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MONETARY POLICY, BUSINESS CYCLES, AND THE BEHAVIOR OF SMALL MANUFACTURING FIRMS*

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We analyze the response of small versus large manufacturing firms to monetary policy. The goal is to obtain evidence on the importance of financial propagation mechanisms for aggregate activity. We find that small firms account for a significantly disproportionate share of the manufacturing decline that follows tightening of monetary policy. They play a surprisingly prominent role in the slowdown of inventory demand. Large firms initially borrow to accumulate inventories. After a brief period, small firms quickly shed inventories. We attempt to sort financial from nonfinancial explanations with evidence on asymmetries and on balance sheet effects on inventory demand across size classes.

I. INTRODUCTION

This paper presents evidence on the cyclical behavior of small versus large manufacturing firms, and on the differential response of the two kinds of firms to monetary policy. Our goal is to gain some empirical sense of the importance of financial propagation mechanisms for aggregate behavior.

A number of recent papers have resurrected the view that credit market frictions may help propagate business cycles and, similarly, that they may play a role in the transmission of monetary

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policy.¹ Although the underlying theories are diverse, a common prediction is that differences in cyclical behavior should emerge across firms, depending on their respective access to capital markets. This prediction leads us to compare the behavior of small and large firms at the business cycle frequency.²

Practical considerations dictate using firm size to proxy for capital market access. Doing so enables us to employ a data set that is comprehensive for the manufacturing sector. As a consequence, we can directly assess the quantitative importance of our findings for overall manufacturing fluctuations. The trade-off is that some caveats arise in interpreting the results, as we discuss.

Section II describes the background theory. Some of the theory is tied directly to monetary policy. In general, however, financial factors may propagate any type of shock to aggregate economic activity. We focus on monetary policy, though, because a number of researchers have identified it as an important source of aggregate demand disturbances in the postwar period [Romer and Romer 1989; Bernanke and Blinder 1992]. We borrow the methods of these researchers to identify monetary disturbances. Our empirical strategy then involves tracing out the effect of these policy shifts on the time series behavior of small firms relative to large firms. This section also discusses ways to discriminate financial factors from nonfinancial factors that might also induce differences in fluctuations across firm size classes.

Section III describes the data set. It consists of quarterly time series variables for all manufacturing firms, disaggregated by size class. We present some justification for using size to proxy for capital market access, and also discuss some of the limitations. The variables we consider include sales, inventories, and short-term debt. Our interest in inventories is motivated by Kashyap, Lamont, and Stein's [1992] case study of the 1981–1982 recession. These authors present evidence that liquidity-constrained firms contributed substantially to the overall inventory decline in the last part of the 1981–1982 recession.³

Section IV presents the empirical work. Using a variety of different methods, we show that small firms account for a signifi-

1. See Bernanke [1993] for a recent survey of this literature.

2. Exploiting cross-sectional implications is a theme of panel studies of liquidity constraints, beginning with Zeldes [1990], who studied consumers, and Fazzari, Hubbard, and Peterson [1988], who studied firms. Gertler and Hubbard [1988] and Kashyap and Stein [1993] discuss the application to aggregate behavior.

3. Milne [1991] obtains similar results, based on British firm-level inventory data for several recessionary episodes.

cantly disproportionate share of the decline in manufacturing that follows a shift to tight money. They play a surprisingly prominent role in the slowdown of aggregate inventory demand. While large firms initially borrow to accumulate inventories, small firms shed inventories at a relatively quick pace. To sort financial from technological explanations, we show that the response of small firms to tight money is asymmetric over the cycle: stronger in bad times than in good times. We also estimate inventory equations and find that balance sheets significantly influence small firm inventory demand but are not significant for large firm inventory demand. Concluding remarks are in Section V.

II. BACKGROUND

This section describes how financial factors may enhance the effects of monetary policy. By “financial factors,” we mean mechanisms that stem from the presence of capital market imperfections. After presenting a general description, we discuss the implications for the dynamics of small versus large firms. Finally, we map out how we plan to distinguish financial factors from nonfinancial factors that might similarly produce differences in behavior across firm size classes.

There are two complementary ways of thinking about how financial factors might influence the impact of monetary policy. One is an outgrowth of recent “financial” theories of the business cycle that emphasize the role of borrowers’ balance sheets.⁴ These theories begin with the idea that capital market imperfections make the spending of certain classes of borrowers depend on their balance sheet positions, owing to the link that arises between collateralizable net worth and the terms of credit. This leads directly to a financial propagation mechanism: swings in balance sheets over the cycle amplify swings in spending.

Monetary policy enters the picture both directly and indirectly. A rise in interest rates directly weakens balance sheets by reducing cash flows net of interest and by lowering the value of collateral assets. This tends to magnify the overall impact of monetary policy on borrowers’ spending. The process can also work indirectly. Suppose that tight money engineers a decline in spending. The

4. Theoretical examples of financial propagation mechanisms that stress the role of borrowers’ balance sheets include Bernanke and Gertler [1989], Calomiris and Hubbard [1990], Gertler [1992], Greenwald and Stiglitz [1993], and Kiyotaki and Moore [1993].

decline in cash flows and asset values associated with this initial drop in spending also causes balance sheets to deteriorate, further propagating the downturn. This indirect channel is highly significant because it suggests that the influence of financial factors may be at work for a considerable time after the shift in policy occurs.⁵

The second theory, known as the “credit” or “lending” view, stresses the ability of monetary policy to regulate the pool of funds available to bank-dependent borrowers, owing to the presence of legal reserve requirements on bank deposits.⁶ This ability, to the degree it exists, provides monetary policy with additional leverage over the spending of bank-dependent borrowers. The credit channel is similar in spirit to the balance sheet channel described earlier. Both suggest that monetary policy should have a disproportionate impact on borrowers with limited access to capital markets, everything else equal. Further, for obvious reasons, the sets of borrowers who are balance-sheet constrained and who are bank-dependent overlap considerably.

The two theories do differ in some important details. The credit view, naturally, is tied to the institutional details of banking. In particular, it requires that banks cannot elastically issue CDs or other managed liabilities to fund loans. Otherwise, monetary policy cannot directly constrain bank lending.⁷ Banks are not central to the balance sheet theory. For that matter, neither is monetary policy. Any disturbance that influences collateralizable net worth can trigger this propagation mechanism. Monetary policy is of interest in this context mainly in the belief that it is an important source of aggregate demand disturbances. Despite the differences, both theories motivate us to study the time series reaction to monetary policy across size classes of firms.

To what extent is firm size a reasonable measure of capital market access? While size *per se* may not be a direct determinant, it is strongly correlated with the primitive factors that do matter. The informational frictions that add to the costs of external finance

5. A number of applied macroeconomic frameworks incorporate both the direct and indirect balance sheet channels of monetary policy. Eckstein and Sinai [1986], for example, include balance sheet variables such as the interest coverage ratio within the investment equations. This leads to dynamics much as described here.

6. Bernanke and Blinder [1992], Romer and Romer [1990], and Kashyap, Stein, and Wilcox [1993] provide recent discussions of the credit view. Fuerst [1991] offers a somewhat related analysis, based on the “liquidity effects” approach.

7. Recent criticism of the lending view focuses on the assumption that banks cannot easily fund loans with CDs. See Romer and Romer [1990], Gertler and Gilchrist [1993], and Kashyap and Stein [1993] for a discussion of this issue. The issue is irrelevant to the balance sheet mechanism.

apply mainly to younger firms, firms with a high degree of idiosyncratic risk, and firms that are not well collateralized.⁸ These are, on average, smaller firms. The evidence supports this notion. There is a strong correlation between size and the form of external finance. Smaller firms rely heavily on intermediary credit while large firms make far greater use of direct credit, including equity, public debt, and commercial paper (see Gertler and Hubbard [1988]). In addition, beginning with Fazzari, Hubbard, and Peterson [1988], a vast number of recent studies of investment find that smaller firms are more likely to face liquidity constraints.

