size of the differences are usually quite pronounced, particularly for the durable goods sector. A Wald test of the equality of cash flow sums across firm size classes generates p-values of 0.060 for nondurables and 0.001 for durables. Dividing each sector into the three time periods greatly reduces the degrees of freedom, but the p-values of the Wald tests remain approximately 10 percent or smaller for all but one cell. Splitting by bond rating gives similar results for firm heterogeneity.[31]

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[30] See, for example, Blinder (1986).

[31] The cash flow sums for non-rated, nondurable firms are 0.206, 0.190, and 0.077, for periods one, two, and three, respectively. For rated nondurables the sums are 0.129, 0.094, and -0.023. For non-rated durables the sums are 0.398, 0.269, and 0.200, and for rated durables they are 0.268, 0.183, and 0.117. These sums are comparable to those reported in table 3. The difference between the rated and non-rated firm sums, however, tends to be about two thirds of the difference obtained for the size splits. This finding is not surprising since many firms in the large firm segment of our sample do not have bond ratings.

Next, consider durable-nondurable differences. In section III we discussed the much greater amplitude of inventory and internal finance fluctuation for firms in durable industries. The question remains, however, whether the internal finance coefficients are at least as large in the durable sector as in the nondurable sector after controlling for accelerator effects through sales. For all six comparisons for table 3, the answer is yes. In fact, the durable cash flow sums are larger than the comparable nondurable sums in almost every case.

Finally, consider the results for different time periods. The cash flow coefficients, for both small and large firms, are largest for the first time period, consistent with the dramatic cycle in inventory investment that occurred in this period. Perhaps most interesting are the findings for the second period. While monetary policy is widely regarded to be "easy" in this period, there were sharp declines in both inventory investment and internal finance. We find an economically large cash flow effect in this period for small firms (especially small durables). The effect for large firms is smaller, but still statistically and economically significant. These results imply that financial constraints can have important effects on inventory investment through fluctuations in internal finance flows even in the absence of tight money that might restrict access to external finance. In the third period, which contains the last recession, we find economically significant cash flow effects for small firms, but not for large firms.

The internal finance hypothesis holds up quite well when confronted with all three dimensions of heterogeneity. The results in table 3 help explain why inventory investment is much more cyclical in the durable goods sector. Using reduced-form regressions for quantitative structural comparisons has well-known pitfalls. Nevertheless, we performed some suggestive calculations that show how the estimated cash flow effects, together with the pronounced cycles of cash flow, can explain a substantial portion of the cyclical movement in inventory investment. We measured the shortfall in both median cash flow and inventory investment across both sector and firm size for the three inventory downturns

evident in our data. Using the estimates from table 3, the cash flow shortfall for small durable firms explains an average of 47 percent of the inventory investment shortfall across downturns in the three time periods. For large durables, the average is 19 percent, a smaller effect, but still economically important. The corresponding figures for nondurable firms are 32 percent for small firms and 16 percent for large firms.[32]

B. Stock of Cash Results

As discussed in section II, KLS (1994) test the bank lending hypothesis by including the ratio of a firm's beginning-of-period stock of cash and marketable securities to total assets. They measure firm heterogeneity by whether or not firms have a bond rating. For comparison, we follow their approach and report the results in table 4 for firms classified by bond ratings instead of firm size. (The results are quite similar if we split by size.) There are, however, differences between the KLS approach and the one employed here. KLS used annual rather than quarterly data. In addition, they estimated cross-sectional regressions for individual years. That is, they used "between-firm" regressions rather than the fixed-effect or "within-firm" regressions, that are employed here to control for unobservable firm effects. Finally, their annual cross-sections overlap our first period (tight money), and second period (easy money), but not our final period.

The results for the first two periods in table 4 are consistent with the qualitative findings in KLS. In particular, in the first period, the stock of cash coefficients are larger for non-rated firms than for firms with bond ratings. In the second period, similar to KLS, the stock of cash coefficients for non-rated firms are much smaller and clearly not

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[32] The period-by-period figures are as follows (percentages for periods 1, 2, and 3): small nondurables 39,11,46; large nondurables 16,13,18; small durables 56,39,47; and large durables 23,27,7. The downturns are defined as the period during which inventory investment was below its mean. The shortfalls in both inventory investment and cash flow were computed by summing the difference between the relevant variable and its mean over the downturn. The figures in the text are the shortfalls of cash flow multiplied by the sum of the cash flow coefficients from table 3 divided by the shortfall of inventory investment.

statistically larger than the coefficients for rated firms. In the third period the small coefficients and absence of heterogeneity in the cash stock coefficients do not support the bank lending hypothesis if a "credit crunch" occurred.

The results in table 4 suggest that the bank lending view, as captured by the KLS cash stock variable, does not explain as many aspects of inventory behavior as the internal finance hypothesis. Even though non-rated firms have bigger coefficients for the stock of cash in the first period, the point estimates are not large enough to explain much of the cyclical decline in inventory investment in the first period. Using the same method described in the preceding subsection, the decline in median cash stocks from the period peak to trough explain an average of only 4.8 percent of the shortfall of inventory investment in the first period, with higher figures for rated firms than for non-rated firms. The decline in cash stocks explains an even smaller percentage of the shortfall in inventory investment in periods 2 and 3.[33] Finally, because there is no systematic difference in the stock of cash coefficients between the durable and non-durable sectors, the results in table 4 do not help explain greater inventory cyclicality in the durable goods sector.

