# RETAIL INVENTORIES, INTERNAL FINANCE, AND AGGREGATE FLUCTUATIONS: EVIDENCE FROM FIRM-LEVEL PANEL DATA

By

Egon Zakrajsek*
Department of Economics
New York University

CES 95-9 May 1995

## Abstract

This paper investigates the cross-sectional and time-series implications of capital imperfections for inventory investment in retail trade. In particular, it focuses on the relevance of firms' balance sheet positions in obtaining access to external sources of finance. The paper utilizes an entirely new source of firm-level data at a quarterly frequency; the micro data underlying the published *Quarterly Financial Reports (QFR)*. Under the maintained hypothesis, firms with "weak" balance sheet positions face a higher-and quite possibly prohibitive-premium on external finance than do firms with "strong" balance sheet positions. Consequently, inventory investment decisions of firms with "weak" balance sheet positions are in large part determined by the availability of internally generated funds-that is, profits or cash flow. A panel data modification of an error-correction model that incorporates internal finance variables and forward-looking expectations of the stochastic process of sales is not rejected by the data. Both the cross-sectional and time-series results are consistent with the existence of capital market imperfections; namely, (1) internal finance is a highly significant-statistically and economically-predictor of inventory investment of firms with "weak" balance sheet positions; and (2) the predictive power of internal finance for inventory investment of firms with "weak" balance sheet positions is highly asymmetric over the course of a business cycle, increasing considerably in recession relative to expansionary times. The quantitative significance of financial factors suggests that a large portion of the observed volatility in aggregate retail inventory investment over a business cycle is potentially due to fluctuations in internal finance.



Keywords: retail inventories, internal finance, business cycles



*I am grateful to Mark Gertler and Simon Gilchrist for their extensive comments and for giving me an opportunity to work with the QFR data. Discussions with Sharon Kozicki and Mitch Post were also helpful. I thank members of the MAQS section at the Federal Reserve Board for their gracious hospitality during the project and the CES staff at the Bureau of the Census for providing the data.

# 1 Introduction

A well-known fact among macro-economists is that inventory movements play a dominant role in business cycle fluctuations—the drop in inventory investment can account for a majority of the decline in output during recessions. For the average U.S. postwar recession, Blinder and Maccini [7] report that inventory disinvestment accounted for 87% of the total peak-to-trough decline in GNP. Another salient qualitative feature of a postwar business cycle is the fact that business income—and therefore the flow of internal finance—is extremely volatile, pro-cyclical, and tends to lead the cycle (see, for example, Lucas [31]).

By utilizing an entirely new data source, this paper attempts to link these two stylized facts by appealing to a growing theoretical literature which argues that imperfections in the market for capital—caused by informational asymmetries between borrowers and lenders—may amplify aggregate fluctuations by increasing the sensitivity of current spending to movements in internal finance or net worth. This theory offers a possible solution to a longstanding puzzle in business cycle literature of how relatively small shocks can generate large fluctuations in aggregate economic activity. Shifts toward restrictive monetary policy, for instance, that had very modest effects on long-term interest rates—that is, "small" monetary shocks—have been linked to large declines in investment spending and output. Resolution of this puzzling phenomenon, sometimes referred to as the "small shocks, big cycles" paradox, involves an interaction of real and financial decisions in an economy where the financial system does not function smoothly—that is, an economy with an imperfect capital market.

The aim of the theoretical research analyzing macroeconomic implications of the interaction between real and financial activity is to develop mechanisms by which small, transitory, and exogenous shocks—to either the financial or real side—can be amplified and propagated through the economy. Termed the "financial accelerator" mechanism by Bernanke, Gertler, and Gilchrist [3], the amplification and propagation of initial real or monetary shocks results from poorly performing financial markets.[1] Eckstein and Sinai [13] argue that the time

[1] Only to the extent that it has been identified as an important source of aggregate demand disturbances (see, for example, Romer and Romer [39] and Bernanke and Blinder [1]), monetary policy is not central to the situation at hand, since financial factors, in general, may propagate and amplify any exogenous shock to aggregate economic activity.

preceding each of the six recessions between 1957 and 1982 was characterized by a major financial disturbance—the so-called "credit crunch."[2] Furthermore, Bernanke and Lown [4] present evidence that prior to a 1991 recession, a shortage of equity capital impeded banks' ability to make loans, particularly in the most hard-hit regions of the U.S., resulting in what has been called the "capital crunch." In addition, they argue that the decline in the credit quality of borrowers—caused by an increase in debt service burdens and a sharp drop in the value of commercial property—contributed significantly to the overall diminished level of credit extension activity.

Symptomatic of a poorly functioning financial system, a credit or capital crunch during the course of a business cycle usually occurs at the inopportune time when firms and households are financially overextended and may be increasing their demand for external funds (to finance excessive inventory accumulation, for example). In such a precarious economic environment, a small adverse shock to balance sheets or simply, as noted by Eckstein and Sinai [13], the natural and normal end of a business cycle boom can significantly worsen financial conditions. The inability of firms and households to obtain the much needed credit, therefore, results in a concomitant decline in spending and a curtailment of production, thereby exacerbating the ensuing economic downturn.

The formal development of the financial accelerator mechanism is provided by the theoretical literature which emphasizes the financial aspects of a business cycle—namely, the role of borrowers' balance sheet positions. A central implication of capital market imperfections is that internal and external funds are *not* perfect substitutes. External finance is intrinsically more expensive than internal finance, because it incorporates, in the language of the literature, the "*agency premium*"—the inevitable dead-weight loss—associated with imperfect information in financial markets. The agency premium on external finance is inversely related to the strength of a borrower's balance sheet position. Consequently, the spending decisions of certain classes of borrowers are directly determined by the relative positions of their balance sheets. In other words, a strong balance sheet position indicates

[2] A "credit crunch," in Eckstein's and Sinai's temporal description of a business cycle, is a period immediately preceeding an economic downturn that is characterised by substantially depressed liquidity levels and deteriorated balance sheet positions. The consequently diminished capacity of borrowers to absorb debt is combined with increasing interest rates and the inability of many borrowers to obtain funds at any cost.

that a borrower has more resources available to either directly finance a project (for example, inventory or capital accumulation) or to use as collateral in obtaining external finance. A strong balance sheet position therefore reduces the borrower's costs of obtaining external funds by lowering the agency premium on external finance. This connection between the net worth that can be used as collateral and the terms of credit leads naturally to the financial accelerator mechanism—that fluctuations in balance sheet positions over the business cycle amplify swings in spending.[3]

Empirical research to date which explores the effects of the financial accelerator mechanism on inventory investment has focused exclusively on the inventories held by manufacturing firms. Recent papers by Kashyap, Stein, and Wilcox [27]; Kashyap, Lamont, and Stein [26]; Carpenter, Fazzari, and Petersen [12]; Gertler and Gilchrist [17]; Calomiris, Orphanides, and Sharpe [10]; and Calomiris, Himmelberg, and Wachtel [8] offer substantial empirical evidence which suggest that financial factors play an important explanatory and predictive role in the behavior of manufacturers' inventories. Despite the relative importance of non-manufacturing inventories as a component of aggregate inventory stocks, the current scope of empirical research on the effects of the financial accelerator mechanism on inventory investment leaves open the question in what form and magnitude do financial factors affect inventory investment in the remainder of the economy, if indeed they affect inventory investment at all. Blinder and Maccini [7] report that in 1989 manufacturing and (wholesale and retail) trade inventories accounted for over 87% of inventory stocks held in the entire U.S. economy. Focusing only on the inventories in manufacturing and trade sectors of the economy, trade inventories on the average account for almost 40% of the total stocks, thus clearly making them relevant to aggregate fluctuations.

In addition to the significance of retail trade inventories as a component of aggregate inventory stocks, the motivation for the analysis of retail inventory investment in this paper is derived primarily from two findings. First, using the variance of inventory investment as a measure of volatility, inventory investment in retail trade is the *most* volatile component of aggregate inventory investment. Nearly 25% of the aggregate variance comes from the

[3]Dynamic general equilibrium models that incorporate such a financial accelerator mechanism have been developed by Bernanke and Gertler [2]; Calomiris and Hubbard [9]; Gertler [15]; Greenwald and Stiglits [21]; and Kiyotaki and Moore [28].

movements in retail inventories. Dynamics of aggregate inventory investment are dominated by fluctuations both in retail inventories and in raw materials and supplies held by manufacturers (see Blinder and Maccini [7] for full accounting). In their assessment of the state of inventory research, Blinder and Maccini [6] list the volatility of retail inventories as one of the three basic stylized facts that need to be explained.

The second finding motivating this paper centers on the differences in the cross-sectional distribution of firm size between the retail and manufacturing sectors. The cross-sectional distribution of the size of retail trade firms—measured by assets or sales—is skewed toward smaller firms. According to Table 1, in 1990, firms with assets below $250 million accounted for 16.1% of all assets and 30.9% of all receipts in the manufacturing sector. The corresponding class of firms in the retail trade, on the other hand, accounted for 45.3% of all assets and 66.1% of all receipts.[4] In their study of small manufacturing firms, Gertler and Gilchrist [17] found that following a tightening of monetary policy, small firms account for a surprisingly significant share of the decline in inventory investment. To the extent that binding credit constraints associated with capital market imperfections are negatively correlated with size and are felt more acutely by small firms, effects of capital market imperfections may be more prevalent in retail trade than in manufacturing.[5] Consequently, financial factors are likely to have significant explanatory and predictive power for the aggregate as well as for firm-level inventory dynamics in retail trade.[6] Since financial factors may exacerbate economic downturns, the differences in the cross-sectional distribution of size and/or capital market access may prove to be an important source of different cyclical variability within the different sectors of the economy.

The remainder of the paper is organized as follows: Section 2 discusses the identification

[4]See Gertler and Hubbard [18] for additional evidence.

[5]Using firm-level Compustat data for the retail trade sector, Kwon [29] finds that for credit constrained firms, financial factors have significant explanatory power for business fixed investment.

[6]The interaction of financial factors with retail inventory investment has, historically, been neglected by econometric investigations. Two important exceptions are Irvine ([24] and [25]). In both studies, Irvine examines the dependence of retail target inventory levels to financial inventory carrying costs, measured as a cost of capital. His analysis proceeds under the assumption of perfect credit markets in which capital costs of financing inventories depend solely on short-term interest rates and the relative price level. Using monthly sectoral (durable and non-durable) aggregate data, Irvine [25] found that inventory investment in retail trade responds significantly to variations in a cost of capital. Similar results were obtained in Irvine [24], which utilised monthly data of a single large department store.

issue and presents the econometric methodology. A key testable hypothesis which emerges from the theoretical analysis of the interaction between the real and financial aspects of economic activity under asymmetric information in financial markets is that, *ceteris paribus*, relative differences amongst economic agents in their access to financial markets—sources of external finance—imply cross-sectional differences in their behavior as well as differences in agents' behavior over the business cycle. The first part of this hypothesis provides the *cross-sectional* basis for the identification strategy in this paper. That is, due to imperfections in a market for capital, firms with "weak" balance sheet positions face a higher—and quite possibly prohibitive—premium on external finance than do firms with "strong" balance sheet positions. Consequently, inventory investment decisions of firms with "weak" balance sheet positions are in large part determined by the availability of internally generated funds—that is, profits or cash flow.

The second implication of the above hypothesis concerns the *time-series* dynamics of inventory investment during the course of a business cycle. In particular, as business and credit conditions deteriorate in the aggregate, and credit constraints increase in severity, firms with "weak" balance sheet positions should increase their reliance on internally generated funds in order to finance inventory accumulation.[7] Internal finance, consequently, should exhibit greater predictive power for inventory investment in recessions than in booms. The overall identification strategy in this paper involves exploiting the cross-sectional heterogeneity in balance sheet positions in order to compare the cross-sectional and time-series dynamics of inventory investment and their sensitivity to the movement in internal finance between firms which are likely to face binding credit constraints and firms with relatively unimpeded access to various sources of external finance.[8]

In order to discern the impact of a firm's balance sheet position on inventory invest-

[7]This intrinsic nonlinearity of the financial accelerator mechanism over the cycle—that is, the financial accelerator effects increase, the deeper the economy is in a recession—is developed formally by Bernanke and Gertler [2].

[8]In empirical studies of capital market imperfections using disaggregated data, exploiting the cross-sectional heterogeneity has proven to be a useful technique in *a priori* identifying firms that are likely to face significant informational problems in credit markets and, consequently, have a limited, or possibly nonexistent, access to external finance; see Fassari, Hubbard and Petersen [14] for the pioneering application of this methodology. From the methodological perspective, Kashyap, Lamont, and Stein [26]; Carpenter, Fassari, and Petersen [12]; Gertler and Gilchrist [17]; and Calomiris, Himmelberg, and Wachtel [8] employ a similar identification strategy in their studies of manufacturers' inventories.

ment, the baseline structural specification—a panel data modification of an error-correction model that was used by Gertler and Gilchrist [17]—is augmented to include fixed firm and time effects as well as internal finance variables. Under the maintained hypothesis, internal finance ought to have significant explanatory power for inventory investment only for firms that face quantitatively significant agency costs in financial markets. An alternative explanation would suggest that predictive power of internal finance for inventory investment is derived solely from its ability to forecast future expected sales. In order to control for the potential forecasting ability of internal finance, an alternative specification, in addition to lagged and contemporaneous regressors, explicitly includes expectations of the forward-looking stochastic process of sales in inventory demand relation.