Nonfinancial factors, of course, could also explain differences between small and large firms. This is particularly true for the behavior of sales. One possibility is that large firms smooth the impact of variation in demand by contracting out to small firms in booms but servicing all business internally in recessions.⁹ Another is that small firms are concentrated more heavily in cyclical industries. We are unaware of any direct evidence in support of these hypotheses, and we shall present some information that suggests that industry effects cannot account for the cyclical differences between small and large firms. Nonetheless, because we cannot provide direct controls for all the potential nonfinancial alternatives, we take several steps to address the observational equivalence problem, to the maximum degree the data permit.

First, in addition to sales we study inventories. Neither contracting out nor industry effects can easily explain differences in inventory behavior that may arise after controlling for the influence of sales. Credit market frictions, on the other hand, impede the ability of firms to smooth production when sales decline. This leads us to compare the behavior of both inventories and the inventory/sales ratio across size classes. If financial factors are at work, small firms should exhibit a greater propensity to shed inventories as sales drop.

Reduced-form evidence on inventories, of course, is not completely decisive either. Small firms might have more flexible technologies. Nonfinancial factors might therefore explain why

8. Idiosyncratic risk explains why small firms may face large agency costs of investment finance. However, it alone cannot explain the systemic volatility of small firms (i.e., the variation of small firms that is correlated with the business cycle). Idiosyncratic risk is, by definition, uncorrelated with common factors.

9. There is certainly anecdotal evidence of small firms playing a buffer stock role as suppliers for large firms. However, we could not locate any data that could help determine whether this kind of relationship between small and large firms is dominant within the manufacturing sector. Indeed, in our search we uncovered anecdotes of large firms acting as suppliers for small firms.

these firms quickly adjust inventories to movements in sales. Once again, we are unaware of any evidence to support this alternative.¹⁰ But we address this possibility in two ways. First, we look for asymmetries over the cycle. The financial mechanisms described here are likely to be more potent in downturns. Credit constraints are likely to bind across a wider cross section of small firms in recessions than in booms.¹¹ This suggests that small firms should maintain a tighter link between sales and inventories in bad times than in good times. Further, large firms should not exhibit this asymmetry. Differences in technological flexibility do not naturally predict this variety of outcomes. Second, we buttress the reduced-form analysis by estimating some simple inventory equations that allow for the influence of financial factors. Here we control for nonfinancial factors by allowing “technological” coefficients to differ across the size classes.

III. DATA DESCRIPTION

The data set we employ is constructed from the *Quarterly Financial Report for Manufacturing Corporations* (QFR). The QFR reports quarterly time series on a set of real and financial variables for the manufacturing sector. Each aggregate time series is available in disaggregated form, by firm size class. The measure of size is gross nominal assets. There are eight size classes, ranging from under 5 million dollars in gross assets, to over a billion dollars. The data are available from 1958:4 to the present.

The major advantages of the QFR are that it (i) provides cross-sectional information at the business cycle frequency and (ii) is comprehensive for manufacturing. These two features permit us to directly infer the quantitative significance of differences in small and large firm behavior for manufacturing fluctuations. Other

10. Mills and Schumann [1985] argue that because small firms are less capital intensive they may face lower costs of adjustment than large firms face, and therefore may be more volatile. They present evidence from Compustat that demonstrates a negative correlation between size and volatility, but they do not directly test their hypothesis against an alternative based on financial factors. Gertler and Hubbard [1988] find that when firms are sorted by an indicator of access to credit markets, the relation between size and volatility disappears. Instead, volatility is inversely related to financial status. This seems to suggest that in the unconditional correlation between size and volatility, size proxies for credit market access. We view this as providing some additional justification for our approach.

11. Bernanke and Gertler [1989] formalize the idea that the financial propagation mechanism is asymmetric over the cycle.

panel data sets such as Compustat typically restrict attention to publicly traded firms, and therefore underrepresent small firms. Also, Compustat data are often only available at an annual frequency.

There are two limitations to the QFR. The first is that the data are not firm-level. This precludes us from sorting firms by a direct indicator of access to financial markets. Instead, we are constrained to using size as a proxy. We shall argue shortly that our size classification scheme is a reasonable proxy for capital market access, based on information from both the QFR and other sources. We shall also address the possibility that size may capture factors in addition to capital market access, in the variety of ways outlined in the previous section.

The second drawback to the QFR is that the size classifications are in nominal terms. This introduces measurement bias, since inflation and trend real growth may induce firms to drift from low nominal asset categories to high categories. Table I illustrates the problem. It reports the cumulative percentage of all manufacturing sales accounted for by firms with total assets less than the respective QFR cutoff. Note that all categories of firms, except the largest, shrink in importance over time.

To adjust for the bias, we reaggregate the size categories into two groups, "small" and "large." The thirtieth percentile of sales is our cutoff for small firms. We construct an approximate quarterly growth rate of a variable for small firms by taking a weighted average of the growth rates of the two cumulative asset size classes that straddle the thirtieth percentile of sales at the beginning of each period. The weights are chosen so that the two size classes average 30 percent of sales at t . The growth rate for large firms is similarly constructed, using firms above the thirtieth percentile of sales. We next adjust the growth rates to correct for the bias arising

TABLE I
PERCENT OF MANUFACTURING SALES BY CUMULATIVE ASSET SIZE

Year	Asset size						
	\$5m	\$10m	\$25m	\$50m	\$100m	\$250m	\$1b
1960	0.26	0.31	0.38	0.44	0.52	0.65	0.85
1970	0.21	0.24	0.29	0.34	0.39	0.49	0.70
1980	0.13	0.16	0.21	0.24	0.28	0.34	0.47
1990	0.12	0.15	0.19	0.22	0.26	0.32	0.44

TABLE II
COMPOSITION OF DEBT FINANCE BY ASSET SIZE, 1986:4

Type of debt as percentage of total	Asset size (in millions of dollars)				
	All	< 50	50–250	250–1000	> 1000
Short-term debt	0.16	0.29	0.18	0.14	0.13
Bank loans	0.08	0.25	0.15	0.09	0.04
Comm. paper	0.05	0.00	0.00	0.03	0.07
Other	0.02	0.04	0.02	0.02	0.02
Long-term debt	0.84	0.71	0.82	0.86	0.87
Bank loans	0.22	0.43	0.40	0.31	0.14
Other	0.62	0.28	0.42	0.56	0.73
% of bank loans	0.30	0.68	0.55	0.40	0.17

if some firms shifted size classifications between t and $t + 1$.¹² This adjustment is based on using the eight data points available at t on the cross-sectional relation between sales and asset size to approximate the entire distribution. An appendix available upon request describes this procedure in detail.¹³

We next present some information suggesting that our grouping of small and large firms is reasonable from the standpoint of reflecting capital market access. Table II presents information on the composition of debt finance across size classes for 1986:4. The size cutoff for the thirtieth percentile of sales (for 1986:4) lies somewhere between 100 and 250 million dollars in gross assets, as Table I suggests. Given this benchmark, Table II suggests that small firms rely proportionately more on information-intensive financing. This is true in two main respects. First, they rely heavily on bank finance relative to the mean for manufacturing. Second, for the most part they do not issue commercial paper. The vast

12. In practice, the bias in the growth rate from t to $t + 1$ is likely to be quite small, since the percentage of firms near the borders of the cumulative size classes that straddle the thirtieth percentile of sales at any given time t is very low. More generally, "category mixing" has minimal impact on the measured growth rates. In an appendix we show that, on average, more than 98 percent of the sales in the small firm category are accounted for by firms with assets at least 10 percent below the cutoff used for small firms. Similarly, more than 98 percent of the sales in the large firm category are accounted for by firms with assets at least 10 percent greater than the cutoff for large firms. Thus, firms well within the category borders dominate the respective growth rates.