C. Coverage Ratio Results

In a test of the collateral view, GG (1994a) include the interest coverage ratio in a regression similar to equation 2. They state (page 334) that the coverage ratio is highly correlated with other prominent balance sheet indicators, and therefore variation in the coverage ratio should be a good proxy for movements in firms' overall financial position and their ability to obtain debt finance. The GG study splits aggregate data grouped by firm size (with a cutoff similar to the one employed here). Their definition of the coverage ratio --

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[33] Over all three periods, peak-to-trough declines in median cash stocks explain an average of 3.3 percent of the shortfall of median inventory investment. These figures are about 9 times smaller than the corresponding figures for cash flow. KLS report larger cash stock coefficients than those in table 4 from their cross-section regressions in the early 1980s. But even using the KLS estimates, the percentage of inventory investment shortfall explained for small firms in the first period by the decline in cash stocks is only about one-third the size of the percentage for cash flow.

cash flow divided by a proxy for short-term interest expense -- causes problems in micro data since a number of firms in our sample have no debt. We therefore define coverage as interest expense divided by the sum of interest expense plus cash flow, a more robust measure in micro data.[34] The expected sign of this variable is negative under the collateral hypothesis: if interest expense consumes a greater portion of a firm's gross earnings, its balance sheet position is weaker.

The results are reported in table 5. The coverage ratio has the expected negative sign in all twelve regressions, and is statistically significant in most cases. The evidence for size heterogeneity is mixed. Small firms have significantly larger coefficients (in absolute value) for three out of the six comparisons possible from table 5. The results show some time heterogeneity. The absolute value of the coverage ratio coefficient is largest in the first period when monetary policy was tight for small and large firms in both sectors. There is no evidence of especially large effects in the third "credit crunch" period, however.

The results in table 5 do not help explain the sectoral heterogeneity of inventory investment. The coefficient estimates for small non-durable firms are larger than those for durable firms; across the three periods the estimates are roughly the same for large firms in both sectors. When one links the movement in sample medians for the coverage ratio and the coefficient estimates, the regressions explain about 15 percent of the shortfall in inventory investment for non-durable firms, but only 4 percent for durable firms.

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[34] The micro data results are much weaker when coverage is defined as the ratio of cash flow to interest expense. GG proxy short-term interest expense by multiplying the stock of short-term debt by the prime rate. We use the same approach with the three-month commercial paper rate. We delete a small number of observations that have negative coverage ratios due to negative cash flows.

D. Flow of Debt Results

The tests presented in the previous subsections for the importance of external finance employ the measures of access to debt used by previous studies in the literature. We now consider a new test which includes the flow of short-term debt in the inventory investment regressions. This test is informative for both the bank lending and collateral hypotheses. Both of these hypotheses imply that financing constraints operate by affecting the flow of debt, either because the supply of loans changes or because changes in firms' balance sheets affect collateral values and their ability to obtain new credit.

Table 6 summarizes the effect of the quarterly change in short-term debt on inventory investment. The change in debt variable is scaled by total assets, and contemporaneous and two lagged values are included in the regression. We must recognize that contemporaneous debt flows are endogenous choice variables for the firm. A positive shock to desired inventory investment, for example, might induce firms to obtain more short-term debt in a quarter. For this reason, the coefficient sums reported in table 6 come from regressions estimated with two-stage least squares. The contemporaneous change in debt variable is instrumented with the beginning-of-quarter stock of short-term debt (scaled by total assets). The first stage of this regression functions like a stock-adjustment model to predict the contemporaneous change in short-term debt.[35]

The results reported in table 6 suggest an economically important role for short-term debt and are therefore consistent with the implications of the bank lending and collateral hypotheses. The coefficient sums for the change in debt are positive in eleven of twelve regressions and statistically significant in six cases.[36] It is somewhat surprising to find

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[35] See Fazzari and Petersen (1993) for further discussion of this approach in a financing constraint context. The beginning-of-period debt stock has a negative and highly significant coefficient in the first-stage regression for the flow of short-term debt, consistent with our interpretation of the first-stage as a stock-adjustment model.

[36] The only regression with a negative coefficient sum for the debt flow variable, non-durable firms in the first period, is unusual in that the negative effect comes entirely from the second lag. None of the other regressions have this feature.

among the largest effects of debt flows for *large* firms in the first period. This finding is different from those in the literature suggesting that financial constraints work primarily (even exclusively) through small firms (or groups of firms defined by characteristics that are highly correlated with size). The effect of debt flows on small firms' inventory investment exceeds that for large firms in the second period. In the third period, the small firm coefficient sums are somewhat bigger than the large firm sums, but the difference is not substantial. Results are similar if the data are split by the presence of a bond rating.

Since the evidence presented earlier indicates that there is no important difference in cyclical variations in debt flows across durable and non-durable sectors, the debt flow channel can contribute to the explanation of sectoral differences in inventory investment volatility only if the coefficients are larger for durable firms than for non-durables. There is some evidence in table 6 that the debt flow effects are significantly larger for durable firms in period three.[37]

To examine the interaction between internal and external finance flows in explaining inventory investment, we include both cash flow and the changes in short-term debt in the regressions reported in table 7. Because the flow of short-term debt and cash flow have the same dimensions, their coefficient estimates are directly comparable. The coefficient sums for both cash and debt flows in table 7 are quite close to the results obtained in regressions that included these variables individually in all cases except for small non-durable firms in period 1 (for which the coefficient sums for both cash flow and the flow of debt are insignificant).[38]

In addition, these findings show that the effect of cash flow is not simply a proxy for access to debt. Even controlling for short-term debt flows, the cash flow coefficients

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[37] The Wald test for the hypothesis that the sum of the change in debt coefficients for durables equals that for nondurables is rejected at the 8 percent level for small firms and the 11 percent level for large firms.