Section 3 describes the data. It consists of two non-overlapping *quarterly* panels at the firm level covering the time period of 1979:Q1 to 1991:Q3. Panel I covers the time period 1979:Q1 to 1984:Q4, and Panel II covers the remainder of the sample period—that is, 1985:Q1 to 1991:Q3. With the exception of Carpenter, Fazzari, and Petersen [12] and Calomiris, Himmelberg, and Wachtel [8], who also use quarterly data, panel data studies investigating the effects of the financial accelerator mechanism on inventory investment to date have relied on annual data. Given the extreme volatility of inventory investment and internal finance over a business cycle, the use of quarterly data seems essential in order to capture such high-frequency phenomena.

The two panels were constructed from the firm-level data underlying the published *Quarterly Financial Reports* (QFR). Considered by many to be ideal for empirical investigations of financial effects on real activity—due to quarterly frequency and long time-series dimension, extensive sampling of non-publicly and publicly traded companies, and detailed information on real and financial variables—firm-level QFR data have only recently become available.[9] On the aggregate level, pronounced movements in inventory investment during recessions of the 1980s and early 1990s were matched with large aggregate fluctuations in internal finance. The data are thus well suited to examine the impact of internal finance fluctuations on inventory investment.

---

[9] Bernanke, Gertler, and Gilchrist [3] and Gilchrist and Zakrajšek [19] contain first empirical results using this new data source.

Section 4 presents the empirical results. Several robust findings emerge. Internal finance is a highly significant—statistically and economically—predictor of inventory investment of firms with "weak" balance sheet positions. The predictive power of internal finance for inventory investment of firms with "weak" balance sheet positions is highly asymmetric over the course of a business cycle, increasing considerably in recessions relative to expansionary times. Both the cross-sectional and time-series results are robust to econometric specifications which explicitly control for the potential forecasting ability of internal finance for future expected sales. Section 5 summarizes and concludes.

## 2 Identification and Econometric Methodology

What is a good indicator of a firm's ability to mitigate informational asymmetries present in financial markets and, consequently, to enjoy relatively unimpeded access to various forms of external finance? In an attempt to provide an answer, empirical research on capital market imperfections has utilized indicators such as firm size, dividend-retention practices, predominant reliance on bank debt, lack of commercial paper issuance, and the absence of a bond rating to identify firms with limited access to various forms of external credit. While each identification strategy has its advantages and caveats, this paper, in the spirit of the theoretical literature on the financial accelerator mechanism, emphasizes the role of borrowers' balance sheet positions.

In an imperfect capital market a "strong" balance sheet position reduces a firm's cost of obtaining external finance by lowering the agency premium on external funds. Firms with "weak" balance sheet positions that face a prohibitive wedge between the cost of internal and external finance, on the other hand, must rely predominantly on internal funds in order to finance their inventory investment. In this section, the notion of "weak" and "strong" balance sheet positions is made precise, and a structural inventory investment specification is presented.

## 2.1 Balance Sheet Positions

Financial leverage—the ratio of total debt to total assets—can be thought of as a traditional measure of a firm's balance sheet position. A firm with a high leverage ratio has large interest payments relative to its business income and, therefore, has fewer resources available to directly finance inventory accumulation than does a low leverage firm. Similarly, a high leverage ratio implies that a firm has fewer resources to use as collateral in obtaining external finance and, therefore, faces a higher agency premium on external finance than does a low leverage firm. Consequently, inventory investment of a firm with a high leverage ratio should be closely tied to fluctuations in its own internal funds.

In addition, firms with high leverage ratios tend to be financially overextended and, therefore, "vulnerable" at cyclical peaks. With the onset of a recession, a decline in aggregate spending lowers their cash flows, thereby inducing a further deterioration in their balance sheet positions. Consequently, high leverage firms should increase their reliance on internal funds in order to finance inventory investment the deeper the economy is in a recession.

A potential problem with a identification strategy based on a leverage ratio is that total assets consist of a variety of different assets. In particular, a highly liquid component of total assets, in addition to cash stocks, includes time deposits, CDs, and other readily marketable securities. Such liquid assets can be quickly and at little cost converted to cash-on-hand and used in conjunction with the existing cash stocks to finance inventory investment if internal funds are low and external credit is unavailable. In their case study of the 1982 recession, Kashyap, Lamont, and Stein [26] find strong evidence of this phenomenon. Manufacturing firms with low levels of cash stocks and other liquid assets and no access to public debt markets—firms with "weak" balance sheet positions—did indeed cut their inventories by significantly more than did their counterparts with "strong" balance sheet positions. A more comprehensive measure of a firm's overall balance sheet position is, according to Sharpe [40] and Calomiris, Orphanides, and Sharpe [10], the "net" leverage ratio. The net leverage ratio is constructed by subtracting a firm's net short-term assets from both the numerator and denominator of a firm's leverage ratio. Net short-term assets consist of cash stocks, all short-term investments, and trade receivables, less trade payables.

In order to discern the impact of a firm's balance sheet position on inventory investment, firms in both panels are split into categories according to their balance sheet positions during the *first* period of each respective panel (that is, 1979:Q1 for Panel I and 1985:Q1 for Panel II). In particular, a firm is classified as having a "weak" balance sheet position, using the net leverage ratio (NL-ratio) as an indicator, if two conditions during the first period of each respective panel hold: (1) the firm's NL-ratio is greater than or equal to 0.25; and (2) the firm has not issued commercial paper. If the firm's NL-ratio is less than 0.25, or the firm has issued commercial paper, then the firm is classified as having a "strong" balance sheet position, according to the NL-ratio indicator.

By way of comparison, firms are classified into "weak" and "strong" balance sheet position categories using the traditional leverage ratio (L-ratio) indicator as well. The corresponding criteria for a "weak" balance sheet position using the L-ratio indicator are as follows: If, during the first period of each respective panel, the firm's L-ratio exceeds or is equal to 0.40, and the firm has not issued commercial paper, then the firm is classified as having a "weak" balance sheet position, according to the L-ratio indicator. The converse implies that the firm is classified as having a "strong" balance sheet position.[10] The first period of each panel is then dropped in order to avoid violating the orthogonality conditions that will be used in identifying the subsequent econometric specifications.

## 2.2 Econometric Specification

According to the identification strategy outlined in the preceding section, a strong balance sheet position reduces a borrower's costs of obtaining external finance by lowering the agency premium on external funds. Firms with weak balance sheet positions, on the other hand, face a substantial wedge between the cost of internal and external finance and, consequently, must rely predominantly on internal funds in order to finance their inventory investment. In this section, a structural inventory investment specification is augmented with a variable that captures internal funds. The variable considered is the ratio of a firm's cash flow to its

[10]Both the NL-ratio and the L-ratio split are based approximately on the median NL-ratio and L-ratio during the first period of each panel. Firms that issued commercial paper were classified as having a "strong" balance sheet position regardless of their leverage, since a commercial paper line guarantees a firm an access to external finance at essentially sero agency premium (see Calomiris, Himmelberg, and Wachtel [8]).

last period's total assets.[11] The augmented inventory investment relation is then estimated separately for firms with "weak" and "strong" balance sheet positions, as determined by the NL-ratio and L-ratio indicators of balance sheet conditions.

What is the appropriate structural framework for analyzing retail inventory investment? For obvious reasons, the widely used production-smoothing/buffer stock model is not appropriate, since it was meant to analyze manufacturers' finished goods inventories. Compelling theoretical arguments, advanced by Blinder [5] and Blinder and Maccini [7]—buttressed by some broadly consistent empirical facts—suggest that $(S, s)$ inventory policies are the appropriate structural framework for analyzing retail inventory investment.[12] Given the inherent mathematical difficulties in solving $(S, s)$ inventory models, in addition to non-trivial aggregation problems, the current state of inventory research using $(S, s)$ policies abstracts from the type of financial considerations that form a primary motivation for this paper. Consequently, the econometric specification of inventory investment in this paper is not based on $(S, s)$ inventory rules.[13]

An alternative structural specification, with a long and venerable history in empirical inventory literature, is the target-adjustment model (see Lovell [30] and Irvine ([24], [25]) for example). The target-adjustment model is based on the hypothesis that each firm has a

[11] The reason for not using just the level of cash flow is that all other variables that enter into subsequent econometric specifications are in natural logarithms. Since cash flow can take on zero or negative values and, therefore, is not suitable for logarithmic transformation, it was scaled by a lag of total assets. Note that this definition of internal finance can be interpreted as the rate of profit on last period's total assets.

[12] The optimality of $(S, s)$ inventory policies is based on the cost function of orders that a retailer places with a manufacturing firm. Unlike a manufacturing firm that faces increasing marginal costs of production, a retailer usually faces a fixed cost of placing an order and constant or possibly declining—if there are quantity discounts—marginal costs of ordering an additional unit. A sporting goods store gearing up for the upcoming ski season, for example, faces substantial fixed costs—associated with transportation and warehousing expenses—when it places an order for the latest skis with a manufacturer, while it may only cost a little more to receive a truckload of new skis than to receive a few dozen. In addition, bookkeeping costs depend far more on the number of orders than on the actual quantity of goods ordered. This type of cost structure leads to an inventory strategy called the $(S, s)$ inventory policy. That is, inventory stocks are allowed to decrease to some (optimal) minimum level, $s$, at which time an order is placed that restores inventories to their (optimal) maximum level, $S$.

The key empirical prediction of the $(S, s)$ inventory strategies that is consistent with the observed data is that the variance of deliveries (that is, orders) exceeds the variance of sales. This implication follows very naturally from the $(S, s)$ inventory model, while it is fundamentally contradictory to the production-smoothing/buffer stock framework.

[13] Despite the seminal work of Caplin [11] on the aggregation of $(S, s)$ economies, evidence that aggregate inventory investment in retail trade is consistent with $(S, s)$ inventory rules is mixed. Mosser [32] obtains indirect empirical evidence that is consistent with the $(S, s)$ model of inventory behavior, while Granger and Lee [20] reject the $(S, s)$ model in favor of an error-correction framework.

"desired" (optimal) target level of inventories, and that a firm, finding its actual inventory level not equal to its target level, attempts only partial adjustment towards the target level within any one period.[14] In addition, aggregate and industry-level (2-digit SIC) time-series evidence for the retail trade sector, obtained by Granger and Lee [20], indicates that retail inventory levels and sales are co-integrated, suggesting that an error-correction framework may adequately capture the dynamics of inventory investment in retail trade. An error-correction specification can be thought of as a generalization of a target-adjustment model, and, given its flexibility, can be easily augmented to include financial factors.

In particular, let $N_{it}$ denote firm $i$'s seasonally adjusted logarithmic level of real inventories in period $t$; let $X_{it}$ denote firm $i$'s seasonally adjusted logarithmic level of real sales in period $t$; and let $\Pi_{it}$ denote firm $i$'s seasonally adjusted ratio of real cash flow in period $t$ to real total assets in period $t-1$. (The construction of variables and the seasonal adjustment procedure is described in detail in the Data Appendix.) Equation (1) gives the baseline specification for inventory growth estimated in this paper:

$$(1) \quad \Delta N_{it} = \beta_1[E_{it-1}X_{it} - N_{it-1}] + \beta_2\Pi_{it-1} + f_i + d_t + \beta_3\Delta\Pi_{it-1} + \sum_{k=1}^{2}\beta_{4,k}\Delta X_{it-k} + \sum_{k=1}^{2}\beta_{5,k}\Delta N_{it-k} + u_{it}.$$

Equation (1) captures the basic features of the target-adjustment model. The first two terms imply that the firm $i$'s long-run inventory target level is a linear function of firm $i$'s expected (based on period $t-1$ information set) level of sales and firm $i$'s level of internal funds from the previous period. The fixed firm effect, $f_i$, is included to capture any time-invariant and firm-specific characteristics that may affect firm $i$'s long-run target. The fixed time effect, $d_t$, is included to capture any aggregate changes (movements in prices, interest

[14]The inertia in a firm's adjustment process is attributed to the costs of changing inventory levels. An increase of inventory stocks to a new higher target may involve costs of setting up new display facilities, extra storage costs, or hiring and training of new personnel, for example. Decreasing the level of inventories to a new lower target is costly since it takes time to sell off the excess inventory of goods. In order to speed up the rate of decrease, a firm may have to hold a sale, thereby incurring extra advertising costs. In general, the costs of changing the inventory level to a new target increase with the amount of inventory change attempted per period—that is, the adjustment cost function is convex. Consequently, a firm will spread its adjustment of the inventory level toward the new target over several periods.

rates, or aggregate shocks, for example) that could similarly affect the inventory target level. Note that, conditional on internal funds and fixed firm and time effects, the long-run inventory-sales ratio is restricted to be constant.[15] The inclusion of lagged differences of each of the variables in the regression equation is consistent with the co-integrating relationship between inventory levels and sales and, consequently, gives equation (1) a general error-correction format. Essentially, the first four terms on the right-hand-side of equation (1) reflect the influence of the long-run target level on inventory growth, while lagged differences are included to capture any additional short-run dynamics. The error term $u_{it}$ is a white noise expectation error that is, by definition, orthogonal to all variables dated $t-1$ or earlier.[16]

Equation (1) is estimated separately for firms with "weak" and "strong" balance sheet positions. Under the maintained hypothesis that firms with "weak" balance sheet positions face a significant wedge between the cost of internal and external finance, internal funds—measured as a rate of profit on the last period's total assets—ought to have significant explanatory power only for firms with "weak" balance sheet positions.

A potential problem with this identification strategy lies in the fact that lags of internal finance variable could contain information about the expected level of current sales, $E_{it-1}X_{it}$. Accordingly, the hypothesized predictive power of internal finance for inventory growth of firms with "weak" balance sheet positions could be due entirely to the predictive power of internal finance for current expected sales. The interpretation of the financial variable as the rate of profit on total assets certainly supports this alternative hypothesis, since lagged profit rates are likely to have substantial predictive power for current sales. In order to control for this effect, firm $i$'s $t-1$ period's information set—which is used to forecast current sales—includes lagged internal finance variables.