13. To provide some cross-validating evidence on our procedure, we obtained data on individual firms from Compustat, and then organized the data into the QFR nominal size class format. We then found that applying the QFR procedure to construct real growth rates from nominal size class data closely approximated the true real growth rates, as our appendix describes.

majority of their short-term financing is obtained from banks, in contrast to large firms, which rely heavily on the paper market. Overall, these differences in financial structure suggest significant differences in capital market access across size classes.

Our use of size to proxy for capital market access also squares with previous firm-level studies of liquidity constraints on investment.¹⁴ Rather than directly sorting firms by size, this literature sorts firms by a more direct indicator of access to financial markets, such as retention behavior or whether the firm has a bond rating. However, in nearly every study the “likely to be constrained” firms are much smaller on average than the control group. This phenomenon also arises in Kashyap, Lamont, and Stein’s [1992] study of inventory behavior. The firm-level studies thus provide support for our classification scheme.

A further important consideration is that all the firm-level studies to date only consider publicly traded companies. Nontraded firms dominate the lower tier of the size distribution in our sample. Thus, we believe that the vast majority of companies in our small firm sample would be considered likely to be constrained, using one of the conventional financial indicators.¹⁵ Conversely, while some financially constrained firms may enter our large firm category, the group as a whole is likely dominated by unconstrained firms.

We also have evidence to suggest that our size control is not simply capturing differences in industry cyclicity. From 1981 on the QFR has disaggregated the data by industry as well as by size. Table III reports information from 1986, a year that was representative of the industry mix in the 1980s. The numbers suggest that there are no significant differences in the concentration of small firms across durable and nondurable goods industries.

To summarize, for each QFR variable we aggregate the eight size class time series into two time series, small and large, using the thirtieth percentile of sales each period as the cutoff for small

14. Examples of firm-level studies of liquidity constraints and investment include Fazzari, Hubbard, and Peterson [1988], Gilchrist [1990], Whited [1992], Oliner and Rudebusch [1993], and Gilchrist and Himmelberg [1992].

15. In Whited’s [1992] Compustat study, firms without a bond rating had a median and mean capital stock of \$26 and \$234 million in 1982 dollars, while firms with bond ratings had a median and mean of \$441 and \$1775 million. For our small firm category, capital stocks average about one-third of gross assets. Therefore, we estimate that, for 1982, our small firms had a median capital stock in the vicinity of \$10 million and that the biggest firms in the small firm category averaged about \$50–\$70 million. Thus, firms in our small firm category are probably smaller on average than those in Whited’s “no bond rating category.” This in part reflects the fact that we include nontraded firms.

TABLE III
RATIO OF DURABLE/TOTAL MANUFACTURING SALES 1986:4

	Cumulative asset size class (in millions of dollars)				
	< 25	< 50	< 250	< 1000	All mgf.
Durables/total sales	0.52	0.52	0.52	0.50	0.51

firms. We then use an approximation of the true cross-sectional distribution between size class and sales (updated each period) to help construct growth rates of the variable for each category of firms. Information from several sources suggests that our size control is strongly correlated with access to financial markets. Whether it may also be capturing nonfinancial factors is an issue we address in the subsequent analysis.

IV. EMPIRICAL RESULTS

We study three sets of variables: sales, inventories, and short-term debt. We use sales rather than output as an indicator of firm activity over time because we cannot construct an exact output measure. The QFR inventory variable is not disaggregated between finished goods and materials. Inventories are of interest partly because they are important to business fluctuations, and partly because they provide some help in identifying the influence of financial factors, as Section II described. We note also that, on average, small firms are roughly as significant to the total of manufacturing inventories as they are to the total of sales. The trend (as opposed to cyclical) inventory/sales ratio for small firms is reasonably similar to that for large firms.¹⁶ Finally, short-term debt is highly relevant because of its role in financing inventories and other working capital needs.

The empirical work proceeds in three main stages. First, we present an informal descriptive analysis, designed to illustrate the basic properties of the data. Second, we quantify the relative responses of small and large firms to monetary policy, using a

16. Since at least 1980 the trend inventory/sales ratios are very similar across the size classes. The difference narrowed from earlier times, but was never that large. In 1960, for example, the inventory/sales ratio of small firms was about 80 percent the size of the large firm ratio.

variety of different reduced-form methods. For reasons discussed in Section II we also look for asymmetries over the cycle. Third, we supplement the reduced-form analysis with some estimates of simple inventory models that allow for financial effects.

A. Descriptive Analysis of Sales, Inventories, and Short-Term Debt

For each variable we construct time series of growth rates for small and large firms, along the lines described in the previous section. We then deseasonalize the data. Figure I plots smoothed versions of all the time series.¹⁷ The vertical lines labeled *R* denote dates of shifts to tight money, using the criteria established by Romer and Romer [1988, 1992], and the vertical line labeled *CC* denotes the 1966 credit crunch. We shall refer to all of these points as “Romer dates.”

The top panel illustrates the relative growth rates of sales. For the most part it appears that small firms decline sharply relative to large firms after episodes of tight money and during recessions. Inventory growth exhibits a similar pattern, as the middle panel suggests.¹⁸ If anything, the differences in inventory growth are more pronounced. The growth rate of inventories for large firms picks up slightly just prior to recessions, except in the last recession. Inventory growth for small firms declines steadily over recessionary periods and generally at a faster pace than for large firms.

The bottom panel portrays short-term debt, defined as debt with maturity of one year or less. Short-term debt for small firms consists mainly of bank loans, as Table II indicates. For large firms it consists mainly of commercial paper and bank loans, with the commercial paper share rising steadily since 1974. The relative patterns of short-term debt flows mirror the relative patterns of inventory behavior. Prior to each of the last five recessions, short-term debt growth for large firms rises before declining as the recession sets in. For small firms the decline in short-term debt growth begins prior to the recession and is steady throughout.

17. We smoothed the growth rate series using an Splus program that applies a nonparametric filter to the data. It robustly smooths a time series by means of running medians. The filter is designed to pick up broad trends in the data. The growth rates in the figure are portrayed as deviations from the mean.

18. The measure of inventories we use is based on book value. As we discuss in an appendix, a correction for FIFO and LIFO accounting procedures is unlikely to affect our results.

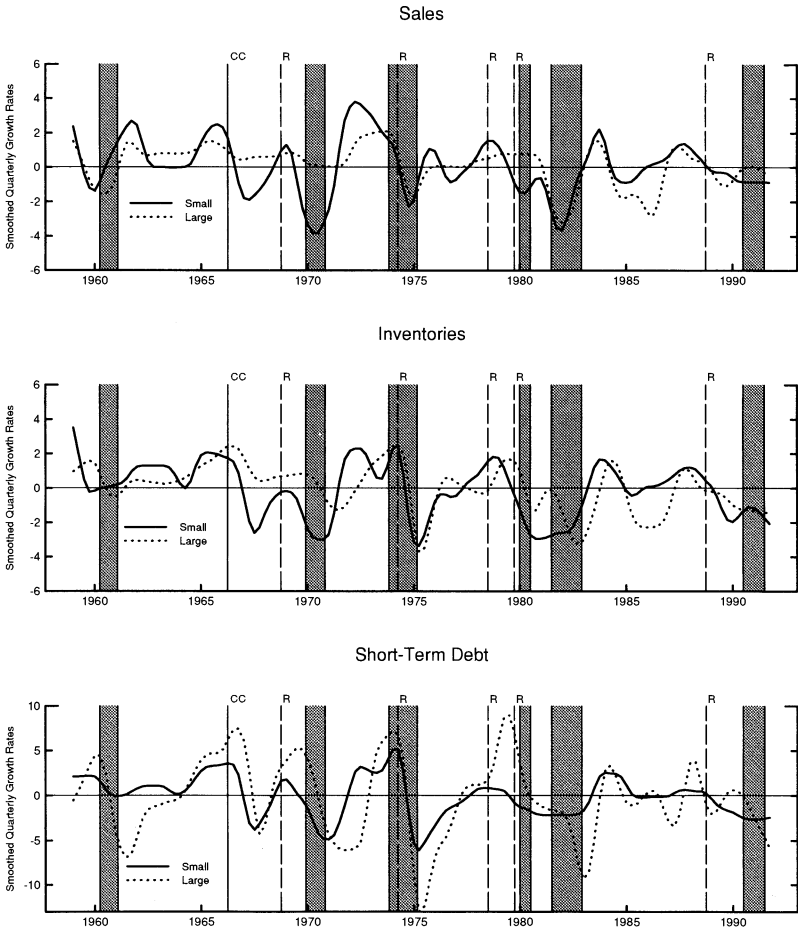


FIGURE I

R indicates a Romer date; *CC* indicates the 1966:2 Credit Crunch; the shaded regions indicate the NBER recessions.