[38] The results presented in this section are largely similar if the sample is split by presence of a bond rating. Again, however, firm heterogeneity is not as clear, in some cases, as it is for size splits.

remain significant, especially for small durable firms for which inventory investment is most volatile and financial constraints are likely to be most important. In most cases, including short-term debt flows has virtually no effect on the cash flow results (compare tables 3 and 7). These findings provide empirical support for the predictions of the internal finance hypothesis: internal finance strongly matters for firm activity independent of any influence it has on debt flows.

It is also interesting to note that, in a majority of cases reported in table 7, the debt flow and cash flow coefficient sums are roughly the same size. This finding is consistent with the presence of financial constraints. Funds obtained from any source can be allocated to a constrained firm's most highly valued activity.[39] Sources of finance become perfect, or at least very close, substitutes once they are inside the firm. Hence, we would expect the impact of an additional dollar of debt on inventory investment to be similar to the effect of an additional dollar of cash flow.

The results in table 7 indicate that the internal and external finance hypotheses are complementary. In comparing the financial effects of internal and external fund flows on the cyclical behavior of inventory investment, however, one must consider not only the coefficient estimates but also the extent of cyclical variation in the financial sources themselves. The evidence presented in section III implies that internal fund flows vary more than debt flows in each of the three inventory cycles covered by our data. This fact is true in our micro data as well (see figures 4 and 5). With the coefficients from table 7, the median changes in cash flow explain about 27 percent of the shortfall of inventory investment (averaged over all three periods), while the change in short-term debt explains only 6 percent. For small firms alone, the difference is more striking: 37 percent for cash flow versus 5 percent for the change in debt. Moreover, internal finance flows are more

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[39] This point is obviously true for cash flow. New debt may be obtained for a specific purpose (firms may borrow specifically to finance inventories, for example), but it then would reduce the need to allocate internal funds for that purpose and hence may lead to expansion of other activities.

cyclically volatile for durable firms than for non-durables, while there is no clear sectoral difference in the cyclical behavior of debt flows. Therefore, the internal finance hypothesis appears to explain a wider range of the features of inventory investment than the hypotheses that focus exclusively on external finance.

E. Alternative Specifications and Robustness

We have tested a variety of alternatives to the specifications reported above. This subsection summarizes these results; more detailed results are available from the authors. Overall, the findings and interpretations discussed to this point hold up well in these additional tests. Any substantial changes are noted in the following discussion.

One concern raised in the empirical financing constraint literature is that variables that measure financial effects may be statistically significant in regressions because they contain information about investment opportunities not captured by variables that control for investment demand. Hubbard (1995, section 3) surveys the large literature that has arisen to address these concerns. Of particular relevance here is the contribution by Gilchrist and Himmelberg (1994). They use a set of VAR forecasting equations, which explicitly include cash flow as one of the fundamentals, to construct the expected value of future profits. They find that, for small firms, including a measure of expected future profits that accounts for the fundamental information in cash flow has little effect on the estimated cash flow coefficient in fixed investment regressions.

For inventory investment, the primary concern is that financial variables may proxy expected sales and therefore significant effects of these variables may be due to expectations rather than financial constraints.[40] To address this concern directly, we included two quarterly leads of sales in the regressions. If the financial effects merely proxied for expectations, one would expect that these leads would greatly diminish, if not eliminate, the significance of the financial variables. The first lead of sales did have a significant effect in almost all of the regressions indicating that sales expectations may have an important effect on inventory investment (the second lead was usually insignificant). The cash flow sums,

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[40] Gertler and Gilchrist (1994a, p. 335) indicate that the main issue of concern for inventory models is the potential correlation between expected sales and financial variables. Gilchrist and Zakrajsek (1995) point out that structural models of inventories employ sales expectations rather than profit expectations.

however, as well as the differences between small and large firms, were remarkably stable.[41] The stock of cash coefficients were somewhat more variable when leads of sales were included, but the overall size and pattern of the coefficients across the three dimensions of heterogeneity remained similar. Results for regressions that include the coverage ratio or the flow of short-term debt were also not much affected by including leads of sales.[42]

A related issue is the potential endogeneity of contemporaneous cash flow. Although this concern has been raised in the literature, it is mitigated in our context. With high-frequency quarterly data, it is less likely that contemporaneous cash flow is affected by investment shocks (inventory investment shocks in particular) than in the annual data employed by most studies. Also, the most likely source of a correlation between contemporaneous inventory investment shocks and cash flow is unanticipated sales movements, for which our specification controls. Nevertheless, we checked the robustness of our cash flow results by instrumenting contemporaneous cash flow with two cash flow lags. The cash flow effects *increase* (compared with table 3) and the pattern of results across firm size, sector, and time is similar to those presented in previous tables. The instrumented cash flow variable remains significant in all cases for small firms. While the coefficients are smaller for large firms, they remain significant in periods one and two. To the extent that simultaneity affects the results presented earlier, it appears that it causes the cash flow effects to be understated.

The results are also consistent with those presented in previous tables if contemporaneous cash flow is excluded from the regressions and the internal finance effect works through only the first and second lag of cash flow. The cash flow effects decline, on

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[41] When two leads of sales are included, the sums of the cash flow coefficients are as follows (for periods 1, 2, and 3): small nondurables 0.250 0.255, 0.118; large nondurables 0.125, 0.104, 0.006; small durables 0.560, 0.283, 0.245; and large durables 0.301, 0.186, 0.018.