An extension of the argument which attributes the predictive power of internal finance for inventory growth to its ability to forecast current expected sales, however, would imply that the hypothesized predictive power of internal finance for inventory growth merely re-

[15] Although tests of this restriction are not reported, the restriction of constant long-run inventory-sales ratio could not be rejected for any of the subsequent regressions.

[16] Equation (1) is a panel data modification of the inventory investment specification that was used by Gertler and Gilchrist [17] in their study of the differential behavior of small and large manufacturing firms.

flects the predictive power of internal finance for the expected future sales. In equation (1), the long-run inventory target depends on the expected level of current sales. It certainly makes plausible an argument that, in addition to current expected sales, the long-run inventory target should also depend on the expected *future* growth of sales. In order to test this hypothesis, equation (1) is modified to include the potential forward-looking nature of the long-run inventory target. In particular,

$$(2) \quad \Delta N_{it} = \sum_{k=1}^{2} \beta_{1,k} E_{it-1} \Delta X_{it+k} + \beta_2 [E_{it-1} X_{it} - N_{it-1}] + \beta_3 \Pi_{it-1} + f_i + d_t$$
$$+ \beta_4 \Delta \Pi_{it-1} + \sum_{k=1}^{2} \beta_{5,k} \Delta X_{it-k} + \sum_{k=1}^{2} \beta_{6,k} \Delta N_{it-k} + u_{it}.$$

In equation (2), the long-run inventory target is allowed to depend on the expected growth of sales in periods $t+1$ through $t+2$, the expected level of sales in period $t$, the level of internal funds from period $t-1$, as well as fixed firm and time effects. As before, firm $i$ information set in period $t-1$, which is used to forecast the current level of expected sales and the expected future growth of sales, includes lags of internal finance variable.

## 3 Data Construction and Characteristics

The key implication of the preceding identification strategy is that due to inherent informational asymmetries that exist between borrowers and lenders in financial markets, cross-sectional differences amongst economic agents in access to various financial markets play a crucial role in determining agents' spending decisions and behavior over the course of a business cycle. Empirical implementations of these theories, therefore, require a data set having the following three characteristics: First, the data should have a long time-series dimension at the business cycle frequency; second, it should capture a sufficiently rich cross-section of the underlying population; and finally, the data should include an array of both real and financial variables.

A firm-level data set coming closest to the above three specifications to date has been the Compustat data base. In addressing a variety of issues concerning the interaction of real and financial decisions, empirical research using firm-level data has relied exclusively on the Compustat data base. The principal disadvantage of Compustat data is that it includes only publicly traded firms. By the sheer virtue of being traded in an open capital market, publicly traded firms have at least partially mitigated informational asymmetries and thus are not as likely to experience the same kind of credit constraints that acute informational problems impose on non-publicly traded operations. In addition, Compustat data are often available only at an annual frequency which makes it difficult to analyze and interpret phenomena that occur at the business cycle frequency.[17]

Another data set that has been used extensively in the empirical literature on capital market imperfections is the data set consisting of *Quarterly Financial Reports* (QFR); see, for example, Gertler and Gilchrist ([16], [17]) and Oliner and Rudebusch ([37], [38]). Published by the Bureau of the Census, QFR data appeared promising because of its long time series dimension and extensive sampling of smaller and non-publicly traded firms. Unfortunately, prior to publication, the Census Bureau partially aggregates the underlying firm-level data, which forces all of the above mentioned studies to use firm size—measured by gross assets—as a proxy for capital market access.[18] Despite this shortcoming, published QFR data provides considerable time-series evidence about the differential behavior of small and large firms over business cycles and in response to changes in monetary policy—evidence which is consistent with theoretical literature on capital market imperfections and previous empirical studies. A key question, of course, is whether the differences in behavior between small and large firms are in fact caused by financial factors or, instead, can be attributed to some other non-financial phenomena which may be associated with size. Given the aggregated nature of published QFR data, this question can be only addressed indirectly, making

[17] This was precisely the argument that led Carpenter, Fassari, and Petersen [12] to use quarterly Compustat data in their panel data analysis of manufacturing inventory investment. As they noted, quarterly Compustat data—to the extent that they are available—have been virtually unexploited by empirical research on capital market imperfections; the restriction to publicly traded firms only, however, still applies.

[18] In published QFR data, each firm in the sample is assigned at each point in time into one of eight categories, based upon its level of nominal assets; the asset categories range from under 5 million to greater that 1 billion. All the variables in firms' income and balance sheet statements are then aggregated within each asset category. The prototypical empirical strategy employed by researchers using QFR data is to obtain, from firm-level panel studies, the typical size of liquidity constrained firms. The eight asset categories in QFR data are then re-aggregated into two categories, "small" and "large," using the typical size of liquidity constrained firms as a cutoff for the small firms category. The studies then proceed to analyse the time-series behavior of small and large firms.

it difficult to discriminate among competing hypotheses.[19]

Given the above mentioned problems with both Compustat and QFR data, firm-level data underlying the published partially aggregated QFR data would seem to provide an ideal data set for analyzing the influence of financial factors on real behavior. Namely, firm-level QFR data are at quarterly frequency; the cross-section includes non-publicly traded firms and is thus more representative of the underlying population. Furthermore, firm-level income and balance sheets include information on real and financial variables. Working with the original QFR files through the Center of Economic Studies (CES) at the Bureau of the Census, Mark Gertler, Simon Gilchrist, and I have, over the past year and a half, constructed consistent firm-level data sets for the manufacturing, retail, and wholesale sectors of the U.S. economy, spanning the time period 1977:Q1 to 1991:Q3. Unfortunately, the original QFR file containing 1978:Q4 data is missing. In order to avoid discontinuities in data, this paper begins the analysis in 1979:Q1.

### 3.1 Construction of Panels

This section describes the selection rules that were used in the construction of the data set(s) used in the analysis. First, the empirical methodology is restricted to balanced panels.[20] Due to the long time-series dimension of the QFR data (1979:Q1-1991:Q3), construction of a balanced panel spanning the entire sample period proved impossible. Consequently, the QFR sample range was divided into two non-overlapping periods, and a balanced panel of firms was then constructed for each period. Panel I contains 256 firms and covers the time period 1979:Q1 to 1984:Q4 (24 quarters). Panel II covers the remainder of the sample period—that is, 1985:Q1 to 1991:Q3 (27 quarters)—and contains 258 firms.

[19] Gertler and Gilchrist [17] contain a thorough discussion of this issue, and their empirical strategy addresses the problem to the maximum degree permitted by data. Subsequent work by Bernanke, Gertler, and Gilchrist [3] using firm-level QFR data confirms that differences between small and large firms are in fact caused by financial factors.

[20] Restricting the analysis to balanced panels, of course, introduces the problem of selection bias. This critique applies to most other empirical studies of inventory investment that use firm-level data as well. Since QFR data do provide some information on the reason why a firm may be dropped from the sample (including, statistical sampling reasons, M&A, business failure), an estimate of the relative importance of firms that exit in any given period was computed. One quarter prior to their exit, the percentage of total assets held by firms that exit in a subsequent quarter for economic reasons (business failures and M&As) is of the order of 1 to 2 percent. Thus it seems unlikely that restricting the analysis to surviving firms only would seriously bias the results.

In order to avoid results that are driven by a small number of extreme observations, three criteria were used to eliminate firms with substantial outliers or obvious errors:

1. If a firm's growth rate of (real) inventories was in the 0.50th or 99.50th percentile of the distribution at any point during a firm's tenure in the sample, a firm was eliminated in its entirety.

2. If a firm's growth rate of (real) sales was in the 0.50th or 99.50th percentile of the distribution at any point during a firm's tenure in the sample, a firm was eliminated in its entirety.

3. If a firm's ratio of total current liabilities to total current assets was in the 0.50th or 99.50th percentile of the distribution at any point during a firm's tenure in the sample, a firm was eliminated in its entirety.

As a consequence of these selection rules, 48 firms were eliminated from Panel I, and 62 firms were eliminated from Panel II.[21] Table 2 contains summary statistics for the two panels. (The Census Bureau's regulations prohibit the disclosure of median statistics on firm/plant level data.)

### 3.2 Summary Statistics by Balance Sheet Positions

Summary statistics by balance sheet positions for Panel I and Panel II are provided in Table 3A and Table 3B, respectively. Readily apparent are differences in the average leverage ratio and the average net leverage ratio between firms with "weak" balance sheet positions and firms with "strong" balance sheet positions. The average ratio of total debt to total assets for firms classified as having a "weak" balance sheet position is over one and a half times larger than the average leverage ratio for firms classified as having a "strong" balance sheet position. Controlling for net short-term assets results in even more pronounced differences. The net leverage ratio of firms with "weak" balance sheet positions is over three times larger than the net leverage ratio of firms with "strong" balance sheet positions.

[21] The subsequent analysis of firms that were deleted from the sample revealed severe anomalies in their data, including quarterly growth rates for sales and inventories in the excess of 200%, and implausibly large discrete jumps in the ratio of current liabilities to current assets.

Another striking feature of the sample is the predominance of trade credit as a source of short-term finance for all classes of firms. From Table 2 it can be seen that short-term bank loans account, on the average, for only about 10% of the total short-term debt in both panels—the majority of total short-term debt consists of trade credit.[22] Splitting the sample according to *ex ante* balance sheet positions shows that, on the average, over 80% of short-term finance for firms with "weak" as well as for firms with "strong" balance sheet positions consists of trade credit.

Relative to short-term bank loans, trade credit is a very expensive form of external finance. Nilsen [35] shows that the typical financial contract involving the use of trade credit implies that a firm may be foregoing over 40% in interest earnings if it extends trade credit over its normal duration.[23] Is the predominance of trade credit as a source of short-term debt for all firms in both panels indicative that all firms lack a good alternative in financial markets? If that is the case, inventory investment of firms with "strong" balance sheet positions should also be tied to movements in internal finance. On the other hand, the provision of trade credit does not occur through regular capital market channels. Rather, trade credit is a non-capital market credit, in the sense that it exists as a credit arrangement amongst firms that share long-term business relationships. Whether trade credit should be viewed purely as a financial instrument, or analyzed in the framework of industrial organization is an important question left for future research.

## 4 Results

Before turning to results, a comment regarding the estimation technique used is in order. It is well known that the standard technique of eliminating individual fixed effects—by transforming all variables to deviations from their respective individual means—is inappropriate

[22] Total short-term debt consists of short-term bank loans, short-term other debt, commercial paper, and trade credit.

[23] The typical financial contract regarding trade credit between a supplier firm and a retailer is, according to Nilsen [35], the so called "2/10, net 30" agreement. That is, the supplier will accept a 2% discount on its goods, provided that the retailer makes the payment within 10 days; otherwise the full payment is due in 30 days. Consequently, the retailer should pay 98% of the amount due at 10 days, unless the return from using these funds for the next 20 days exceeds the full amount owed. A simple calculation shows that in order for the retailer to pass up the discount, market (annual) interest rates should be in the excess of 40%.

in a context of an autoregressive fixed effect model; see Nickell [34], for example. The OLS estimator obtained from data that have been transformed in this manner is inconsistent, for finite $T$, due to the asymptotic correlation that exists between the transformed lagged endogenous variables and the error term. The theoretically correct way to estimate an autoregressive fixed effect model is to first suitably difference the data—to eliminate the individual fixed effect—and then to estimate the differenced equation using an instrumental variables procedure like GMM; a coherent set of procedures for estimating and testing of vector auto-regressions using panel data is outlined by Holtz-Eakin, Newey, and Rosen [23].

This kind of transformation, however, may substantially magnify the variation in the error component of the data relative to the variation in the true value—that is, the noise-signal ratio is very likely to increase. Because differencing equation (1), in order to eliminate the firm-specific fixed effect, $f_i$, would entail first as well as second differences of all the variables in the final estimable specification, fixed firm effects in every subsequent regression were eliminated by transforming all the variables to deviations from their respective individual means.

The implication of this transformation is that the resulting estimates are biased. Relative to typical panel data studies, however, the duration of both panels in this paper is rather long (23 quarters for Panel I and 26 quarters for Panel II).[24] Since the asymptotic bias induced by transforming all the variables to deviations from their respective individual means goes to 0 as $T \rightarrow \infty$, at the rate $1/T$, the large number of periods in both panels should ensure that the asymptotic bias of the subsequent estimates is negligible. In order to check that this is indeed the case, the following "sensitivity" analysis was performed. For each panel, equation (1) was estimated for $T = 20$ and $T = 18$. The parameter point estimates obtained from the "shortened" panels were essentially the same as the parameter point estimates obtained from full panels.[25]

[24]Recall that due to *ex ante* balance sheet conditions splits, the first period of both panels has been dropped in order to avoid violating the orthogonality conditions that are used to identify equation (1).

[25]For statistically significant coefficients, differences in point estimates were roughly in the order of $\pm 0.01$ for $T = 20$ and $\pm 0.03$ for $T = 18$.

## 4.1 Structural Estimates: Target-Adjustment Model

Estimates of equation (1) using both panels simultaneously are presented in Table 4.[26] The results indicate that the rate of profit on last period's assets is a highly significant predictor of inventory demand for firms with "weak" balance sheet positions but not for firms with "strong" balance sheet positions. Furthermore, the significance of internal funds for firms with "weak" balance sheet positions is robust to both the L-ratio and NL-ratio indicators of balance sheet conditions. For firms with "weak" balance sheet conditions, the hypothesis that the internal finance variables should be omitted from the equation can be rejected at, essentially, 100% confidence level. For firms with "strong" balance sheet positions, on the other hand, the same hypothesis cannot be rejected; probability values on the test statistic are approximately 0.57 for firms with low leverage ratio and 0.36 for firms with low net leverage ratio.