We next present some pictures of the raw time series around episodes of tight money. The pictures reinforce the impressions given by the smoothed data. Figure II plots the log deviations of small firm and large firm sales from their respective values at Romer dates, relative to trend. The raw data indicate that, after Romer dates, small firms drop substantially more on average than do large firms. Further, there is no single episode where the reverse happens.

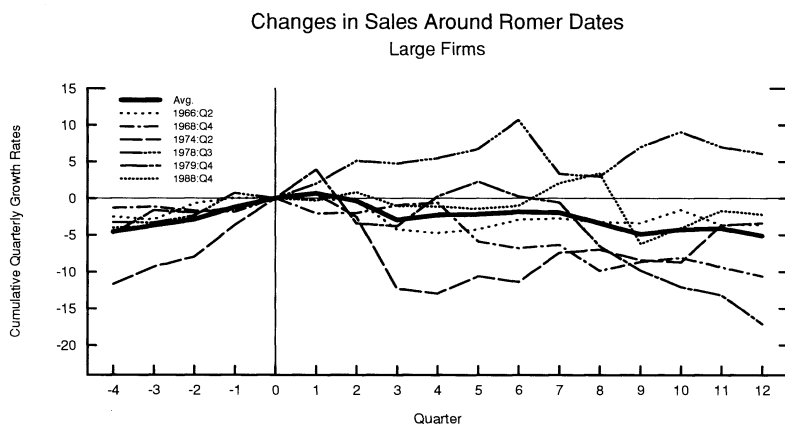
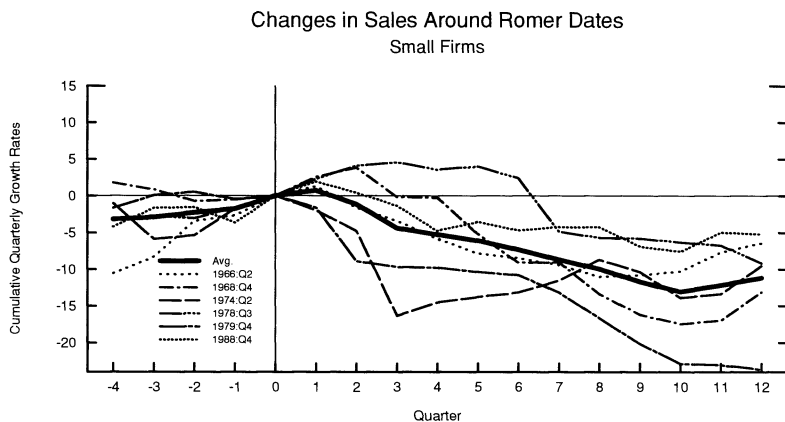


FIGURE II

All series are shown as log deviations from their values at Romer dates.

Figure III illustrates the outcome of the same exercise for inventories and short-term debt. For parsimony, however, we report only the average log deviation of each variable from the Romer date. Inventories for large firms rise after a Romer date, on average, before settling back to trend, as the top left panel indicates. For small firms, there is a short surge followed by a large, steady contraction. Further, small firm inventories appear to drag down the total, noticeably. Short-term debt exhibits a similar pattern. Large firms rise after a Romer date, and then move back to

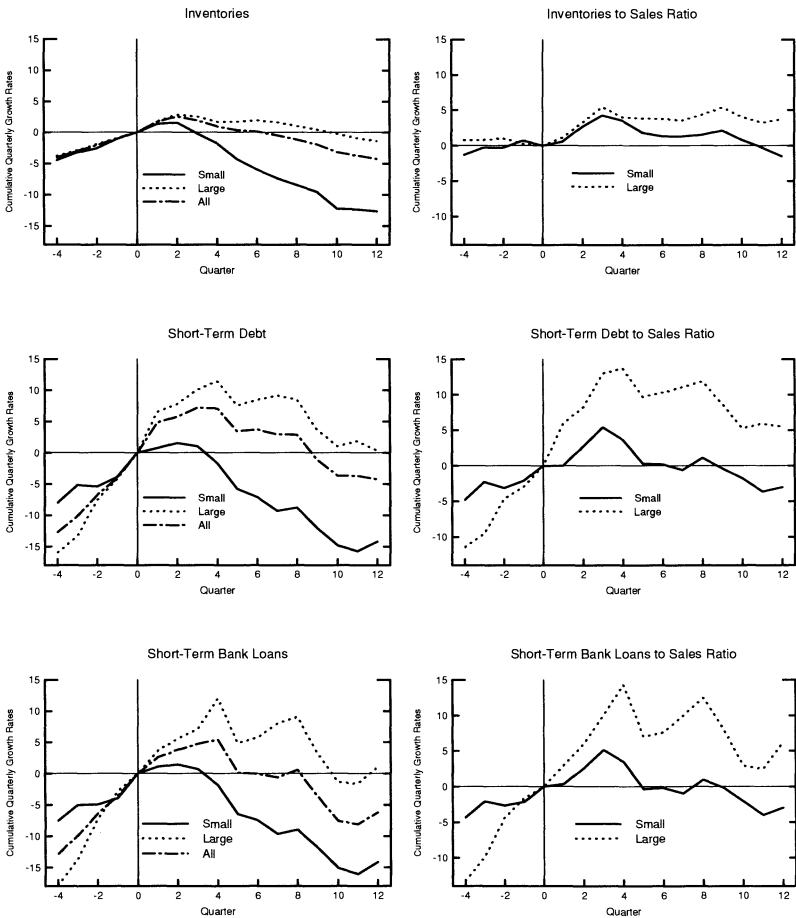


FIGURE III

The Average Deviation from Trend Around Romer Dates
 All series are shown as log deviations from their values at Romer dates.

trend. Small firms rise slightly and then contract sharply. These results, further, hold for each of the major components of short-term debt: bank loans and commercial paper. The bottom left panel in Figure III indicates that short-term bank lending across size classes closely mimics the behavior of the short-term debt aggregate. Our data also indicate that commercial paper issues, which are concentrated almost entirely among large firms, rise after

Romer dates and at about the same general pace as bank loans to large firms.¹⁹

We next examine the inventory/sales ratio. The top panel on the right indicates that this ratio rises initially for both types of firms, but that the rise is sharper and more persistent for large firms. The implication is that after tight money (and as a downturn settles in), large firms exhibit a greater propensity to borrow to carry inventories. Supporting this interpretation is the fact that the relative differences in the short-term debt/sales ratios display a pattern similar to the differences in the inventory/sales ratios. Thus, large firms appear to borrow heavily to smooth the impact of declining sales, while small firms do not.

B. The Response of Small Versus Large Firms to Monetary Policy

We now supplement the descriptive analysis with some formal evidence. We estimate the reactions of both small and large firms to the Romer episodes.²⁰ For robustness we also consider capturing shifts in monetary policy with the Federal Funds rate, as Bernanke and Blinder [1992] propose. We use the funds rate experiments, further, to look for asymmetries.