[42] We also included stock price growth (contemporaneous and two lags) as a broad measure of expectations. The stock price variables had no consistent pattern of sign or significance, indicating that this variable had little systematic explanatory power for inventory investment.

average, by less than 20 percent relative to the results in table 3, and the pattern across regressions is similar.

Finally, we considered the effect of adding cost shocks to the model. A temporary increase in production costs might reduce both cash flow and the desired stock of inventories, inducing a positive cash flow-inventory correlation even in the absence of financing constraints. (Although there is no reason to expect that this correlation would differ by firm size or presence of a bond rating.) To control for this effect, we included a variety of cost variables--real wages, real energy costs, and real interest rates--in the regression.[43] These variables were included in separate regressions as contemporaneous and lagged levels, as well as first differences. The cost variables were occasionally significant. The cash flow coefficients declined somewhat in the first period, due primarily to a significant effect of energy costs, but the pattern of results across firm size and sector was unchanged.[44] The cash flow effects were virtually unaffected in the second and third periods.

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[43] See Maccini and Rosanna (1984) and Blinder (1986) for a similar approach. The real wage and energy cost data are defined at the two-digit S.I.C. level. The wage data are from the *Monthly Labor Review* and the energy data from the *Monthly Energy Review*. The real interest rate is the three-month Treasury bill rate less inflation measured by the GDP deflator.

[44] The biggest differences occurs when the contemporaneous levels of cost variables enter the regression. The cash flow sums for small and large non-durables in these regressions are 0.249 and 0.141, respectively. For durables the cash flow sums for small and large firms are 0.350 and 0.231.

VII. Conclusion and Policy Implications

An extensive body of recent research indicates the importance of financing constraints for understanding firm behavior, macroeconomic fluctuations, and the impact of a variety of public policies. The scope of this literature is likely to continue to grow at a rapid pace. There are three main hypotheses about how financing constraints operate: i) the collateral, ii) the bank lending, and iii) the internal finance hypotheses. Each has a long history, but, to our knowledge, no previous study has examined them together. We have made such a comparison here by focusing on inventory investment, both because of the importance of inventory investment for the business cycle and because it has been the subject of recent studies that employed different views of financing constraints.

To facilitate comparison of the hypotheses we have extended the empirical methodology, used in much of the financing constraint literature, that focuses on heterogeneity. We have added tests based on sectoral and time heterogeneity to the now standard practice of testing for heterogeneity in financing constraints across firms. Our sectoral heterogeneity tests exploit the fact that durable goods sectors of manufacturing exhibit much greater investment cyclicality than nondurable sectors. Time heterogeneity tests are based on the fact that separate business cycles differ in important ways, including the stance of monetary policy. Combining firm heterogeneity with sectoral and time heterogeneity provides more discriminating tests as well as more experiments to examine the success of the different financing constraint hypotheses in explaining facts about inventory investment.

We estimate within-firm regressions for a standard inventory stock adjustment model augmented with four different financial variables. Three of the financial variables--cash flow, the stock of cash, and the interest coverage ratio--match variables chosen by previous studies that each focus on one of the three financing constraint hypotheses. The internal finance hypothesis performs well along all three dimensions of heterogeneity and explains a substantial amount of inventory fluctuations for each of the three cycles in our

sample period. Evidence from the variables that measure access to external finance in previous studies provides some support for the collateral and bank lending views that is largely consistent with the findings in previous work. Compared with cash flow, however, these variables are not as successful in explaining all dimensions of heterogeneity in the data and they do not appear to account for as large a portion of the cyclical movement of inventory investment.

We also estimate a model including both cash flow and the flow of short-term debt finance. We find statistically and economically important effects for both cash flow and debt flows, indicating that the internal finance and the two external finance hypotheses are complementary. These results also show that cash flow plays a role as an independent source of finance, rather than simply proxying for internal net worth and access to debt. Again, we find the cash flow results in these regressions are strongest on all three dimensions of heterogeneity and explain a much greater portion of inventory investment fluctuations than the flow of short-term debt.

That our evidence supports both internal and external finance hypotheses is not surprising, given that the hypotheses are based on similar microfoundations. Our evidence suggests, however, that the internal finance hypothesis is the most general because it explains a broader set of facts about the amplitude, sectoral heterogeneity, and the time heterogeneity of inventory investment.

We conclude by noting that it is important to distinguish between the three financing constraint hypotheses because they have different implications for both tax and monetary policy. The internal finance hypothesis focuses directly on firms' after-tax cash flow; each additional dollar of tax payment lowers cash flow by a dollar. As a result, average tax levels (not just marginal tax rates) will have a direct effect on financially constrained firms' investment.[45] (The collateral hypothesis also suggests an indirect link between average tax

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[45] See Fazzari, Hubbard, and Petersen (1988b) for further discussion.

rates and investment, although the impact may be more difficult to quantify.) These effects imply, for example, that there may be a substantial difference between the impact of a standard investment tax credit (which affects both marginal and average tax rates) and some of the "marginal" investment tax credits that have been proposed recently.[46]

Considerable attention in recent literature has also been directed toward the relevance of the bank lending and collateral hypotheses for monetary policy. In particular, recent research has sought to identify whether there is an empirically significant "credit channel" through which monetary policy affects the real economy.[47] Some of this research has been discussed throughout this paper. In contrast, much less attention has been given to the implications of the internal finance hypothesis for monetary policy. These implications differ from those of the bank lending and collateral views. Tight money will reduce demand in interest-sensitive sectors of the economy. Small contractions in demand can create large proportionate changes in business income and cash flow, especially when much of firms' costs are fixed in the short run. These reductions in the flow of internal finance will lead to lower investment for financially constrained firms, propagating the monetary shock to more sectors of the economy and magnifying its impact on real activity. These effects indicate the need for policymakers to consider internal finance as they analyze the historical effects of past monetary policy and forecast the impact of monetary actions on future economic activity.