Somewhat puzzling is the overwhelming rejection, across all balance sheet categories, of the over-identifying restrictions imposed on the model. This suggests that the simple error-correction format of equation (1), when estimated simultaneously across both panels, is inadequate to capture the dynamics of inventory investment in retail trade. Before discussing reasons for a possible misspecification, equation (1) is estimated separately for Panel I and Panel II. The results are presented in Table 4A and Table 4B, respectively. The results obtained from estimating equation (1) on both panels separately confirm the results from Table 4. Internal finance is a highly significant predictor of inventory growth for firms with "weak" balance sheet positions in both panels. As before, this result is robust to both the L-ratio and NL-ratio indicators of balance sheet conditions. The hypothesis that the rate of profit on last period's assets should not be included in the equation is rejected in all cases for firms with "weak" balance sheet positions; the lowest confidence level of this exclusion test is approximately 95%.

The results obtained thus far are consistent with the existence of capital market imperfections: Due to asymmetric information between borrowers and lenders in credit markets, firms with "weak" balance sheet positions face a substantial, or possibly prohibitive, pre-

[26] In practice, this is accomplished by splicing together Panel I and Panel II, after removing fixed firm and time effects separately from each panel.

mium on external finance. In contrast to firms with "strong" balance sheet positions that, consequently, enjoy relatively unimpeded access to external funds, firms with "weak" balance sheet positions, on the other hand, must rely predominantly on internally generated funds in order to finance their inventory investment.

## 4.2 Incorporating Forward-Looking Expectations

As noted earlier, an alternative hypothesis would ascribe the predictive power of internal finance for inventory growth of firms with "weak" balance sheet positions to its ability to forecast future expected sales. The fact that expectations about the future growth of sales are missing from equation (1) could, in principle, explain the overwhelming rejection of the over-identifying restrictions, as well as the apparent predictive power of internal finance for inventory demand.

In order to test this hypothesis, estimates of equation (2) using both panels simultaneously are presented in Table 5. The results indicate that internal finance remains a highly significant predictor of inventory demand for firms with "weak" balance sheet positions, even when controlling for the expected future growth of sales. The hypothesis that the rate of profit on last period's assets should be omitted from equation (2) is rejected at, essentially, 100% confidence level for firms with "weak" balance sheet positions. The same hypothesis cannot be rejected in case of firms with "strong" balance sheet positions; probability values on the exclusion test are roughly 0.65 for firms with low leverage and 0.59 for firms with low net leverage ratio. Furthermore, the significance of internal finance in predicting current inventory demand for firms with "weak" balance sheet positions is robust to both the L-ratio and NL-ratio indicators of balance sheet conditions.

Expectations about the future growth of sales are also important in predicting current inventory demand. Inventory investment of firms with "weak" balance sheet positions is highly sensitive to the expected growth in sales over the immediate future quarter, $\Delta X_{it+1}$; t-statistics exceed 2.50 for both the high L-ratio and high NL-ratio firms. Inventory investment of firms with "strong" balance positions, on the other hand, appears to respond more to the expected growth in sales two quarters ahead of the current quarter—that is, the growth in sales over period $t+2$.[27] In order to discern whether inventory demand of firms with "strong" balance sheet positions responds more to the expectations about a "distant" future state of demand, additional leads of the growth of sales were included in equation (2). The inclusion of additional leads for the growth of sales in equation (2), however, resulted in very unstable parameter estimates and large standard errors. Inspection of the first stage regression statistics revealed that the quality of the instrument set used for equation (2), for variables dated $t+3$ or more, is very poor.

Based on the over-identifying restrictions test, the model specification clearly favors equation (2). The over-identifying restrictions imposed on the model—while unequivocally rejected for equation (1) across all balance sheet categories—cannot be rejected, at the 5% significance level, for all balance sheet classifications.

Table 5A and Table 5B present the estimates of equation (2) for Panel I and Panel II separately. The results obtained from the two panels separately confirm the overall picture. The only notable difference is the loss of predictive power of internal finance for inventory growth in Panel I for firms with "weak" balance sheet conditions according to the L-ratio indicator. The hypothesis that internal finance variables should be omitted from the inventory demand relation for firms with a high leverage ratio in Panel I can no longer be rejected; the probability value on the exclusion test for internal finance variables is 0.17. Note, however, that internal finance remains a highly significant predictor of inventory growth for firms with "weak" balance sheet positions, according to the NL-ratio indicator of balance sheet conditions.

This result is consistent with the argument advanced by Sharpe [40] that the net leverage ratio provides a more accurate picture of a firm's overall balance sheet condition. The "netting out" of short-term assets from a firm's leverage ratio precludes a high net leverage firm from using its liquid assets to finance inventory accumulation if internal funds are low and the cost of external finance is prohibitive. Consequently, a high net leverage ratio is more indicative of the overall "tightness" in a firm's balance sheet position. Accordingly, a firm with a high NL-ratio should be more responsive to the fluctuations in internal finance.

[27]The sum of coefficients on the forward leads is probably a better indicator of the responsiveness of inventory growth to expected future demand conditions. The sum of coefficients on the forward sales growth, however, is about the same for both classes of firms.

In Panel II, however, both the L-ratio and NL-ratio seem to provide an accurate description of firms' balance sheet conditions, although coefficients on internal finance variables are estimated more tightly for the high net leverage firms.

In contrast to Panel I, the explanatory power of internal finance for inventory investment of firms with "weak" balance sheet in Panel II is robust to both the L-ratio and NL-ratio indicators of balance sheet positions. In the mid and late 1980s, many retail firms underwent rapid expansion, financed largely by assuming substantial amounts of debt. Deteriorated balance sheet positions of many large retailers that financed their rapid growth by heavy reliance on debt and their subsequent financial distress have been a focus of numerous popular press accounts.[28] Given that sample characteristics of the two panels are very much alike, the fact that the sample period of the second panel coincides with a time period during which the use of LBOs and heavy reliance on debt to finance rapid expansion was in widespread use could, in principle, account for divergent results regarding the L-ratio indicator between the two panels. Given the complete firm-level income and balance sheet statements, a detailed examination of the composition of total assets should reveal if a "structural" break occured sometime in the mid 1980s that could explain this phenomenon.[29]

## 4.3 Business Cycle Asymmetries

As noted in the introduction, the drop in inventory investment accounts for a vast majority of the decline in GNP for the average U.S. postwar recession. The analysis of retail inventory investment within the framework of capital market imperfections to this point was based solely on the *cross-sectional* dimension of the identification strategy outlined in section 2. The *time-series* dimension of the identification strategy in this paper concerns the dynamics of inventory investment during the course of a business cycle. In particular, as business

[28]See, for example, "Woodward & Lothrop seeks protections from its creditors; chairman resigns," by Patrick M. Reilly, the *Wall Street Journal*, January 18, 1994 (page A4), for the case of Woodward & Lothrop, a Washington D.C. department store chain; or "But it wasn't broken; expansion fever and bad partners hurt Parisian Inc. department stores," by Amy Feldman, *Forbes*, March 14, 1994 (pages 66-67) for the case of Parisian Inc., an up-scale department store chain based in Birmingham, Alabama.

[29]In fact, in Panel I, the overlap of the high L-ratio and high NL-ratio categories is roughly 80%, while in Panel II, the two categories overlap in 95% of all the cases.

and credit conditions deteriorate in the aggregate, financial accelerator effects on inventory investment should increase disproportionately for firms that are already facing severe agency problems in credit markets—namely, firms with "weak" balance sheet positions. The onset of a recession induces a further deterioration in their balance sheet positions, thereby raising the agency premium on external finance to even higher levels. Consequently, firms with "weak" balance sheet position should increase their reliance on internal funds in order to finance inventory investment the deeper the economy is in a recession.

In order to examine the business cycle asymmetries in the use of internal finance for inventory investment, a N.B.E.R. recession indicator variable, $R_t$, is interacted with internal finance variables in both equation 1 and equation 2. Specifically, the recession indicator $R_t$ is equal to one, if period $t$ falls in a N.B.E.R. dated recession; otherwise, $R_t$ is equal to zero.[30]

Estimates of equation (1) using both panels simultaneously are presented in Table 6. The explanatory variable $R_{t-1} \times \Pi_{it-1}$ measures the increase in the predictive power of internal finance for inventory growth during recessions relative to normal times. The results indicate that for firms with "weak" balance sheet positions, the increase in the predictive power of internal finance during recessions is substantial and statistically significant.[31] For both the high leverage ratio and high net leverage ratio firms, the increase in point estimates of the predictive power of internal finance for inventory growth during recessions is at least 66 percent and is significant at the 1% level. The corresponding coefficients for firms with "strong" balance sheet positions, on the other hand, are statistically insignificant and exhibit no substantive asymmetric pattern.

Table 7 presents the identical exercise for equation (2). Even when controlling for the potentially asymmetric forecasting power of internal finance, firms with "weak" balance sheet positions exhibit a considerable and statistically significant asymmetry in their reliance on internal funds to finance inventory accumulation over the course of a business cycle. The point estimates in the predictive power of internal finance during recessions—relative

[30] $R_t$ is equal to one in 1980:Q1-1980:Q3; 1981:Q3-1982:Q4; and 1990:Q3-1991:Q3. In all other quarters, $R_t$ is equal to zero.

[31] Note that the null hypothesis is $R_{t-1} \times \Pi_{it-1} = 0$, and the alternative hypothesis is $R_{t-1} \times \Pi_{it-1} > 0$. Consequently, one-sided tests based on t-statistics are appropriate.

to normal times—are nearly two thirds higher and are significant at the 5% level. In addition, the over-identifying restrictions imposed by equation (2) cannot be rejected across all balance sheet classifications.

For firms with "weak" balance sheet positions, the effect of internal finance on inventory growth is quantitatively meaningful. Using equation (2) as a "structural" model of retail inventory investment, the point estimates on internal finance coefficients from Table 7 imply that a one standard deviation drop in the profit rate during a recession reduces the annual inventory growth of firms with "weak" balance sheet positions by approximately 12%, everything else held constant.[32] Relative to one standard deviation in the annual growth rate of inventories for firms with "weak" balance sheet positions—which exceeds 60%—the effect of internal finance may seem negligible. This number, however, understates the effect of internal finance on inventory investment, since the standard deviation in the rate of profit is calculated across booms as well as recessions. A peak-to-trough decline in the rate of profit on last period's total assets is on the order of two to three standard deviations for a typical business cycle. Drawing structural inference from reduced-form specifications, of course, must be regarded with scepticism, nonetheless, the quantitative significance of financial factors is consistent with the hypothesis that fluctuations in internal finance contribute significantly to the observed volatility in aggregate retail inventory investment over a business cycle.

# 5 Conclusion

By utilizing a new source of firm-level data at a quarterly frequency, this paper analyzes the cross-sectional and time-series implications of capital market imperfections for retail inventory investment. Consistent with the existence of capital market imperfections, evidence presented in this paper supports the view that firms' balance sheet positions—by influencing the terms of credit—play a significant role in determining the availability of external credit in order to finance inventory accumulation. As a consequence of this link between

[32]The standard deviation of the profit rate on last period's assets on the annual level for firms with "weak" balance sheet positions (NL-ratio indicator) is 10.8%. This number times 1.10—the point estimate on the predictive power of internal finance during recession for high NL-ratio firms—is approximately 0.12.

the net worth that can be used as collateral and the terms of credit, inventory investment of firms with "weak" balance sheet positions responds significantly to fluctuations in internal finance.

The predictive power of internal finance for inventory investment of firms with "weak" balance sheet positions is highly asymmetric over the course of a business cycle, increasing substantially during recessions relative to expansionary times. The asymmetry in the predictive power of internal finance for inventory investment is consistent with the theoretical arguments which emphasize the cyclical aspects of borrowers' balance sheet positions—that fluctuations in borrowers' balance sheet positions over the business cycle amplify swings in spending. Although the data sets employed in the analysis are not comprehensive for the retail trade sector, crude calculations show that fluctuations in internal finance have a potential to be a significant cause of the observed volatility in retail inventory investment.

In this paper, a panel data modification of an error-correction model that incorporates internal finance variables and forward-looking expectations for the stochastic process of sales is not rejected by the data. This result, however, should not be interpreted as evidence against the $(S, s)$ model of inventory behavior. In particular, an interesting "structural" extension of this paper would involve embedding an $(S, s)$ model of inventory behavior in an economy with an imperfect capital market. Given the complex mathematical nature of this problem, this is a question left for future research.

Table 1:
Percent of Assets and Receipts by Firm Size (1990)

| Cumulative Asset Size | Manufacturing | | Retail | |
|---|---|---|---|---|
| | Assets | Receipts | Assets | Receipts |
| < $1M | 1.30 | 4.30 | 13.1 | 21.9 |
| < $5M | 3.70 | 10.2 | 25.4 | 40.9 |
| < $10M | 5.20 | 13.4 | 29.9 | 48.2 |
| < $25M | 7.50 | 18.2 | 34.5 | 54.6 |
| < $50M | 9.40 | 21.5 | 37.3 | 58.0 |
| < $100M | 11.6 | 25.0 | 40.1 | 61.1 |
| < $250M | 16.1 | 30.9 | 45.3 | 66.1 |

*Source*: Statistics of Income, 1990.