Romer dates. We begin by estimating a bivariate VAR for each size class of firms that includes sales and the dummy for tight money. The idea is to ascertain, in the simplest fashion possible, the statistical significance of the Romer episodes for the dynamics of small versus large firms. We repeat the exercise for both inventories and short-term debt. But we keep sales in the regression. This procedure helps us sort out whether the Romer dates have an influence on each variable that works independently of their influence on sales.

We also estimate a multivariate system that adds a set of macroeconomic variables to each of the three equations. For inventories and short-term debt, we keep sales on the right-hand side, along with the macroeconomic variables. The purpose of this

19. Kashyap, Stein, and Wilcox [1992] document the surge in commercial paper after Romer dates.

20. Dotsey [1992] argues that the predictive power of the Romer dates reflects the impact of oil price increases rather than exogenous shifts to tight money. See Romer and Romer [1992] for a reply. The outcome of this debate affects the interpretation that we give to the macro disturbances. However, it need not affect our basic conclusions since oil price shocks may also trigger the financial propagation mechanism that we describe, by reducing cash flows. Indeed, Dotsey cites these types of theories as one way to rationalize the asymmetric effects of oil price shocks that he finds in the data (stronger effects of oil price increases than of decreases).

second system is to examine the predictive power of the Romer dates after controlling for some standard indicators of the business cycle. The macroeconomic variables we add are real GNP growth, inflation, and the Federal Funds rate.²¹

In each regression we include four lags of the relevant quantitative variables and twelve lags of the dummy variable for tight money. Our choice of twelve lags for the dummy variable follows Romer and Romer's [1990] specification. We augment the Romer dates with the 1966 credit crunch, as suggested by Kashyap, Stein, and Wilcox [1993].²² The sample period is 1960:1 to 1991:4.

Table IV reports summary statistics. For small firms the Romer dates are highly significant predictors of all three variables. The sum of the coefficients on the dummy variable is significantly negative in each case, as we would expect.²³ These results are robust to the inclusion of macroeconomic variables. For large firms the opposite is true. The Romer dates have no marginal predictive power, and the sums-of-coefficients never differ significantly from zero. Importantly, the differences between small and large firms that the tight money indicator predicts are statistically significant. This is true for sales and inventories across both models and for short-term debt in the multivariate case.

We emphasize that the predictive significance of the tight money indicator for inventories and for short-term debt arises after conditioning on sales and on macroeconomic variables. In periods of tight money, therefore, small firms appear to shed inventories and scale back borrowing significantly beyond the level that both sales and some standard business cycle indicators would predict. This same phenomenon does not arise for large firms. These results provide a first cut at sorting financial from nonfinancial factors. They are hard to explain by some nonfinancial factors that hypothetically could account for the differential behavior of sales, such as contracting out or industry effects.

To judge the overall quantitative impact of a tight money

21. Our results are robust to using the detrended log level of GNP instead of GNP growth.

22. We also conduct a sensitivity analysis to ensure that any one Romer date is not driving the results. This analysis is reported in the working paper version [Gertler and Gilchrist 1992].

23. The sum of the coefficients provides an indication of what the forecast errors would be around periods of tight money, if we did not include the dummy variables in the regression. In this respect, it provides information about the sign of the effect of the monetary indicator on the dependent variable. Assessing the quantitative impact of the Romer dates on the dependent variable, however, requires taking into account the dynamic response of the full system of variables. We do this later in the text.

TABLE IV
THE EFFECT OF A ROMER EPISODE

System	Dep. var.	<i>p</i> val for excl. test		<i>t</i> -stat on sum of coeffs ^a		
		Small	Large	Small	Large	Diff.
Bi- & Trivariate ^b	Sales	0.00	0.12	-4.39	-2.06	-2.32
	Inventories	0.00	0.20	-5.15	-1.44	-4.17
	Short debt	0.04	0.50	-2.39	-0.38	-1.18
Multivariate ^c	Sales	0.00	0.56	-3.51	-0.72	-2.61
	Inventories	0.00	0.18	-5.15	0.83	-5.43
	Short debt	0.02	0.19	-3.70	1.36	-3.48

a. To compute standard errors on the differences in sums of coefficients for small and large firms, the small and large firm regressions for each variable are estimated jointly using a SUR system.

b. The dependent variable is in growth rates. Each regression includes four lags of the dependent variable, and twelve lags of the Romer episode. The inventory and short debt regressions also include four lags of sales growth. Sample: 1960:1 to 1991:4.

c. Each regression also includes four lags of GNP growth, the funds rate, and the inflation rate.

episode on small versus large firms, we now report a set of impulse response functions. We report the results for the multivariate system with the full set of Romer dates, though the outcomes are quite similar across both model specifications. In each case we simulate the impact of a shift to a Romer date. Figure IV illustrates the results. In addition to sales, inventories, and short-term debt, we report the behavior of the inventory/sales and short-term debt/sales ratios.

The Romer episodes have a substantially larger effect on small firms. Small firm sales drop more than 4 percent per year faster than large firms sales for a period of ten quarters after a Romer shock. The cumulative difference across size classes becomes highly significant about six quarters out, and reaches a maximum at ten quarters. We cannot directly rule out nonfinancial factors in this experiment. But it is interesting that the sales gap does not peak until two and a half years after the shift to tight money. This seems enough time for supply side factors such as investment or employment decisions to affect the course of small firm sales. Liquidity constraints are thus relevant to the extent that they influence small firms' employment and investment demand.

Even sharper differences emerge in inventory behavior. This outcome is consistent with the diagnostic tests presented in Table IV. After a slight initial surge, small firm inventories decline at a faster pace than sales decline. In contrast, large firm inventories drift up for a considerable period. The net effect is that, relative to sales, the gap in inventories across size classes widens at a faster

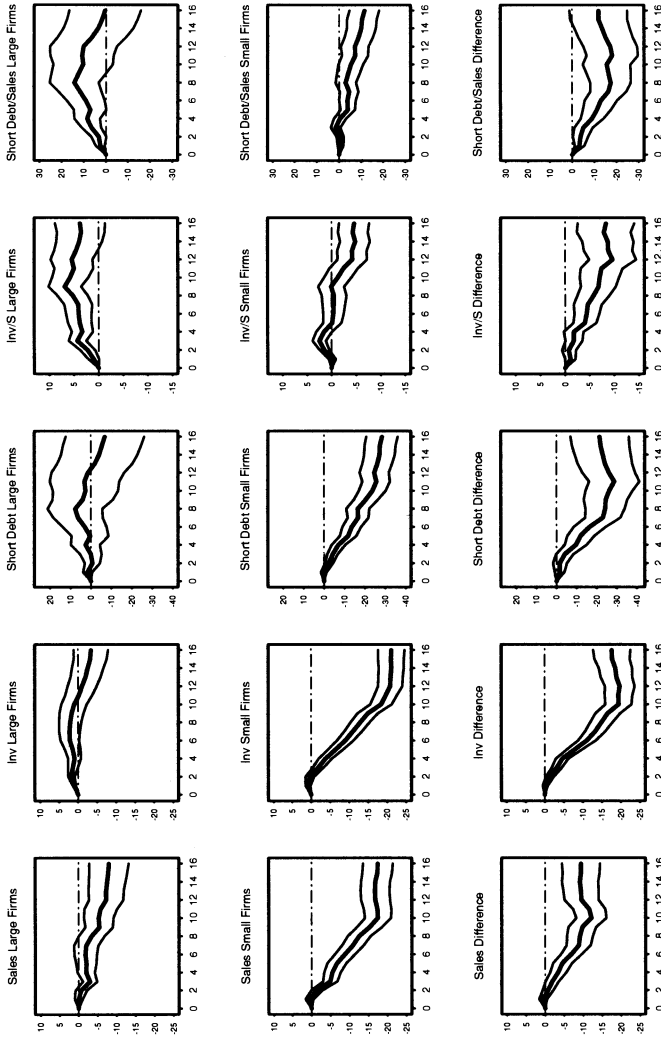


FIGURE IV

Impulse Response to a Romer Episode

Each column represents a separate VAR that includes the growth rate in GNP, Inflation, Large firm variable, Small firm variable, and twelve lags of a Romer episode. All figures report the cumulative response of the quarterly growth rate to a one-standard deviation shock to a Romer episode. One standard deviation error bands also included. Sample: 1960:1 to 1991:4.