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[46] D. Petersen (1993) provides evidence that the cash flow impact of tax changes is important. Meyer, Prakken, and Varvares (1993) summarize some of the recent "marginal" investment tax credit proposals and evaluate their effectiveness through a variety of channels.

[47] See, for example, Friedman and Kuttner (1993) and the survey by Hubbard (1994).

Data Appendix

Compustat contains balance sheet and income statement data compiled in a fiscal-year format. We use the company's reported fiscal year end to adjust the data so that fiscal quarters are aligned with calendar quarters. We then adjust both the lagged stock of inventories and the inventory investment variable in our regressions to account for 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 (last-in-first-out) methods. To adjust, we group firms into LIFO and non-LIFO categories. For LIFO firms, we apply an algorithm developed by Michael Salinger and Lawrence Summers (1983) to estimate the replacement value for the inventory stock. For FIFO (first-in-first-out) 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.

We define cash flow 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 change in short-term debt variable is constructed by differencing debt in current liabilities, the only short-term debt variable available on the quarterly Compustat database. The stock of cash is defined as cash and short-term investments. Short-term investments are securities readily transferable to cash. 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.

We constructed the series used in figures 2 and 3 from the QFR. The QFR contains selected balance sheet and income statement data, disaggregated by nominal size class and industrial classification. From the aggregate balance sheet, we obtained short-term bank and non-bank debt variables for durable and nondurable manufacturing and corrected these series for discontinuities introduced by changes in accounting and sampling techniques by using the method described in Gertler and Gilchrist (1994a) and Oliner and Rudebusch (1993).

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Table 1
Sample Medians of Physical Characteristics

		Period 1 (81.3-84.1)		*Period 2 (84.2-88.3)*		*Period 3 (88.4-92.4)*	
		Small Firms	Large Firms	Small Firms	Large Firms	Small Firms	Large Firms
Number of Firms							
	Nondurables	96	116	141	117	172	139
	Durables	136	131	288	109	402	138
Total Assets							
	Nondurables	107.4	1696.1	71.7	1465.2	71.3	1361.1
	Durables	96.8	1286.3	58.5	1284.6	58.7	1167.21
Inventories							
	Nondurables	21.0	279.5	14.9	218.6	14.5	202.4
	Durables	26.5	268.1	14.8	215.5	14.0	201.5
Sales							
	Nondurables	46.8	536.6	28.0	436.6	23.3	369.9
	Durables	32.4	401.1	17.3	332.6	17.6	315.3

Source: Authors computations from compustat data. Total assets, inventories and sales expressed as millions of 1987 dollars.

Table 2
Sample Medians of Financial Statistics

		Period 1 (81.3-84.1)		*Period 2 (84.2-88.3)*		*Period 3 (88.4-92.4)*	
		Small Firms	Large Firms	Small Firms	Large Firms	Small Firms	Large Firms
Retention Ratio							
	Nondurables	0.761	0.578	0.836	0.636	0.911	0.611
	Durables	0.843	0.681	1.000	0.741	1.000	0.807
Cash Flow to Net Sources							
	Nondurables	0.926	0.926	0.922	0.902	0.959	0.899
	Durables	0.769	0.931	0.851	0.837	0.911	0.806
Debt Issues to Net Sources							
	Nondurables	0.000	0.042	0.022	0.053	0.000	0.032
	Durables	0.087	0.000	0.060	0.075	0.000	0.110
Stock Issues to Net Sources							
	Nondurables	0.002	0.009	0.002	0.005	0.000	0.003
	Durables	0.002	0.014	0.006	0.014	0.005	0.009

Source: Authors computations from Compustat data. Total assets, inventories and sales expressed as millions of 1987 dollars.