Table 2:
Summary Statistics

| | Panel I: 79:Q1–84:Q4 | | Panel II: 85:Q1–91:Q3 | |
|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. |
| Inv. Growth | 0.006 | 0.159 | 0.010 | 0.155 |
| Sales Growth | 0.014 | 0.196 | 0.010 | 0.200 |
| Inv./Sales | 0.480 | 0.381 | 0.586 | 0.393 |
| Inv./Assets | 0.343 | 0.176 | 0.341 | 0.181 |
| Inventories | 179.978 | 480.990 | 211.211 | 618.937 |
| Sales | 353.897 | 800.987 | 385.957 | 964.197 |
| Assets | 592.689 | 2004.637 | 761.397 | 2665.339 |
| Income/Assets | 0.040 | 0.027 | 0.033 | 0.032 |
| Total Debt/Assets | 0.405 | 0.166 | 0.459 | 0.204 |
| Curr. Liab./Curr. Assets | 0.623 | 0.263 | 0.650 | 0.306 |
| Bank Loans/S-T Debt | 0.102 | 0.196 | 0.118 | 0.208 |
| Trade Credit/S-T Debt | 0.860 | 0.232 | 0.846 | 0.236 |
| Number of Firms | 208 | 208 | 196 | 196 |
| Observations | 4992 | 4992 | 5292 | 5292 |

*Notes:* All variables are in millions of real (1987) dollars.

Table 3A:
Summary Statistics by Balance Sheet Position
Panel I: 79:Q2–84:Q4

| | "Weak" Balance Sheet[a] | | "Strong" Balance Sheet[b] | |
|---|---|---|---|---|
| | L-ratio | NL-ratio | L-ratio | NL-ratio |
| Inv. Growth | | | | |
| mean | 0.006 | 0.007 | 0.006 | 0.006 |
| std. dev. | 0.157 | 0.156 | 0.164 | 0.164 |
| Sales Growth | | | | |
| mean | 0.011 | 0.011 | 0.012 | 0.013 |
| std. dev. | 0.188 | 0.178 | 0.203 | 0.210 |
| Inv./Sales | | | | |
| mean | 0.529 | 0.517 | 0.546 | 0.554 |
| std. dev. | 0.367 | 0.371 | 0.399 | 0.385 |
| Inv./Assets | | | | |
| mean | 0.348 | 0.363 | 0.337 | 0.327 |
| std. dev. | 0.177 | 0.186 | 0.175 | 0.187 |
| Cash Flow/Assets | | | | |
| mean | 0.038 | 0.039 | 0.042 | 0.041 |
| std. dev. | 0.028 | 0.026 | 0.027 | 0.027 |
| Debt/Assets (L-ratio) | | | | |
| mean | 0.528 | 0.519 | 0.307 | 0.325 |
| std. dev. | 0.126 | 0.132 | 0.122 | 0.137 |
| "Net" Debt/Assets (NL-ratio) | | | | |
| mean | 0.337 | 0.363 | 0.104 | 0.097 |
| std. dev. | 0.188 | 0.131 | 0.211 | 0.225 |
| Curr. Liab./Curr. Assets | | | | |
| mean | 0.693 | 0.727 | 0.575 | 0.556 |
| std. dev. | 0.264 | 0.261 | 0.251 | 0.242 |
| Bank Loans/S-T Debt | | | | |
| mean | 0.145 | 0.133 | 0.069 | 0.081 |
| std. dev. | 0.233 | 0.215 | 0.159 | 0.181 |
| Trade Credit/S-T Debt | | | | |
| mean | 0.824 | 0.838 | 0.887 | 0.874 |
| std. dev. | 0.259 | 0.245 | 0.206 | 0.223 |
| Number of Firms | 92 | 86 | 116 | 122 |
| Observations | 2116 | 1978 | 2668 | 2806 |

[a]Based on 1979:Q1 balance sheet position: If a firm's L-ratio (NL-ratio) was greater than or equal to 0.40 (0.25), and a firm did not issue commercial paper, a firm was classified as having a "weak" balance sheet position.

[b]Based on 1979:Q1 balance sheet position: If a firm's L-ratio (NL-ratio) was less than 0.40 (0.25), or a firm did issue commercial paper, a firm was classified as having a "strong" balance sheet position.

Table 3B:
Summary Statistics by Balance Sheet Position
Panel II: 85:Q2–91:Q3

| | "Weak" Balance Sheet[a] | | "Strong" Balance Sheet[b] | |
|---|---|---|---|---|
| | L-ratio | NL-ratio | L-ratio | NL-ratio |
| Inv. Growth | | | | |
| mean | 0.010 | 0.009 | 0.010 | 0.012 |
| std. dev. | 0.158 | 0.150 | 0.154 | 0.163 |
| Sales Growth | | | | |
| mean | 0.007 | 0.006 | 0.008 | 0.008 |
| std. dev. | 0.191 | 0.188 | 0.212 | 0.215 |
| Inv./Sales | | | | |
| mean | 0.567 | 0.568 | 0.605 | 0.604 |
| std. dev. | 0.358 | 0.383 | 0.429 | 0.400 |
| Inv./Assets | | | | |
| mean | 0.350 | 0.363 | 0.328 | 0.314 |
| std. dev. | 0.173 | 0.191 | 0.190 | 0.164 |
| Cash Flow/Assets | | | | |
| mean | 0.028 | 0.030 | 0.040 | 0.038 |
| std. dev. | 0.029 | 0.029 | 0.037 | 0.036 |
| Debt/Assets (L-ratio) | | | | |
| mean | 0.532 | 0.535 | 0.368 | 0.374 |
| std. dev. | 0.156 | 0.160 | 0.223 | 0.217 |
| "Net" Debt/Assets (NL-ratio) | | | | |
| mean | 0.354 | 0.397 | 0.173 | 0.134 |
| std. dev. | 0.219 | 0.165 | 0.319 | 0.320 |
| Curr. Liab./Curr. Assets | | | | |
| mean | 0.682 | 0.710 | 0.611 | 0.582 |
| std. dev. | 0.287 | 0.308 | 0.328 | 0.292 |
| Bank Loans/S-T Debt | | | | |
| mean | 0.141 | 0.137 | 0.089 | 0.096 |
| std. dev. | 0.227 | 0.221 | 0.175 | 0.189 |
| Trade Credit/S-T Debt | | | | |
| mean | 0.831 | 0.846 | 0.865 | 0.846 |
| std. dev. | 0.252 | 0.233 | 0.213 | 0.240 |
| Number of Firms | 110 | 105 | 86 | 91 |
| Observations | 2860 | 2730 | 2236 | 2366 |

[a]Based on 1985:Q1 balance sheet position: If a firm's L-ratio (NL-ratio) was greater than or equal to 0.40 (0.25), and a firm did not issue commercial paper, a firm was classified as having a "weak" balance sheet position.

[b]Based on 1985:Q1 balance sheet position: If a firm's L-ratio (NL-ratio) was less than 0.40 (0.25), or a firm did issue commercial paper, a firm was classified as having a "strong" balance sheet position.

Table 4:
Equation 1
Panel I and Panel II: 79:Q2–91:Q3
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet | | "Strong" Balance Sheet | |
|---|---|---|---|---|---|
| | | L-ratio | NL-ratio | L-ratio | NL-ratio |
| $X_{it} - N_{it-1}$ | 0.233 | 0.221 | 0.215 | 0.254 | 0.241 |
| | (0.014) | (0.020) | (0.022) | (0.019) | (0.019) |
| $\Delta X_{it-1}$ | 0.017 | 0.024 | 0.014 | 0.022 | 0.026 |
| | (0.016) | (0.021) | (0.021) | (0.023) | (0.027) |
| $\Delta X_{it-2}$ | 0.010 | 0.027 | 0.015 | -0.003 | -0.001 |
| | (0.014) | (0.020) | (0.020) | (0.020) | (0.021) |
| $\Delta N_{it-1}$ | -0.104 | -0.096 | -0.098 | -0.121 | -0.112 |
| | (0.016) | (0.022) | (0.023) | (0.021) | (0.022) |
| $\Delta N_{it-2}$ | -0.022 | 0.012 | 0.008 | -0.031 | -0.043 |
| | (0.014) | (0.020) | (0.021) | (0.019) | (0.019) |
| $\Pi_{it-1}$ | 0.434 | 0.689 | 0.697 | 0.091 | 0.179 |
| | (0.097) | (0.137) | (0.136) | (0.135) | (0.139) |
| $\Delta\Pi_{it-1}$ | -0.065 | -0.150 | -0.183 | 0.042 | -0.003 |
| | (0.083) | (0.117) | (0.119) | (0.121) | (0.120) |
| Excl. Test[a] | 0.000 | 0.000 | 0.000 | 0.565 | 0.357 |
| J-Statistic[b] | 26.213 | 19.025 | 17.251 | 8.775 | 7.445 |
| P-value | 0.000 | 0.000 | 0.000 | 0.012 | 0.024 |
| d.f. | 2.000 | 2.000 | 2.000 | 2.000 | 2.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-3}$; $N_{it-1}, \ldots, N_{it-3}$; and $\Pi_{it-1}, \ldots, \Pi_{it-3}$ as instruments.

[a]P-value for the exclusion test on internal finance variables (see Newey and West [33]).

[b]Test of the over-identifying restrictions (see Hansen [22]).

Table 4A:
Equation 1
Panel I: 79:Q2–84:Q4
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet | | "Strong" Balance Sheet | |
|---|---|---|---|---|---|
| | | L-ratio | NL-ratio | L-ratio | NL-ratio |
| $X_{it} - N_{it-1}$ | 0.235 | 0.246 | 0.231 | 0.240 | 0.236 |
| | (0.020) | (0.028) | (0.028) | (0.028) | (0.026) |
| $\Delta X_{it-1}$ | -0.010 | 0.010 | -0.019 | -0.017 | 0.005 |
| | (0.025) | (0.033) | (0.033) | (0.038) | (0.035) |
| $\Delta X_{it-2}$ | 0.050 | 0.032 | 0.007 | 0.065 | 0.079 |
| | (0.024) | (0.030) | (0.033) | (0.036) | (0.033) |
| $\Delta N_{it-1}$ | -0.136 | -0.010 | -0.148 | -0.148 | -0.129 |
| | (0.021) | (0.031) | (0.031) | (0.029) | (0.028) |
| $\Delta N_{it-2}$ | -0.016 | 0.030 | 0.007 | -0.039 | -0.030 |
| | (0.019) | (0.028) | (0.029) | (0.027) | (0.025) |
| $\Pi_{it-1}$ | 0.287 | 0.442 | 0.825 | -0.016 | -0.194 |
| | (0.146) | (0.201) | (0.216) | (0.200) | (0.206) |
| $\Delta\Pi_{it-1}$ | -0.009 | -0.105 | -0.305 | 0.104 | 0.185 |
| | (0.132) | (0.181) | (0.185) | (0.195) | (0.189) |
| Excl. Test[a] | 0.119 | 0.047 | 0.007 | 0.442 | 0.534 |
| J-Statistic[b] | 10.942 | 5.210 | 6.282 | 2.546 | 3.586 |
| P-value | 0.004 | 0.074 | 0.043 | 0.280 | 0.166 |
| d.f. | 2.000 | 2.000 | 2.000 | 2.000 | 2.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-3}$; $N_{it-1}, \ldots, N_{it-3}$; and $\Pi_{it-1}, \ldots, \Pi_{it-3}$ as instruments.

[a]P-value for the exclusion test on internal finance variables (see Newey and West [33]).

[b]Test of the over-identifying restrictions (see Hansen [22]).

Table 4B:
Equation 1
Panel II: 85:Q2–91:Q3
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet | | "Strong" Balance Sheet | |
|---|---|---|---|---|---|
| | | L-ratio | NL-ratio | L-ratio | NL-ratio |
| $X_{it} - N_{it-1}$ | 0.181 | 0.182 | 0.126 | 0.191 | 0.209 |
| | (0.022) | (0.029) | (0.029) | (0.024) | (0.025) |
| $\Delta X_{it-1}$ | 0.034 | 0.037 | 0.037 | 0.024 | 0.018 |
| | (0.019) | (0.026) | (0.026) | (0.027) | (0.030) |
| $\Delta X_{it-2}$ | -0.024 | 0.005 | 0.022 | -0.064 | -0.058 |
| | (0.018) | (0.024) | (0.024) | (0.024) | (0.025) |
| $\Delta N_{it-1}$ | -0.100 | -0.110 | -0.131 | -0.085 | -0.088 |
| | (0.022) | (0.029) | (0.030) | (0.032) | (0.032) |
| $\Delta N_{it-2}$ | -0.059 | -0.058 | -0.058 | -0.059 | -0.078 |
| | (0.019) | (0.026) | (0.027) | (0.028) | (0.028) |
| $\Pi_{it-1}$ | 0.516 | 0.884 | 0.793 | 0.213 | 0.374 |
| | (0.125) | (0.180) | (0.177) | (0.162) | (0.175) |
| $\Delta\Pi_{it-1}$ | -0.140 | -0.308 | -0.167 | -0.024 | -0.073 |
| | (0.098) | (0.143) | (0.143) | (0.133) | (0.141) |
| Excl. Test[a] | 0.000 | 0.000 | 0.000 | 0.383 | 0.149 |
| J-Statistic[b] | 11.741 | 6.864 | 8.333 | 3.973 | 4.597 |
| P-value | 0.003 | 0.032 | 0.016 | 0.137 | 0.100 |
| d.f. | 2.000 | 2.000 | 2.000 | 2.000 | 2.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-3}$; $N_{it-1}, \ldots, N_{it-3}$; and $\Pi_{it-1}, \ldots, \Pi_{it-3}$ as instruments.

[a]P-value for the exclusion test on internal finance variables (see Newey and West [33]).

[b]Test of the over-identifying restrictions (see Hansen [22]).