rate. It becomes significant after only four quarters. At the peak ten quarters out, the cumulative difference between small and large firm inventory growth rates is roughly 20 percent, versus roughly 12 percent for sales. The behavior of the relative inventory/sales ratios reflects this pattern. For large firms the change in the ratio becomes significantly positive three quarters after the tight money shock. The small firm ratio never changes significantly. The point estimate actually declines steadily after a slight initial surge. The point estimate of the cumulative difference in the growth of the two ratios is large at the peak, and significantly different from zero twelve quarters out.²⁴

Short-term debt mirrors the response of inventories. Though noisy, the point estimate for large firms rises.²⁵ For small firms short-term debt drops rapidly along with inventories. The drop in short-term debt is significant after four quarters. The difference across size classes also becomes significant at about four quarters, and the difference in the debt/sales ratio between small and large firms becomes significantly different from zero at about nine quarters.²⁶ Overall, large firms appear to borrow to smooth the impact of a downturn, but small firms do not.

How important is the behavior of small firms for manufacturing as a whole? Here we provide a rough calculation of the fraction that small firms contribute to the total decline in manufacturing that follows a tight money episode. Table V reports the percentage change in sales and inventories for small firms and large firms, and the total, for four, eight, and twelve quarters after the Romer date. It then breaks down the total change between the contribution of small firms and the contribution of large firms. Even though (by our definition) small firms' share of sales each period is 30 percent

24. One year after the shock, the *t*-statistics on the difference in impulse response functions between small and large firm inventory/sales ratios are negative and greater in absolute value than -1.70 in seven of the next eight quarters, with the two lowest *t*-statistics occurring at quarter 9 (-1.92) and quarter 12 (-2.03).

25. The wide standard error bands for large firm short-term debt are in part due to "outlier" behavior after the 1974 Romer date. Short-term debt to large firms drops sharply after this date, in contrast to the other episodes (see Figure I). Note, however, that the 1974 date is the only Romer episode that does not lead the recession; rather it occurs several quarters into the recession. From this perspective, the timing of the drop in large firm short-term debt is not unusual (since it occurs after the recession is underway).

26. It is not the case that small firms are substituting to trade credit. That is, it is not the case that large manufacturing firms are offsetting the contraction of short-term loans to small manufacturing firms by supplying them with trade credit. In Gertler and Gilchrist [1993] we show that trade credit to small manufacturing firms contracts sharply after tight money, similar in behavior to short-term loans. Nor does net credit to small firms (payables minus receivables) rise.

TABLE V
CONTRIBUTION OF SMALL VERSUS LARGE FIRMS DURING ROMER EPISODE

Quarter:		Change in log-level ^a			Total contribution ^b		
		4	8	12	4	8	12
Sales	Large	-1.24	-2.44	-4.39	-0.93	-1.79	-2.97
	Small	-4.45	-11.66	-14.93	-1.10	-3.11	-4.82
	All	-2.03	-4.90	-7.79	-2.03	-4.90	-7.79
Inventories	Large	+2.40	+5.12	+3.09	+2.02	-4.15	+2.45
	Small	-2.18	-10.75	-17.55	-0.35	-2.02	-3.64
	All	+1.67	+2.13	-1.18	+1.67	+2.13	-1.19

a. The change in the log-level for small and large firms is obtained from the impulse response to a Romer episode from a VAR that includes four lags of the small and large firm variable, GNP growth, inflation, the funds rate, and twelve lags of the Romer episode. The change in log-level for all firms (total manufacturing) is obtained from a similar VAR, replacing large firms with all firms. Sample period for both VARs: 1960:1-1991:4.

b. Total contribution for small firms equals w_s^* (change in log-level at t). Total contribution for large firms is computed as $(1 - w_s)^*$ (change in log-level at t), where w_s is chosen to satisfy w_s^* (small firm change at t) + $(1 - w_s)^*$ (large firm change at t) = Change in all firms at t .

on average, they account for between 55 and 60 percent of the drop in total manufacturing sales, four, eight, and twelve quarters out. The results for inventories are more startling. Four quarters out, total inventory accumulation is about 80 percent of large firm inventory accumulation, owing to the drop in small firm inventories. Eight quarters out, the percentage drops to 50, as the small firm inventory decline exerts an even greater impact. Even though large firms begin reducing inventories after eight quarters, small firms continue to drag the total down at a faster rate, twelve quarters out.²⁷

The Federal Funds Rate and Asymmetries. We now explore how the results are affected by using the Federal Funds rate to measure the stance of monetary policy. We first reestimate the

27. An issue is whether large firms may quickly pick up the business of credit-constrained small firms. For several reasons, this is unlikely to be the case. First, in many industries, small and large firm products are not perfect substitutes (often they are complements). Second, factors of production are imperfectly mobile in the short run. (Indeed, Davis and Haltiwanger [1992] find no evidence of reallocation of workers from small to large firms during downturns.) Third, markups may rise as competition from small firms declines. Note also that about half of the relative decline in small firm inventories is due to a relative drop in the inventory/sales ratio. Thus, even if there were perfect output substitution, the impact of the small/large firm differential on aggregate inventory behavior would still be at least half the total listed in Table V. Finally, if there are either aggregate demand spillovers or factor-market linkages, then our calculations may understate the impact of small firms on the aggregate.

multivariate system (see Table IV), after dropping the Romers' dummies from each equation.

Figure V plots the cumulative responses of the small versus large firm variables to a one-standard-deviation increase in the funds rate for the period 1960:1–1991:4.²⁸ This figure suggests that the relative responses are qualitatively similar to those generated by a shift to a Romer episode of tight money. The funds rate shock has a greater cumulative impact on small firms than on large firms. The differences are reasonably significant for inventories and short-term debt,²⁹ though not for sales.³⁰

Nonetheless, the differences in small and large firm behavior produced by a funds rate shock are generally not of the same degree of significance as those produced by a Romer episode. As Section II describes, however, the financial propagation mechanism is likely to be asymmetric over the cycle—more potent in downturns than in booms. This nonlinear behavior arises because credit constraints bind across a wider cross section of small firms in bad times, when balance sheets are weak. Since the Romer dates restrict attention to periods of tight money that tend to precede downturns in real activity, they may capture this asymmetric behavior. The combination of high interest rates and declining cash flows that follow Romer dates are likely periods of general balance sheet weakness. We expect, for example, that production smoothing by small firms is more difficult around these episodes, relative to good times, when balance sheets are strong.

We pursue this idea by allowing for an asymmetric response to the funds rate over the cycle. Due to both direct and indirect effects on balance sheets (see Section II), we should expect that a

28. The variables are ordered: GNP, inflation, large firms, small firms, and the funds rate. The funds rate is placed last to capture the idea that monetary policy may adjust to current events, but its effects operate with a one quarter lag. The results on the relative behavior of small and large firms, however, are not sensitive to the ordering.

29. It is of no consequence that the point estimates for small firm inventories and short-term debt rise initially after the funds rate shock. Financial constraints do not imply that firms cannot borrow. They only imply that the terms of credit they face are worse relative to a setting of perfect markets.