Table 3
Inventory Investment Regressions
With Internal Finance

		Nondurables				Durables			
		Small Firms		Large Firms		Small Firms		Large Firms	
Period 1	N_{it-1}	-0.246	(0.038)	-0.346	(0.035)	-0.222	(0.025)	-0.174	(0.037)
81.3-84.1	S_{it}	-0.073	(0.021)	0.007	(0.220)	-0.043	(0.017)	0.002	(0.019)
	S_{it-1}	0.029	(0.020)	0.014	(0.021)	0.080	(0.019)	0.044	(0.020)
	S_{it-2}	0.062	(0.019)	0.078	(0.018)	-0.011	(0.018)	0.005	(0.017)
	CF_{it}	0.111	(0.091)	0.057	(0.043)	0.196	(0.059)	0.170	(0.056)
	CF_{it-1}	0.127	(0.093)	0.141	(0.051)	0.163	(0.064)	0.123	(0.049)
	CF_{it-2}	0.098	(0.094)	-0.045	(0.049)	0.125	(0.066)	-0.021	(0.049)
	ΣCF	0.336	p=0.004	0.152	p=0.019	0.484	p=0.000	0.272	p=0.000
	Adj. R^2	0.587		0.626		0.431		0.239	
Period 2	N_{it-1}	-0.207	(0.020)	-0.189	(0.028)	-0.134	(0.012)	-0.096	(0.018)
84.2-88.3	S_{it}	-0.067	(0.017)	0.008	(0.017)	-0.051	(0.012)	0.022	(0.018)
	S_{it-1}	0.069	(0.016)	0.047	(0.018)	0.086	(0.012)	0.066	(0.017)
	S_{it-2}	0.037	(0.005)	0.006	(0.015)	0.023	(0.011)	-0.030	(0.013)
	CF_{it}	0.149	(0.045)	-0.023	(0.042)	0.174	(0.026)	0.081	(0.031)
	CF_{it-1}	0.054	(0.043)	0.071	(0.034)	0.024	(0.023)	0.063	(0.031)
	CF_{it-2}	0.033	(0.046)	0.051	(0.030)	0.080	(0.024)	0.044	(0.023)
	ΣCF	0.236	p=0.000	0.099	p=0.067	0.278	p=0.000	0.188	p=0.000
	Adj. R^2	0.440		0.513		0.318		0.251	
Period 3	N_{it-1}	-0.237	(0.024)	-0.290	(0.028)	-0.171	(0.011)	-0.174	(0.021)
88.4-92.4	S_{it}	-0.107	(0.018)	0.006	(0.018)	-0.047	(0.011)	0.011	(0.020)
	S_{it-1}	0.077	(0.016)	0.041	(0.019)	0.089	(0.011)	0.098	(0.019)
	S_{it-2}	0.056	(0.015)	0.050	(0.020)	0.024	(0.010)	0.015	(0.015)
	CF_{it}	0.126	(0.035)	0.036	(0.022)	0.160	(0.022)	0.014	(0.026)
	CF_{it-1}	-0.012	(0.038)	0.004	(0.026)	0.041	(0.019)	0.004	(0.020)
	CF_{it-2}	0.010	(0.037)	-0.016	(0.024)	0.025	(0.019)	0.004	(0.022)
	ΣCF	0.124	p=0.019	0.024	p=0.495	0.226	p=0.000	0.023	p=0.539
	Adj. R^2	0.406		0.538		0.221		0.239	

Fixed firm and time effects not reported. The standard errors to the right of each point estimate have been adjusted for heteroscedasticity. The p-value to the right of the sum of cash flow coefficients is generated by the test that their sum is equal to zero.

Table 4
Inventory Investment Regressions
With Cash Stocks
Sample Split by Bond Ratings

		Nondurables				Durables			
		Not Rated		Rated		Not Rated		Rated	
Period 1	N_{it-1}	-0.231	(0.038)	-0.329	(0.034)	-0.154	(0.028)	-0.191	(0.033)
81.3-84.1	S_{it}	-0.041	(0.019)	-0.013	(0.020)	-0.008	(0.015)	0.058	(0.018)
	S_{it-1}	0.035	(0.016)	0.051	(0.021)	0.086	(0.016)	0.102	(0.020)
	S_{it-2}	0.075	(0.016)	0.067	(0.019)	0.003	(0.014)	0.001	(0.016)
	Cash Stocks $_{it}$	0.094	(0.021)	0.065	(0.020)	0.049	(0.017)	0.034	(0.018)
	Adj. R^2	0.551		0.662		0.351		0.357	
Period 2	N_{it-1}	-0.229	(0.025)	-0.181	(0.023)	-0.142	(0.013)	-0.079	(0.018)
84.2-88.3	S_{it}	-0.040	(0.016)	0.008	(0.016)	-0.020	(0.011)	0.025	(0.016)
	S_{it-1}	0.069	(0.014)	0.047	(0.017)	0.096	(0.011)	0.069	(0.017)
	S_{it-2}	0.046	(0.013)	0.012	(0.015)	0.034	(0.010)	0.007	(0.013)
	Cash Stocks $_{it}$	0.007	(0.010)	0.036	(0.011)	0.020	(0.010)	0.022	(0.010)
	Adj. R^2	0.425		0.447		0.291		0.272	
Period 3	N_{it-1}	-0.287	(0.025)	-0.189	(0.029)	-0.165	(0.012)	-0.181	(0.024)
88.4-92.4	S_{it}	-0.064	(0.016)	0.008	(0.019)	-0.017	(0.009)	0.013	(0.021)
	S_{it-1}	0.050	(0.015)	0.046	(0.019)	0.105	(0.009)	0.091	(0.021)
	S_{it-2}	0.080	(0.015)	0.029	(0.015)	0.024	(0.008)	0.036	(0.018)
	Cash Stocks $_{it}$	-0.015	(0.011)	0.026	(0.010)	0.025	(0.007)	0.023	(0.012)
	Adj. R^2	0.354		0.388		0.176		0.235	

Fixed firm and time effects not reported. The standard errors to the right of each point estimate have been adjusted for heteroscedasticity.