Table 5:
Equation 2
Panel I and Panel II: 79:Q2–91:Q3
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet L-ratio | "Weak" Balance Sheet NL-ratio | "Strong" Balance Sheet L-ratio | "Strong" Balance Sheet NL-ratio |
|---|---|---|---|---|---|
| $\Delta X_{it+2}$ | 0.183 | -0.212 | -0.021 | 0.535 | 0.410 |
| | (0.227) | (0.442) | (0.294) | (0.261) | (0.230) |
| $\Delta X_{it+1}$ | 0.646 | 1.006 | 0.792 | 0.168 | 0.305 |
| | (0.234) | (0.419) | (0.262) | (0.336) | (0.304) |
| $X_{it} - N_{it-1}$ | 0.267 | 0.257 | 0.260 | 0.306 | 0.293 |
| | (0.018) | (0.029) | (0.028) | (0.026) | (0.024) |
| $\Delta X_{it-1}$ | 0.053 | 0.079 | 0.067 | 0.041 | 0.037 |
| | (0.020) | (0.031) | (0.030) | (0.031) | (0.028) |
| $\Delta X_{it-2}$ | 0.032 | 0.050 | 0.063 | -0.021 | -0.017 |
| | (0.023) | (0.031) | (0.032) | (0.041) | (0.038) |
| $\Delta N_{it-1}$ | -0.089 | -0.090 | -0.083 | -0.075 | -0.071 |
| | (0.019) | (0.030) | (0.028) | (0.027) | (0.027) |
| $\Delta N_{it-2}$ | 0.012 | 0.030 | 0.016 | 0.001 | 0.004 |
| | (0.017) | (0.035) | (0.028) | (0.024) | (0.023) |
| $\Pi_{it-1}$ | 0.461 | 0.795 | 0.738 | 0.191 | 0.164 |
| | (0.112) | (0.180) | (0.167) | (0.180) | (0.164) |
| $\Delta\Pi_{it-1}$ | -0.180 | -0.435 | -0.393 | -0.023 | -0.059 |
| | (0.116) | (0.208) | (0.192) | (0.163) | (0.141) |
| Excl. Test[a] | 0.000 | 0.000 | 0.000 | 0.649 | 0.587 |
| J-Statistic[b] | 8.946 | 6.654 | 5.429 | 4.212 | 7.474 |
| P-value | 0.030 | 0.084 | 0.143 | 0.239 | 0.058 |
| d.f. | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-4}$; $N_{it-1}, \ldots, N_{it-4}$; and $\Pi_{it-1}, \ldots, \Pi_{it-4}$ as instruments.

[a]P-value for the exclusion test on internal finance variables (see Newey and West [33]).

[b]Test of the over-identifying restrictions (see Hansen [22]).

Table 5A:
Equation 2
Panel I: 79:Q2–84:Q4
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet L-ratio | "Weak" Balance Sheet NL-ratio | "Strong" Balance Sheet L-ratio | "Strong" Balance Sheet NL-ratio |
|---|---|---|---|---|---|
| $\Delta X_{it+2}$ | 0.174 | -0.081 | -0.014 | 0.117 | 0.118 |
| | (0.234) | (0.501) | (0.410) | (0.204) | (0.222) |
| $\Delta X_{it+1}$ | 0.663 | 0.668 | 0.797 | 0.304 | 0.158 |
| | (0.446) | (0.855) | (0.805) | (0.341) | (0.292) |
| $X_{it} - N_{it-1}$ | 0.261 | 0.265 | 0.264 | 0.277 | 0.257 |
| | (0.030) | (0.042) | (0.057) | (0.030) | (0.029) |
| $\Delta X_{it-1}$ | 0.012 | 0.037 | -0.016 | -0.046 | -0.009 |
| | (0.033) | (0.049) | (0.058) | (0.045) | (0.042) |
| $\Delta X_{it-2}$ | 0.091 | 0.074 | 0.094 | 0.047 | 0.058 |
| | (0.066) | (0.096) | (0.110) | (0.055) | (0.054) |
| $\Delta N_{it-1}$ | -0.142 | -0.126 | -0.157 | -0.144 | -0.112 |
| | (0.037) | (0.077) | (0.071) | (0.036) | (0.036) |
| $\Delta N_{it-2}$ | 0.033 | 0.070 | 0.052 | -0.001 | 0.010 |
| | (0.023) | (0.035) | (0.038) | (0.030) | (0.027) |
| $\Pi_{it-1}$ | 0.345 | 0.547 | 0.752 | 0.091 | -0.127 |
| | (0.184) | (0.351) | (0.311) | (0.242) | (0.227) |
| $\Delta\Pi_{it-1}$ | -0.039 | -0.169 | -0.238 | 0.089 | 0.200 |
| | (0.153) | (0.240) | (0.303) | (0.200) | (0.216) |
| Excl. Test[a] | 0.213 | 0.170 | 0.037 | 0.491 | 0.691 |
| J-Statistic[b] | 3.238 | 2.283 | 6.329 | 2.075 | 0.641 |
| P-value | 0.356 | 0.516 | 0.097 | 0.557 | 0.887 |
| d.f. | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-4}$; $N_{it-1}, \ldots, N_{it-4}$; and $\Pi_{it-1}, \ldots, \Pi_{it-4}$ as instruments.

[a] P-value for the exclusion test on internal finance variables (see Newey and West [33]).

[b] Test of the over-identifying restrictions (see Hansen [22]).

Table 5B:
Equation 2
Panel II: 85:Q2–91:Q3
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet | | "Strong" Balance Sheet | |
|---|---|---|---|---|---|
| | | L-ratio | NL-ratio | L-ratio | NL-ratio |
| $\Delta X_{it+2}$ | 0.572 | 1.458 | 0.782 | 0.732 | 1.138 |
| | (0.706) | (1.314) | (0.742) | (0.530) | (0.999) |
| $\Delta X_{it+1}$ | 0.583 | 0.078 | 0.493 | 0.501 | 0.374 |
| | (0.362) | (0.627) | (0.305) | (0.330) | (0.723) |
| $X_{it} - N_{it-1}$ | 0.221 | 0.187 | 0.130 | 0.227 | 0.261 |
| | (0.037) | (0.074) | (0.047) | (0.035) | (0.043) |
| $\Delta X_{it-1}$ | 0.084 | 0.051 | 0.010 | 0.059 | 0.067 |
| | (0.036) | (0.078) | (0.055) | (0.051) | (0.060) |
| $\Delta X_{it-2}$ | -0.006 | -0.003 | 0.023 | -0.014 | 0.000 |
| | (0.028) | (0.054) | (0.039) | (0.042) | (0.059) |
| $\Delta N_{it-1}$ | -0.076 | -0.105 | -0.134 | -0.083 | -0.026 |
| | (0.032) | (0.066) | (0.053) | (0.044) | (0.067) |
| $\Delta N_{it-2}$ | -0.048 | 0.161 | -0.107 | 0.024 | -0.016 |
| | (0.043) | (0.125) | (0.074) | (0.038) | (0.054) |
| $\Pi_{it-1}$ | 0.555 | 0.814 | 0.878 | 0.460 | 0.331 |
| | (0.175) | (0.359) | (0.245) | (0.267) | (0.385) |
| $\Delta\Pi_{it-1}$ | -0.238 | 0.123 | -0.215 | -0.239 | 0.025 |
| | (0.279) | (0.716) | (0.384) | (0.263) | (0.544) |
| Excl. Test[a] | 0.040 | 0.004 | 0.000 | 0.701 | 0.916 |
| J-Statistic[b] | 6.097 | 0.744 | 2.099 | 6.253 | 8.328 |
| P-value | 0.107 | 0.863 | 0.552 | 0.100 | 0.040 |
| d.f. | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-4}$; $N_{it-1}, \ldots, N_{it-4}$; and $\Pi_{it-1}, \ldots, \Pi_{it-4}$ as instruments.

[a]P-value for the exclusion test on internal finance variables (see Newey and West [33]).

[b]Test of the over-identifying restrictions (see Hansen [22]).

Table 6:
Equation 1 (Continuous interaction with a N.B.E.R. recession indicator)
Panel I and Panel II: 79:Q2–91:Q3
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet | | "Strong" Balance Sheet | |
|---|---|---|---|---|---|
| | | L-ratio | NL-ratio | L-ratio | NL-ratio |
| $X_{it} - N_{it-1}$ | 0.234 | 0.219 | 0.214 | 0.259 | 0.244 |
| | (0.014) | (0.021) | (0.022) | (0.020) | (0.019) |
| $\Delta X_{it-1}$ | 0.016 | 0.024 | 0.016 | 0.020 | 0.022 |
| | (0.016) | (0.021) | (0.021) | (0.023) | (0.024) |
| $\Delta X_{it-2}$ | 0.009 | 0.027 | 0.016 | -0.010 | -0.005 |
| | (0.014) | (0.020) | (0.020) | (0.020) | (0.021) |
| $\Delta N_{it-1}$ | -0.107 | -0.102 | -0.103 | -0.122 | -0.112 |
| | (0.016) | (0.023) | (0.023) | (0.022) | (0.022) |
| $\Delta N_{it-2}$ | -0.021 | 0.013 | 0.009 | -0.030 | -0.040 |
| | (0.014) | (0.020) | (0.021) | (0.019) | (0.019) |
| $R_{t-1} \times \Pi_{it-1}$ | 0.204 | 0.511 | 0.429 | 0.043 | 0.063 |
| | (0.115) | (0.184) | (0.189) | (0.147) | (0.145) |
| $\Pi_{it-1}$ | 0.375 | 0.591 | 0.616 | 0.107 | 0.158 |
| | (0.103) | (0.145) | (0.145) | (0.144) | (0.147) |
| $R_{t-1} \times \Delta\Pi_{it-1}$ | 0.108 | -0.153 | 0.090 | 0.362 | 0.322 |
| | (0.171) | (0.233) | (0.238) | (0.242) | (0.238) |
| $\Delta\Pi_{it-1}$ | -0.080 | -0.114 | -0.194 | -0.064 | -0.048 |
| | (0.096) | (0.136) | (0.138) | (0.135) | (0.136) |
| J-Statistic[a] | 25.587 | 18.167 | 16.174 | 8.221 | 7.655 |
| P-value | 0.000 | 0.000 | 0.000 | 0.016 | 0.022 |
| d.f. | 2.000 | 2.000 | 2.000 | 2.000 | 2.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-3}$; $N_{it-1}, \ldots, N_{it-3}$; and $\Pi_{it-1}, \ldots, \Pi_{it-3}$, $R_{t-1} \times \Pi_{it-1}$, $R_{t-1} \times \Pi_{it-2}$ as instruments.

[a]Test of the over-identifying restrictions (see Hansen [22]).

Table 7:
Equation 2 (Continuous interaction with a N.B.E.R. recession indicator)
Panel I and Panel II: 79:Q2–91:Q3
Dependent Variable: $\Delta N_{it}$

| Explanatory Variables | Entire Sample | "Weak" Balance Sheet L-ratio | "Weak" Balance Sheet NL-ratio | "Strong" Balance Sheet L-ratio | "Strong" Balance Sheet NL-ratio |
|---|---|---|---|---|---|
| $\Delta X_{it+2}$ | 0.160 | -0.226 | -0.084 | 0.627 | 0.507 |
| | (0.243) | (0.461) | (0.311) | (0.280) | (0.253) |
| $\Delta X_{it+1}$ | 0.678 | 1.035 | 0.836 | 0.111 | 0.237 |
| | (0.244) | (0.432) | (0.271) | (0.372) | (0.318) |
| $X_{it} - N_{it-1}$ | 0.266 | 0.250 | 0.256 | 0.304 | 0.294 |
| | (0.018) | (0.029) | (0.029) | (0.027) | (0.025) |
| $\Delta X_{it-1}$ | 0.051 | 0.083 | 0.071 | 0.038 | 0.029 |
| | (0.020) | (0.033) | (0.032) | (0.033) | (0.030) |
| $\Delta X_{it-2}$ | 0.033 | 0.055 | 0.067 | -0.032 | -0.028 |
| | (0.023) | (0.031) | (0.033) | (0.044) | (0.039) |
| $\Delta N_{it-1}$ | -0.096 | -0.098 | -0.092 | -0.079 | -0.070 |
| | (0.019) | (0.031) | (0.029) | (0.028) | (0.029) |
| $\Delta N_{it-2}$ | 0.012 | 0.031 | 0.017 | 0.000 | 0.005 |
| | (0.017) | (0.036) | (0.029) | (0.025) | (0.023) |
| $R_{t-1} \times \Pi_{it-1}$ | 0.310 | 0.467 | 0.436 | 0.127 | 0.073 |
| | (0.146) | (0.264) | (0.248) | (0.199) | (0.196) |
| $\Pi_{it-1}$ | 0.387 | 0.696 | 0.662 | 0.183 | 0.173 |
| | (0.117) | (0.194) | (0.182) | (0.196) | (0.179) |
| $R_{t-1} \times \Delta\Pi_{it-1}$ | 0.304 | 0.463 | 0.346 | 0.027 | 0.179 |
| | (0.221) | (0.405) | (0.355) | (0.328) | (0.311) |
| $\Delta\Pi_{it-1}$ | -0.211 | -0.516 | -0.487 | -0.025 | 0.065 |
| | (0.142) | (0.270) | (0.231) | (0.182) | (0.164) |
| J-Statistic[a] | 9.383 | 7.122 | 5.908 | 2.704 | 5.896 |
| P-value | 0.025 | 0.068 | 0.116 | 0.440 | 0.117 |
| d.f. | 3.000 | 3.000 | 3.000 | 3.000 | 3.000 |

*Notes:* Standard errors in parenthesis. All variables are in natural logarithms, except internal finance which is defined as cash flow relative to last period's total assets. All equations include fixed firm and time effects (not reported) and are estimated with GMM using $X_{it-1}, \ldots, X_{it-4}$; $N_{it-1}, \ldots, N_{it-4}$; and $\Pi_{it-1}, \ldots, \Pi_{it-4}$, $R_{t-1} \times \Pi_{it-1}$, $R_{t-1} \times \Pi_{it-2}$ as instruments.

[a]Test of the over-identifying restrictions (see Hansen [22]).