30. In addition to estimating the model over the entire sample, we also consider the subperiod 1960:1–1979:4. We do this because the Federal Reserve may have significantly reduced its reliance on the funds rate as an intermediate target for a period of time after 1979:4. Therefore, it may not be legitimate to treat innovations in the funds rate over the entire sample as exogenous shifts in monetary policy, as Bernanke and Blinder [1992] suggest. The results from this exercise, (reported in the working paper version) are generally stronger in significance for the pre-1980 period. The difference in the drop in sales between large and small firms is significant four to ten quarters out, and the same is roughly true for inventories. The difference in short-term debt growth is sharpest four quarters out.

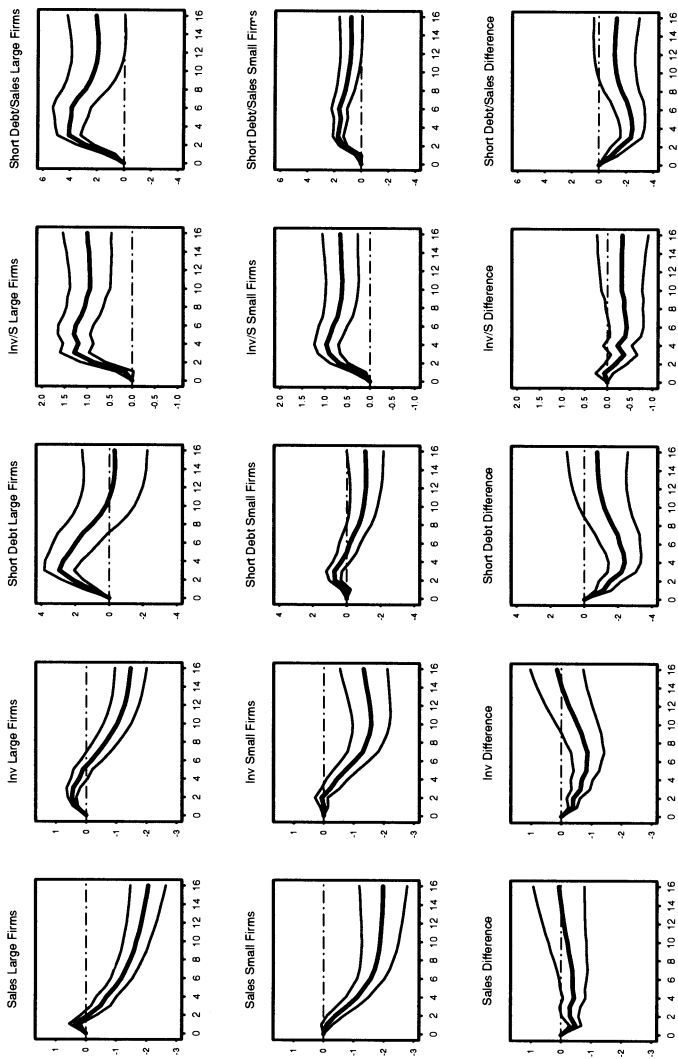


FIGURE V

Impulse Response to Funds Rate, Sample: 1960:1–1991:4

Each column represents a separate VAR that includes the growth rate in GNP, Inflation, Large firm variable, Small firm variable, and Funds Rate. All figures report the cumulative response of the quarterly growth rate to a one-standard deviation shock to Funds Rate. One standard deviation error bands also included. Sample: 1960:1–1991:4.

TABLE VI
THE ASYMMETRIC EFFECT OF THE FEDERAL FUNDS RATE

Sample	Dependent variable	<i>P</i> -value on coef. switch ^a		<i>P</i> -value on FFR exclusion test ^b		<i>t</i> -stat on FFR sums of coeffs	
		Small	Large	Small	Large	Small	Large
All	Sales	0.03	0.38	0.00	0.03	—	—
	Inventories	0.01	0.68	0.00	0.32	—	—
Low growth	Sales	—	—	0.00	0.00	-2.98	-2.74
	Inventories	—	—	0.00	0.66	-1.83	-1.16
High growth	Sales	—	—	0.81	0.67	-0.97	-1.35
	Inventories	—	—	0.05	0.08	-0.11	-0.59

a. Tests the hypothesis that the funds rate coefficients are equal across high and low growth sample periods. The low growth and high growth periods are defined by the indicator function $D_t = 1$ if $\Delta \log(GNP)_{t-1} <$ median ($\Delta \log(GNP)_{t-1}$), where the median is computed over the postwar period. All regressions include D_t , $1 - D_t$, four lags of the funds rate interacted with D_t , and $1 - D_t$, and four lags of the growth rate of sales and inventories. Sales and inventory equations are estimated jointly using GMM within each size class. All statistics based on heteroskedasticity corrected covariance matrix. Sample period: 1960:1-91:4.

b. FFR exclusion test for the All category tests the hypothesis that the FFR coefficients are jointly zero in both high and low growth periods. FFR exclusion tests and *t*-statistics for low growth and high growth categories tests restrictions on D_t (FFR_{t-3}) and $(1 - D_t)$ (FFR_{t-s}), $s = 1:4$, respectively.

movement in the funds rate has a larger impact on small firms in bad times than in good times.³¹ In bad times, for example, small firms should be more prone to shed inventories as the funds rate rises and sales decline.

To test for asymmetries, we allow the coefficients on the funds rate and the constant term to vary depending on whether or not GNP growth in the prior period was above or below its median value. For parsimony, we consider a trivariate system that includes sales, inventories, and the funds rate. (Thus, in the inventory equation we control for sales and vice-versa in the sales equation.) To test for asymmetries, we allow the coefficients on the funds rate and the constant term to vary according to whether GNP growth in the prior period was above or below its postwar median value. As usual, we include four lags of each independent variable. Table VI presents summary statistics. We find evidence that the coefficients switch across high and low growth states for small firms, but not for large firms. We decisively reject the hypothesis of no change in any of the funds rate coefficients for both small firm sales and

31. While the theory predicts a nonlinear response to the funds rate across good and bad states, it does not in general predict an asymmetric response to increases and decreases in the funds rate. If the financial constraints are not binding on a firm, as might be the case in good times, then there is no reason that increases and decreases in the funds rate should not have symmetric effects.

inventories. But we do not come close to rejection for large firms, either for sales or for inventories.

What do the asymmetries imply for small firm dynamics? Figure VI plots, for each size class, the dynamic response of sales and inventories to a unit rise in the funds rate in low growth versus high growth states.³² Interestingly, in booms the response of small and large firms looks quite similar. The point estimates indicate that sales decline slightly. Inventories and the inventory/sales ratio rise in the first three quarters. As we shift to a low growth state, however, the small firm response changes. Small firm sales and inventories exhibit sharper declines. This switch in behavior is statistically significant, as the second row of Figure VI indicates. The change in inventory dynamics is particularly striking. While, in high growth states, small firms accumulate inventories as sales decline after tight money; in low growth states, they shed inventories. Indeed, in the third quarter after the shock, the small firm inventory/sales ratio is significantly lower in the bad state than in the good state. For large firms there is no evidence of significant asymmetries in the response of sales and inventories. The large firm inventory/sales ratio still rises in the bad state, though the rise occurs one quarter sooner, relative to the good state.

The evidence of asymmetric behavior of small firms helps reconcile why the Romer date experiments produce sharper differences across size classes than do the (linear) funds rate experiments. It also provides further reason to believe that financial factors may be at work. Technological factors do not naturally explain why small firm (and only small firm) inventory/sales dynamics vary across the cycle.³³

32. The dynamic response is the cumulative response of the dependent variable to a 1 percent increase in the funds rate that is implied by the coefficients obtained in the low versus high GNP growth states. The dynamic response for each dependent variable takes into account the joint behavior of sales and inventories. Because we do not take account of the probability of switching between low and high GNP growth states, the dynamic response is not a true impulse response function, however. The dynamic response to the inventory/sales ratio is computed by taking the log difference between the inventory and sales response. Since the dynamic response is computed as a nonlinear function of the regression coefficients, we compute asymptotic one standard deviation error bands using a Taylor series approximation to the nonlinear function to obtain its distribution (i.e., the so-called delta method). We use a White corrected covariance matrix to allow for heteroskedasticity induced by the switching.