Table 5
Inventory Investment Regressions
With Interest Coverage

		Nondurables				Durables			
		Small Firms		Large Firms		Small Firms		Large Firms	
Period 1	N_{it-1}	-0.253	(0.041)	-0.422	(0.044)	-0.192	(0.028)	-0.185	(0.038)
81.3-84.1	S_{it}	-0.065	(0.020)	0.026	(0.025)	0.002	(0.021)	0.045	(0.019)
	S_{it-1}	0.013	(0.019)	0.031	(0.020)	0.077	(0.021)	0.029	(0.021)
	S_{it-2}	0.100	(0.017)	0.077	(0.018)	0.018	(0.019)	0.000	(0.017)
	Coverage Ratio$_{it}$	-0.042	(0.009)	-0.017	(0.006)	-0.031	(0.008)	-0.027	(0.005)
	Adj. R^2	0.596		0.653		0.429		0.241	
Period 2	N_{it-1}	-0.236	(0.021)	-0.169	(0.028)	-0.138	(0.012)	-0.103	(0.022)
84.2-88.3	S_{it}	-0.050	(0.016)	0.008	(0.016)	-0.024	(0.013)	0.023	(0.018)
	S_{it-1}	0.071	(0.017)	0.039	(0.018)	0.072	(0.013)	0.062	(0.017)
	S_{it-2}	0.029	(0.014)	0.006	(0.015)	0.046	(0.010)	-0.012	(0.013)
	Coverage Ratio$_{it}$	-0.039	(0.007)	-0.011	(0.008)	-0.012	(0.004)	-0.013	(0.006)
	Adj. R^2	0.468		0.514		0.248		0.235	
Period 3	N_{it-1}	-0.264	(0.026)	-0.311	(0.030)	-0.181	(0.012)	-0.165	(0.022)
88.4-92.4	S_{it}	-0.083	(0.017)	0.015	(0.018)	-0.015	(0.010)	-0.002	(0.021)
	S_{it-1}	0.096	(0.016)	0.039	(0.019)	0.090	(0.011)	0.097	(0.020)
	S_{it-2}	0.036	(0.014)	0.033	(0.020)	0.027	(0.009)	0.006	(0.015)
	Coverage Ratio$_{it}$	-0.017	(0.007)	-0.015	(0.005)	-0.015	(0.004)	-0.005	(0.003)
	Adj. R^2	0.440		0.543		0.217		0.233	

Fixed firm and time effects not reported. The standard errors to the right of each point estimate have been adjusted for heteroscedasticity.

Table 6
Inventory Investment Regressions with External Finance

		Nondurables				Durables			
		Small Firms		Large Firms		Small Firms		Large Firms	
Period 1	N_{it-1}	-0.277	(0.043)	-0.417	(0.039)	-0.247	(0.026)	-0.250	(0.031)
81.3-84.1	S_{it}	-0.076	(0.019)	0.017	(0.020)	-0.007	(0.018)	0.038	(0.017)
	S_{it-1}	0.038	(0.020)	0.019	(0.019)	0.106	(0.019)	0.067	(0.018)
	S_{it-2}	0.073	(0.017)	0.094	(0.016)	-0.009	(0.018)	-0.004	(0.017)
	ΔDBT_{it}	0.088	(0.102)	0.207	(0.072)	0.089	(0.108)	0.280	(0.070)
	ΔDBT_{it-1}	0.031	(0.039)	0.098	(0.025)	0.104	(0.036)	0.106	(0.022)
	ΔDBT_{it-2}	-0.182	(0.041)	-0.020	(0.026)	-0.003	(0.037)	0.012	(0.028)
	$\Sigma \Delta DBT$	-0.063	p=0.682	0.285	p=0.007	0.190	p=0.207	0.398	p=0.000
	Adj. R^2	0.623		0.669		0.431		0.265	
Period 2	N_{it-1}	-0.231	(0.021)	-0.194	(0.029)	-0.162	(0.013)	-0.120	(0.019)
84.2-88.3	S_{it}	-0.063	(0.015)	-0.010	(0.017)	-0.030	(0.011)	0.030	(0.017)
	S_{it-1}	0.098	(0.014)	0.062	(0.016)	0.103	(0.012)	0.069	(0.016)
	S_{it-2}	0.027	(0.012)	0.005	(0.014)	0.033	(0.010)	-0.020	(0.012)
	ΔDBT_{it}	0.287	(0.068)	0.061	(0.055)	0.206	(0.064)	0.051	(0.089)
	ΔDBT_{it-1}	0.054	(0.021)	0.014	(0.022)	0.060	(0.015)	0.041	(0.026)
	ΔDBT_{it-2}	-0.033	(0.018)	0.005	(0.021)	0.009	(0.016)	0.031	(0.023)
	$\Sigma \Delta DBT$	0.308	p=0.001	0.080	p=0.330	0.275	p=0.001	0.124	p=0.290
	Adj. R^2	0.490		0.544		0.336		0.266	
Period 3	N_{it-1}	-0.237	(0.025)	-0.301	(0.029)	-0.193	(0.012)	-0.197	(0.022)
88.4-92.4	S_{it}	-0.086	(0.015)	0.001	(0.017)	-0.021	(0.010)	-0.002	(0.020)
	S_{it-1}	0.103	(0.015)	0.042	(0.018)	0.108	(0.011)	0.111	(0.019)
	S_{it-2}	0.037	(0.013)	0.054	(0.018)	0.028	(0.009)	0.011	(0.017)
	ΔDBT_{it}	0.165	(0.064)	0.103	(0.047)	0.208	(0.041)	0.161	(0.045)
	ΔDBT_{it-1}	-0.029	(0.019)	-0.019	(0.020)	0.046	(0.011)	0.034	(0.015)
	ΔDBT_{it-2}	-0.046	(0.019)	-0.037	(0.021)	0.008	(0.009)	0.001	(0.010)
	$\Sigma \Delta DBT$	0.089	p=0.287	0.047	p=0.533	0.262	p=0.000	0.196	p=0.000
	Adj. R^2	0.457		0.573		0.198		0.233	

Fixed firm and time effects not reported. The standard errors to the right of each point estimate have been adjusted for heteroscedasticity. The p-value to the right of the sum of debt coefficients is generated by the test that their sum is equal to zero.