# Data Appendix

- **Inventories:** The QFR data report the book value of total inventories. In retail trade, inventories consist almost entirely of finished goods inventories (see Blinder and Maccini [7]). Many retailers are thought to follow a first in, first out (FIFO) pricing practices; namely, once a finished good is placed on shelves, it is given a price tag that remains on the item regardless of what subsequently happens to the price of newly produced goods (see Okun [36], pp. 155-60). Since the firm-level QFR data do not provide any information on the inventory accounting practices, it was assumed that all inventory stocks are evaluated using the FIFO method, in which case, the replacement value of inventory stocks equals their book value. In order to eliminate the inflation bias from the inventory growth rate, inventory stocks were deflated by the implicit GNP deflator prior to constructing growth rates.

- **Sales:** To construct a real measure of sales, the reported nominal value of sales was deflated by the implicit GNP price deflator.

- **Internal Finance:** As noted above, the measure of internal finance in this paper is defined as cash flow relative to last period's total assets. Cash flow is defined as income (or loss) from operations plus depreciation, depletion, and amortization of property plant, and equipment. Both cash flow and the book value of total assets are deflated by the implicit GNP price deflator prior to constructing the internal finance ratio.

Visual inspection of firm-level plots revealed a substantial seasonal variation in all three variables. In order to eliminate the seasonal component from the data, all three variables were firm-by-firm seasonally adjusted as follows: A logarithmic (real) level of inventories, $N_{it}$, and sales, $X_{it}$ and the internal finance ratio, $\Pi_{it}$, were firm-by-firm regressed (using OLS) on four quarterly dummies. In the case of inventories and sales, the residual from the regression was exponentiated, and the original firm-specific mean of each variable was then added back to its respective residual series.

## References


[1] B. Bernanke and A. S. Blinder. The federal funds rate and the transmission of monetary policy. *American Economic Review*, 82:901–922, 1992.

[2] B. Bernanke and M. Gertler. Agency costs, net worth, and business fluctuations. *American Economic Review*, 79:14–31, 1989.

[3] B. Bernanke, M. Gertler, and S. Gilchrist. The financial accelerator and the flight to quality. mimeo, Board of Governors of the Federal Reserve System, July 1994.

[4] B. Bernanke and C. S. Lown. The credit crunch. *Brookings Papers on Economic Activity*, 2:205–239, 1991.

[5] A. S. Blinder. Retail inventory behavior and business fluctuations. *Brookings Papers on Economic Activity*, 2:443–505, 1981.

[6] A. S. Blinder and L. J. Maccini. The resurgence of inventory research: What have we learned? NBER Working Paper No. 3408, August 1990.

[7] A. S. Blinder and L. J. Maccini. Taking stock: A critical assessment of recent research on inventories. *Journal of Economic Perspectives*, 5:73–96, 1991.

[8] C. W. Calomiris, C. P. Himmelberg, and P. Wachtel. Commercial paper, corporate finance, and the business cycle: A microeconomic perspective. NBER Working Paper No. 4848, September 1994.

[9] C. W. Calomiris and R. G. Hubbard. Firm heterogeneity, internal finance, and credit rationing. *Economic Journal*, 100:90–104, 1990.

[10] C. W. Calomiris, A. Orphanides, and S. A. Sharpe. Leverage as a state variable for employment, inventory accumulation, and fixed investment. NBER Working Paper No. 4800, July 1994.

[11] A. S. Caplin. The variability of aggregate demand with (S,s) inventory policies. *Econometrica*, 53:1395–1409, 1985.

[12] R. E. Carpenter, S. M. Fazzari, and B. C. Petersen. Inventory (dis)investment, internal finance fluctuations, and the business cycle. mimeo, Emory University, August 1993.

[13] O. Eckstein and A. Sinai. The mechanism of the business cycle in the postwar era. In R. J. Gordon, editor, *The American Business Cycle: Continuity and Change*, pages 39–122. The University of Chicago Press, Chicago, 1986.

[14] S. M. Fazzari, R. G. Hubbard, and B. C. Petersen. Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, 1:141–195, 1988.

[15] M. Gertler. Financial capacity and output fluctuation in an economy with multi-period financial relationship. *Review of Economic Studies*, 29:455–472, 1992.

[16] M. Gertler and S. Gilchrist. The role of credit market imperfections in the monetary transmission mechanism: Arguments and evidence. *Scandinavian Journal of Economics*, 95:43–64, 1993.

[17] M. Gertler and S. Gilchrist. Monetary policy, business cycles and the behavior of small manufacturing firms. *Quarterly Journal of Economics*, 109:309–340, 1994.

[18] M. Gertler and R. G. Hubbard. Financial factors in business fluctuations. In *Financial Market Volatility: Causes, Consequences, and Policy Recomendations*, pages 33–71. Federal Reserve Bank of Kansas City, Kansas City, 1988.

[19] S. Gilchrist and E. Zakrajsek. Investment and the present value of profits: Evidence from firm-level panel data. mimeo, Board of Governors of the Federal Reserve System, November 1994.

[20] C. W. J. Granger and T. H. Lee. Investigation of production, sales and inventory relationships using multicointegration and non-symmetric error correction models. *Journal of Applied Econometrics*, 4:S145–S159, 1989.

[21] B. C. Greenwald and J. E. Stiglitz. Financial market imperfections and business cycles. *Quarterly Journal of Economics*, 108:77–114, 1993.

[22] L. P. Hansen. Large sample properties of Generalized Method of Moment estimators. *Econometrica*, 50:1029–1054, 1982.

[23] D. Holtz-Eakin, W. Newey, and H. S. Rosen. Estimating vector autoregression with panel data. *Econometrica*, 56:1371–1395, 1988.

[24] F. O. Irvine. The influence of capital costs on inventory investment:Time-Series evidence for a department store. *Quarterly Review of Economics and Business*, 21:25–44, 1981.

[25] F. O. Irvine. Retail inventory investment and the cost of capital. *American Economic Review*, 71:633–648, 1981.

[26] A. Kashyap, O. A. Lamont, and J. C. Stein. Credit conditions and the cyclical behavior of inventories: A case study of the 1981-82 recession. NBER Working Paper No. 4211, November 1992.

[27] A. Kashyap, J. C. Stein, and D. W. Wilcox. The monetary transmission mechanism: Evidence from the composition of external finance. *American Economic Review*, 83:78–98, 1993.

[28] N. Kiyotaki and J. H. Moore. Credit cycles. mimeo, University of Minnesota, March 1993.

[29] E. Kwon. Role of financing constraints on firms' investment: Evidence from the retail trade sector. mimeo, New York University, November 1994.

[30] M. Lovell. Manufacturers inventories, sales expectations, and the acceleration principle. *Econometrica*, 39:293–314, 1961.

[31] R. E. Lucas. Understanding business cycles. In K. Brunner and A. Meltzer, editors, *Stabilization of the Domestic and International Economy*, pages 7–29. Carnegie-Rochester Series in Public Policy, 1977.

[32] P. C. Mosser. Trade inventories and (S,s). *Quarterly Journal of Economics*, 106:1267–1286, 1991.

[33] W. K. Newey and K. D. West. Hypothesis testing with efficient method of moments estimation. *International Economic Review*, 28:777–787, 1987.

[34] S. Nickell. Biases in dynamic models with fixed effects. *Econometrica*, 49:1417–1426, 1981.

[35] J. H. Nilsen. Trade credit and the credit channel of monetary policy transmission. mimeo, Princeton University, June 1993.

[36] A. M. Okun. *Prices and Quantities: A Macroeconomic Analysis*. The Brookings Institution, Washington, D.C., 1981.

[37] S. Oliner and G. Rudebusch. Sources of the financing hierarchy for business investment. *Review of Economics and Statistics*, 74:643–654, 1992.

[38] S. Oliner and G. Rudebusch. The transmission of monetary policy to small and large firms. mimeo, Board of Governors of the Federal Reserve System, June 1992.

[39] C. D. Romer and D. H. Romer. Does monetary policy matter? A new test in the spirit of Friedman and Schwartz. *NBER Macroeconomics Annual*, 4:121–170, 1989.

[40] S. A. Sharpe. Financial market imperfections, firm leverage, and the cyclicality of employment. *American Economic Review*, 84:1060–1074, 1994.

## CENTER FOR ECONOMIC STUDIES DISCUSSION PAPERS

88-1 "Long-Run Expectations and Capacity," by Robert H. McGuckin & Peter A. Zadrozny, 4/88. Forthcoming in Proceedings, Conference on Capacity Utilization, (1988). (29 pages, $7.25)

88-2 "The Longitudinal Research Database (LRD): Status and Research Possibilities," by Robert H. McGuckin & George A. Pascoe, Jr., 7/88. Survey of Current Business, Volume 68, Number 11, pp. 30-37 (1988). (29 pages, $7.25)

88-3 "Public Use Microdata: Disclosure and Usefulness," by Robert H. McGuckin & Sang V. Nguyen, 9/88. Journal of Economic and Social Measurement, Volume 16, Number 1, pp. 19-40, (1990). (29 pages, $7.25)

88-4 "Modelling Technical Progress and Total Factor Productivity: A Plant-Level Example," by Edward C. Kokkelenberg & Sang V. Nguyen, 10/88. Journal of Productivity Analysis, Volume 1, Number 1, pp. 69-90, (1989). (37 pages, $9.25)

88-5 "Analytic Derivatives For Estimation of Linear Dynamic Models," by Peter A. Zadrozny, 11/88. Journal of Computers and Mathematics with Applications, Volume 18, pp. 539-553, (1989). (41 pages, $10.25)

89-1 "Measuring the Trade Balance in Advanced Technology Products," by Thomas A. Abbott, III, Robert H. McGuckin, Paul Herrick, and Leroy Norfolk, 1/89. Proceedings, 1989 American Statistical Association. (33 pages, $8.25)

89-2 "Using Linked Census R&D-LRD Data to Analyze the Effect of R&D Investment on Total Factor Productivity Growth," by Frank R. Lichtenberg and Donald Siegel, 1/89. Economic Inquiry under title "The Impact of R&D Investment on Productivity - New Evidence Using Linked R&D-LRD Data," Volume 29, pp. 2-13, (1990). (46 pages, $11.50)

89-3 "The Effect of Takeovers on The Employment and Wages of Central Office and Other Personnel," by Frank R. Lichtenberg and Donald Siegel, 6/89. Journal of Law and Economics, Volume 33, pp. 383-408, (1990). (36 pages, $9.00)

89-4 "Entrepreneur Factor Inputs and Small Business Longevity," by Timothy Bates, 6/89. Review of Economics and Statistics under the title "Entrepreneur Human Capital Inputs and Small Business Longevity," Volume LXII, Number IV, (1990). (40 pages, $10.00)

89-5 "The Effects of Leveraged Buyouts on Productivity and Related Aspects of Firm Behavior," by Frank R. Lichtenberg and Donald Siegel, 7/89. Presented at the Conference on Innovation in Corporate Organization, Control, and Incentives, 1990. #3022, NBER Working Paper Series. Journal of Finance and Economics, Volume 27, pp. 165-194, (1990). (53 pages, $13.25)

89-6 "Firm Entry and Post-Entry Performance in the U.S. Chemical Industries," by Timothy Dunne, Mark J. Roberts, and Larry Samuelson, 7/89. Journal of Law and Economics, (1989). (49 pages, $12.25)

89-7 "Price Dispersion in U.S. Manufacturing," by Thomas A. Abbott, III, 10/89. (16 pages, $4.00)

89-8 "Multifactor Productivity and Sources of Growth in Chinese Industry: 1980-1985," by Robert H. McGuckin, Sang V. Nguyen, Jeffrey R. Taylor, and Charles A. Waite, 10/89. Presented at the winter meetings of the American Statistical Association, 1/90. An Industrial Census of China, Xu Gang, ed., Beijing, People's Republic of China: The Secretariat of the International Seminar of Analysis on China's 1985 Industrial Census Results, pp. 113-138, (1990). (35 pages, $8.75)

89-9 "The Characteristics of Business Owners (CBO) Database," by Alfred Nucci, 10/89. (28 pages, $7.00)

90-1 "Longitudinal Economic Data at the Census Bureau: A New Database Yields Fresh Insights on Some Old Issues," by Robert H. McGuckin, 1/90. Proceedings of the Statistics Canada Symposium on Analysis of Data in Time, pp. 243-253, (1990). (33 pages, $8.25)

90-2 "An Analysis of Small Business Size and Rate of Discontinuance," by Timothy Bates and Alfred Nucci, 1/90. Journal of Small Business Management, pp. 1-7, (1990). (14 pages, $3.50)

90-3 "Export Performance and State Industrial Growth," by Rodney A. Erickson, 1/90. Economic Geography, Volume 65, Number 4, pp. 280-292, (October 1989). (31 pages, $7.75)

90-4 "Gross Job Creation, Gross Job Destruction, and Employment Reallocation," by Steven J. Davis and John Haltiwanger, 2/90. Forthcoming, Quarterly Journal of Economics. (52 pages, $13.00)

90-5 "Estimating a Multivariate Arma Model with Mixed-Frequency Data: An Application to Forecasting U.S. GNP at Monthly Intervals," by Peter A. Zadrozny, 6/90. (58 pages, $14.50)

90-6 "Wages and the Risk of Plant Closings," by Timothy Dunne and Mark J. Roberts, 7/90. American Statistical Association Proceedings of the Business and Economics Statistics Section, pp. 275-280, (1989). (31 pages, $7.75)

90-7 "The Classification of Manufacturing Industries: An Input-Based Clustering of Activity," by Thomas A. Abbott, III and Stephen H. Andrews, 8/90. Proceedings, Census Bureau Annual Research Conference, pp. 26-45, (1990). (47 pages, $11.75)

90-8 "The Extent and Nature of Establishment Level Diversification in Sixteen U.S. Manufacturing Industries," by Mary L. Streitwieser, 8/90. Journal of Law and Economics, Part 2, pp. 503-534 (1991). (39 pages, $9.75)

90-9 "Self-Employment Trends Among Mexican Americans," by Timothy Bates, 8/90. Quarterly Review of Economics and Business, (1990). (26 pages, $6.50)

90-10 "Gross Job Creation and Destruction: Microeconomic Evidence and Macroeconomic Implications," by Steven J. Davis and John Haltiwanger, 9/90. NBER Macroeconomics Annual, MIT Press: Cambridge, MA, (1990). (51 pages, $12.75)

90-11 "Returns to Scale in Small and Large U.S. Manufacturing Establishments," by Sang V. Nguyen and Arnold P. Reznek, 9/90. Small Business Economics, Number 3, pp. 197-214, (1991). (35 pages, $8.75)

90-12 "The Relationships Among Acquiring and Acquired Firms' Product Lines," by Robert H. McGuckin, Sang V. Nguyen and Stephen H. Andrews, 9/90. Journal of Law and Economics, Part 2, pp. 477-502 (October 1991). (45 pages, $11.25)

90-13 "The Determinants of U.S. Intra-Industry Trade," by F.M. Scherer and Keun Huh, 12/90. International High-Technology Competition, Cambridge, Massachusetts: Harvard University Press (1992). (19 pages, $4.75)

91-1 "Published Versus Sample Statistics from the ASM: Implications for the LRD," by Steven J. Davis, John Haltiwanger and Scott Schuh, 1/91. Proceedings of the American Statistical Association Business and Economics Section, (1990). (38 pages, $9.50)

91-2 "R&D Reactions to High-Technology Import Competition," by F.M. Scherer and Keun Huh, 3/91. Forthcoming in Review of Economics and Statistics. (37 pages, $9.25)

91-3 "Measuring Total Factor Productivity, Technical Change and the Rate of Returns to Research and Development," by Sang V. Nguyen and Edward C. Kokkelenberg, 5/91. Journal of Productivity Analysis, Number 2, pp. 269-282, (1992). (25 pages, $6.25)

91-4 "Decomposing Technical Change," by Michael Gort, Byong-Hyong Bahk, and Richard A. Wall, 5/91. Southern Economic Journal, Volume 60, Number 1, pp. 220-235. (40 pages, $10.00)

91-5 "The Structure of Production Technology, Productivity and Aggregation Effects," by Phoebus J. Dhrymes, 8/91. Proceedings, 1990 Annual Research Conference as "The Structure of Production Technology: Evidence from the LED Sample 1." (62 pages, $15.50)

91-6 "Technical Inefficiency and Productive Decline in the U.S. Interstate Natural Gas Pipeline Industry Under the Natural Gas Policy Act," by Robin C. Sickles and Mary L. Streitwieser, 10/91. Journal of Productivity Analysis, Volume 3, pp. 119-133, June 1992. (27 pages, $6.75)

91-7 "Technology Usage in U.S. Manufacturing Industries: New Evidence from the Survey of Manufacturing Technology," by Timothy Dunne, 11/91. RAND Journal of Economics. (31 pages, $7.75)

91-8 "Multiple Classification Systems for Economic Data: Can a Thousand Flowers Bloom? And Should They?" by Robert H. McGuckin, 12/91. Proceedings of the 1991 Conference on the Classification of Economic Activity, 1991. (36 pages, $9.00)

91-9 "Commercial Bank Lending Practices and the Development of Black-Owned Construction Companies," by Caren Grown and Timothy Bates, 12/91. Journal of Urban Affairs, pp. 25-41, (1992). (31 pages, $7.75)

91-10 "The Influence of Location on Productivity: Manufacturing Technology in Rural and Urban Areas," by Sheila A. Martin, Richard McHugh, and Stanley R. Johnson, 12/91. (33 pages, $8.25)

92-1 "Productivity Dynamics: U.S. Manufacturing Plants, 1972-1986," by Eric J. Bartelsman and Phoebus J. Dhrymes, 2/92. (51 pages, $12.75)

92-2 "The Dynamics of Productivity in the Telecommunications Equipment Industry," by G. Steven Olley and Ariel Pakes, 2/92. (56 pages, $14.00)

92-3 "Price Dispersion in U.S. Manufacturing: Implications for the Aggregation of Products and Firms," by Thomas A. Abbott, III, 3/92. (36 pages, $9.00)

92-4 "Estimating Capital Efficiency Schedules Within Production Functions," by Mark E. Doms, 5/92. Forthcoming in Economic Inquiry. (26 pages, $6.50)

92-5 "Costs, Demand, and Imperfect Competition as Determinants of Plant-Level Output Prices," by Timothy Dunne and Mark J. Roberts, 6/92. Empirical Studies in Industrial Organization, pp. 13-24, (1992). B.B. Audretsch and J.J. Siegfried, eds., Clover Publishers. (29 pages, $7.25)

92-6 "On the Turnover of Business Firms and Business Managers," by Thomas J. Holmes and James A. Schmitz, Jr., 7/92. (49 pages, $12.25)

92-7 "The Characteristics of Business Owners Database," by Alfred Nucci, 8/92. (82 pages, $20.50)

92-8 "Analytic Use of Economic Microdata: A Model for Researcher Access with Confidentiality Protection," by Robert H. McGuckin, 8/92. Proceedings, International Seminar on Statistical Confidentiality, 1992. (23 pages, $5.75)

92-9 "The Structure of Technology, Substitution, and Productivity in the Interstate Natural Gas Transmission Industry under the NGPA of 1978," by Robin C. Sickles and Mary L. Streitwieser, 8/92. (39 pages, $9.75)

92-10 "The Time-Series Pattern of Firm Growth in Two Industries," by Kenneth R. Troske, 9/92. (37 pages, $9.25)

92-11 "Managerial Tenure, Business Age and Small Business Dynamics," by Thomas J. Holmes and James A. Schmitz, Jr., 9/92. (47 pages, $11.75)

92-12 "The Aggregate Implications of Machine Replacement: Theory and Evidence," by Russell Cooper and John Haltiwanger, 10/92. The American Economic Review, Volume 83, Number 3, pp. 360-382, (June 1993). (41 pages, $10.25)

92-13 "Gender Segregation in Small Firms," by William J. Carrington and Kenneth R. Troske, 10/92. Revised, May 1993. Forthcoming in Journal of Human Resources. (45 pages, $11.25)

92-14 "Manufacturing Establishments Reclassified Into New Industries: The Effect of Survey Design Rules," by Robert H. McGuckin and SuZanne Peck, 11/92. Journal of Economic and Social Measurement, Volume 1, Number 2 (1993). (25 pages, $6.25)

92-15 "Wages, Employer Size-Wage Premia and Employment Structure: Their Relationship to Advanced-Technology Usage at U.S. Manufacturing Establishments," by Timothy Dunne and James A. Schmitz, Jr., 12/92. Forthcoming in Economica. (36 pages, $9.00)

92-16 "Decomposing Learning by Doing in New Plants," by Byong-Hyong Bahk and Michael Gort, 12/92. Journal of Political Economy, Volume 101, Number 4, August 1993. (33 pages, $8.25)

93-1 "Academic Science, Industrial R&D, and the Growth of Inputs," by James D. Adams and Leo Sveikauskas, 1/93. (48 pages, $12.00)

93-2 "Science, R&D, and Invention Potential Recharge: U.S. Evidence," by James D. Adams, 1/93. Forthcoming in American Economic Review Papers and Proceedings. (13 pages, $3.25)

93-3 "LBOs, Debt and R&D Intensity," by William F. Long and David J. Ravenscraft, 2/93. The Deal Decade, 1993, Margaret M. Blair, ed., Washington, D.C.: The Brookings Institution. (38 pages, $9.50)

93-4 "Learning By Doing and Competition in the Early Rayon Industry," Ronald S. Jarmin, 2/93. Forthcoming in RAND Journal of Economics. (32 pages, $8.00)

93-5 "Inter Fuel Substitution and Energy Technology Heterogeneity in U.S. Manufacturing," by Mark E. Doms, 3/93. (48 pages, $12.00)

93-6 "Environmental Regulation and Manufacturing Productivity at the Plant Level," by Wayne B. Gray and Ronald J. Shadbegian, 3/93. (29 pages, $7.25)

93-7 "Asymmetric Learning Spillovers," by Ronald S. Jarmin, 4/93. (22 pages, $5.50)

93-8 "Evidence on IO Technology Assumptions from the Longitudinal Research Database," by Joe Mattey, 5/93. (26 pages, $6.50)

93-9 "Energy Intensity, Electricity Consumption, and Advanced Manufacturing Technology Usage," by Mark E. Doms and Timothy Dunne, 7/93. (24 pages, $6.00)

93-10 "The Importance of Establishment Data in Economic Research," by Robert H. McGuckin, 8/93. Proceedings of the International Conference on Establishment Surveys, 1993, and forthcoming, Journal of Economics and Business Statistics. (20 pages, $5.00)

93-11 "Determinants of Survival and Profitability Among Asian Immigrant-Owned Small Businesses," by Timothy Bates, 8/93. Social Forces, Volume 72, Number 3, pp. 671-689. (39 pages, $9.75)

93-12 "Construction of Regional Input-Output Tables from Establishment-Level Microdata: Illinois, 1982," by Eduardo Martins, 8/93. (53 pages, $13.25)

93-13 "The Long-Run Demand for Labor: Estimates from Census Establishment Data," by Timothy Dunne and Mark J. Roberts, 9/93. (35 pages, $8.75)

93-14 "Testing the Advantages of Using Product Level Data to Create Linkages Across Industrial Coding Systems," by SuZanne Peck, 10/93. (30 pages, $7.50)

93-15 "On Productivity and Plant Ownership Change: New Evidence from the LRD," by Robert H. McGuckin and Sang V. Nguyen, 11/93. (42 pages, $10.50) Forthcoming in The Rand Journal of Economics.

93-16 "The Financial Performance of Whole Company LBOs," by William F. Long and David J. Ravenscraft, 11/93. (34 pages, $8.50)

94-1 "The Choice of Input-Output Table Embedded in Regional Econometric Input-Output Models," by Philip R. Israilevich, R. Mahidara, and Geoffrey J.D. Hewings, 1/94. (22 pages, $5.50)

94-2 "A Comparison of Job Creation and Job Destruction in Canada and the United States," by John Baldwin, Timothy Dunne, and John Haltiwanger, 5/94. (32 pages, $8.00)

94-3 "Firms Started as Franchises Have Lower Survival Rates than Independent Small Business Startups," by Timothy Bates 5/94. (27 pages, $6.75)

94-4 "Downsizing and Productivity Growth: Myth or Reality?" by Martin Neil Baily, Eric J. Bartelsman and John Haltiwanger, 5/94. (34 pages, $8.50)

94-5 "Recent Twists of the Wage Structure and Technology Diffusion" by James D. Adams, 6/94. (61 pages, $15.25)

94-6 "Regulation and Firm Size, Foreign-Based Company Market Presence, Merger Choice in the U.S. Pesticide Industry," by Michael Ollinger and Jorge Fernandez-Cornejo, 6/94. (33 pages, $8.25).

94-7 "The Span of the Effect of R&D in the Firm and Industry," by James D. Adams and Adam B. Jaffe, 6/94. (37 pages, $9.25).

94-8 "Cross Sectional Variation in Toxic Waste Releases from the U.S. Chemical Industry," by Mary L. Streitwieser, 8/94. (44 pages, $11.00).

94-9 "A Guide to R & D Data at the Center for Economic Studies U.S. Bureau of the Census," by James D. Adams and SuZanne Peck, 8/94. (64 pages, $16.00).

94-10 "Evidence on the Employer Size-Wage Premium From Worker-Establishment Matched Data," by Kenneth R. Troske, 8/94. (52 pages, $13.00).

94-11 "Capital Adjustment Patterns in Manufacturing Plants," by Mark Doms and Timothy Dunne, 8/94. (40 pages, $10.00).

94-12 "Primary Versus Secondary Production Techniques in U.S. Manufacturing," by Joe Mattey, 10/94. (24 pages, $6.00).

94-13 "Exporters, Skill Upgrading and the Wage Gap," by Andrew B. Bernard and J. Bradford Jensen, 11/94. (40 pages, $10.00).

94-14 "Pollution Abatement Costs, Regulation and Plant-Level Productivity", by Wayne B. Gray and Ronald J. Shadbegian, 12/94. (27 pages, $6.75).

95-1 "Preferential Procurement Programs do not Necessarily Help Minority-Owned Businesses", by Timothy Bates and Darrell Williams, 1/95. (36 pages, $9.00)

95-2 "Small Businesses Do Appear to Benefit from State/Local Government Economic Development Assistance", by Timothy Bates, 2/95. (35 pages, $8.75).

95-3 "Capital Structure and Product Marker Rivalry: How Do We Reconcile Theory and Evidence?", by Dan Kovenock and Gordon Phillips, 2/95. (15 pages, $3.75).

95-4 "Capital Structure and Product Market Behavior: An Examination of Plant Exit and Investment Decisions", by Dan Kovenock and Gordon M. Phillips, 3/95. (56 pages, $14.00).

95-5 "Whittling Away at Productivity Dispersion", by Douglas Dwyer, 3/95. (37 pages, $9.25).

95-6 "Technology Locks, Creative Destruction and Non-Convergence in Productivity Levels", By Douglas Dwyer, 4/95. (59 pages, $14.75).

CES Discussion Papers are available in a variety of subscription formats: (INTERNET, WordPerfect 5.1 Diskette, and Yearly Series single paper copy). Ordering information is found on the attached *CES Discussion Paper Subscription & Request Form*. In addition, papers are sold individually for the amount specified after each title.