Table 7
Inventory Investment Regressions with Internal and External Finance

		Nondurables				Durables			
		Small Firms		Large Firms		Small Firms		Large Firms	
Period 1	N_{it-1}	-0.266	(0.043)	-0.405	(0.039)	-0.236	(0.026)	-0.231	(0.031)
81.3-84.1	S_{it}	-0.079	(0.021)	0.015	(0.021)	-0.030	(0.020)	0.030	(0.018)
	S_{it-1}	0.028	(0.022)	0.000	(0.021)	0.079	(0.020)	0.039	(0.020)
	S_{it-2}	0.074	(0.018)	0.099	(0.017)	-0.024	(0.020)	-0.002	(0.019)
	CF_{it}	0.056	(0.091)	0.043	(0.047)	0.177	(0.062)	0.100	(0.046)
	CF_{it-1}	0.083	(0.096)	0.176	(0.050)	0.144	(0.067)	0.164	(0.050)
	CF_{it-2}	0.006	(0.097)	-0.030	(0.045)	0.122	(0.068)	-0.036	(0.053)
	ΔDBT_{it}	0.054	(0.100)	0.177	(0.071)	0.026	(0.106)	0.250	(0.069)
	ΔDBT_{it-1}	0.023	(0.039)	0.088	(0.024)	0.091	(0.035)	0.095	(0.022)
	ΔDBT_{it-2}	-0.184	(0.041)	-0.031	(0.026)	-0.009	(0.037)	0.007	(0.027)
	ΣCF	0.145	p=0.224	0.189	p=0.004	0.443	p=0.000	0.228	p=0.000
	$\Sigma \Delta DBT$	-0.107	p=0.479	0.234	p=0.024	0.108	p=0.469	0.352	p=0.000
	Adj. R^2	0.619		0.676		0.438		0.279	
Period 2	N_{it-1}	-0.226	(0.021)	-0.190	(0.029)	-0.145	(0.012)	-0.119	(0.019)
84.2-88.3	S_{it}	-0.081	(0.016)	-0.007	(0.018)	-0.058	(0.012)	0.019	(0.019)
	S_{it-1}	0.086	(0.016)	0.057	(0.016)	0.090	(0.012)	0.061	(0.017)
	S_{it-2}	0.027	(0.014)	0.002	(0.014)	0.021	(0.011)	-0.027	(0.013)
	CF_{it}	0.170	(0.044)	0.000	(0.039)	0.183	(0.026)	0.071	(0.031)
	CF_{it-1}	0.080	(0.043)	0.050	(0.033)	0.035	(0.024)	0.062	(0.030)
	CF_{it-2}	-0.001	(0.043)	0.038	(0.029)	0.077	(0.023)	0.054	(0.023)
	ΔDBT_{it}	0.264	(0.066)	0.049	(0.054)	0.157	(0.063)	0.036	(0.089)
	ΔDBT_{it-1}	0.049	(0.020)	0.011	(0.022)	0.056	(0.015)	0.032	(0.026)
	ΔDBT_{it-2}	-0.039	(0.018)	0.004	(0.021)	0.010	(0.015)	0.026	(0.023)
	ΣCF	0.249	p=0.000	0.087	p=0.100	0.294	p=0.000	0.188	p=0.000
	$\Sigma \Delta DBT$	0.274	p=0.002	0.064	p=0.436	0.222	p=0.004	0.095	p=0.414
	Adj. R^2	0.498		0.541		0.349		0.267	
Period 3	N_{it-1}	-0.231	(0.025)	-0.300	(0.029)	-0.180	(0.012)	-0.193	(0.023)
88.4-92.4	S_{it}	-0.109	(0.017)	-0.007	(0.017)	-0.052	(0.011)	-0.008	(0.021)
	S_{it-1}	0.102	(0.016)	0.041	(0.019)	0.092	(0.011)	0.112	(0.020)
	S_{it-2}	0.037	(0.014)	0.059	(0.019)	0.022	(0.010)	0.010	(0.016)
	CF_{it}	0.130	(0.037)	0.053	(0.023)	0.182	(0.022)	0.039	(0.027)
	CF_{it-1}	-0.002	(0.037)	0.000	(0.027)	0.045	(0.019)	-0.009	(0.020)
	CF_{it-2}	-0.002	(0.037)	-0.032	(0.025)	0.029	(0.020)	0.001	(0.022)
	ΔDBT_{it}	0.158	(0.063)	0.102	(0.047)	0.183	(0.039)	0.157	(0.044)
	ΔDBT_{it-1}	-0.031	(0.019)	-0.021	(0.020)	0.045	(0.010)	0.033	(0.015)
	ΔDBT_{it-2}	-0.047	(0.018)	-0.038	(0.021)	0.008	(0.008)	0.001	(0.009)
	ΣCF	0.127	p=0.019	0.022	p=0.550	0.256	p=0.000	0.032	p=0.405
	$\Sigma \Delta DBT$	0.080	p=0.329	0.043	p=0.568	0.236	p=0.000	0.191	p=0.000
	Adj. R^2	0.459		0.573		0.219		0.234	

Fixed firm and time effects not reported. The standard errors to the right of each point estimate have been adjusted for heteroscedasticity. The p-values to the right of the sum of cash flow and short-term debt coefficients are generated by the test that their sum is equal to zero.