33. There is also considerable evidence from firm level data that liquidity constraints on small firms are stronger in recessions than in booms. Gertler and Hubbard [1988] find this asymmetry for investment, and Kashyap, Lamont, and Stein [1992] find it for inventories. Also, Oliner and Rudebusch [1992] present related results using the QFR data set. They show that cash flow affects the investment decisions of small firms more after tight money than in normal periods, while cash flow does not matter for large firm investment decisions.

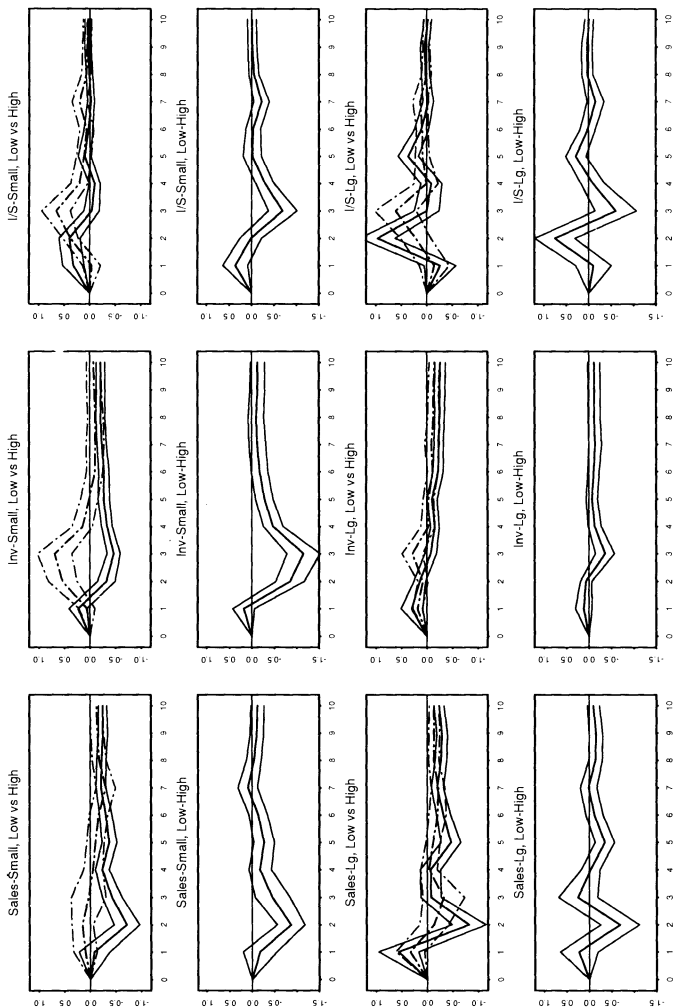


FIGURE VI
Asymmetric Interest Rate Effect

Each figure reports the cumulative response of the quarterly growth rate to a 1 percent rise in the Funds rate. Solid Line = Low Growth. Dashed Line = High Growth. One standard error bands also included.

C. Structural Estimates

We next pursue the identification problem by estimating inventory equations for small and large firms that allow for the influence of financial factors. To isolate the relative influence of financial factors, we permit technological coefficients to vary across the two size classes of firms.

The theory described in Section II suggests that for firms with imperfect access to credit markets, balance sheets should constrain inventory demand. We therefore augment an inventory demand relation with a variable meant to capture balance sheet conditions. The variable we consider is the "coverage ratio," typically defined as the ratio of cash flow to total interest payments. We refrain from using indicators that measure assets directly because we have information only on book values. However, the coverage ratio is highly correlated with the other prominent balance sheet indicators. It is thus reasonable to view variation in the coverage ratio as proxying for movements in firms' overall financial positions.

Because the QFR does not provide a direct measure of interest payments, we proxy interest expenses as the product of a short-term interest rate and the current stock of short-term debt. Thus, the coverage ratio we construct is cash flow divided by the product of the short-term rate and short-term debt. Since interest expenses on short-term debt account for the lion's share of the quarterly fluctuations in firm interest expenses, this proxy seems reasonable for our purposes.

The baseline inventory specification we use is a variant of a simple target adjustment model (e.g., Lovell [1961]). Several related considerations lead us in this direction. First, the QFR data simply provide an aggregate for inventories. Disaggregated numbers for finished goods, work-in-progress, and raw materials are unavailable. Second, as Blinder and Maccini [1991] argue, much of the cyclical fluctuation in manufacturing inventories is due to work-in-progress and raw materials as opposed to finished goods. These two factors suggest that the widely used production-level-smoothing model is inappropriate for our purposes, since this framework is meant to analyze finished goods inventories. The stock adjustment model, though crude, seems a better way to characterize the behavior of work-in-progress and raw material inventories.

Let I , S , and CR denote detrended values of the logarithms of inventories, sales and the coverage ratio, respectively. Let i denote the detrended value of the log of the short-term interest rate, and

let ϵ_t denote a cost shock.³⁴ Equation (1) gives the equation for inventory growth that we estimate:

$$(1) \quad \Delta I_t = \alpha_1(E_{t-1}S_t - I_{t-1}) + \alpha_2 i_{t-1} + \alpha_3 CR_{t-1} \\ + \sum_{s=1}^2 \alpha_{4,s} \Delta I_{t-s} + \sum_{s=1}^2 \alpha_{5,s} \Delta S_{t-s} + \sum_{s=1}^2 \alpha_{6,s} \Delta i_{t-s} + \sum_{s=1}^2 \alpha_{7,s} \Delta CR_{t-s} + \epsilon_t.$$

The dependent variable is the growth rate of inventories. The first three terms reflect the influence of the long-run target inventory level. Our specification allows this long-run target to depend on expected sales, the short-term interest rate, and the coverage ratio. We additionally impose the restriction that the long-run inventory/sales ratio is constant, conditional on the coverage ratio and the interest rate. Though we do not report the results here, we found that we could not reject this restriction. In addition to the level terms, we include lagged differences of each of the variables in the regression to capture any additional short-run dynamics. This gives the specification a general error correction format. While we impose structure on the long-run behavior of inventories and allow the long-run target to influence short-run growth, we remain somewhat agnostic about the precise nature of the short-run dynamics.

We estimate equation (1) separately for small and large firms. Under the maintained hypothesis that firm size is a reasonable proxy for capital market access, we should expect that the coverage ratio ought to be significant only for small firm inventory demand.

A possible objection to this identification strategy is that a financial variable could have predictive power for inventories because it contains information about expected sales, and not because firms are liquidity constrained. This is a possibility with the coverage ratio since the components of this indicator, particularly profits and the short-term interest rate, may have predictive power for current sales. We address this issue by permitting the coverage ratio to enter the information set in the forecasting equation for sales.³⁵

Table VII presents estimates of three inventory specifications

34. To obtain approximate values for levels of variables, we cumulated growth rates.

35. Rather than use a two-step procedure, however, we replace expected sales with actual sales, and then estimate the equation using a set of instruments for sales that includes the lagged coverage ratio. This is equivalent to a two step-procedure that first regresses sales on the instrument list and then uses the fitted value to proxy expected sales in the inventory equation.

TABLE VII
STRUCTURAL INVENTORY EQUATIONS

	Small firm equation ^a			Large firm equation		
$S_t - I_{t-1}$	0.22 (0.06)	0.19 (0.05)	0.18 (0.06)	0.07 (0.04)	0.02 (0.00)	0.04 (0.02)
ΔI	0.36 (0.11)	0.27 (0.10)	0.24 (0.10)	0.27 (0.14)	0.23 (0.13)	0.43 (0.09)
ΔS	0.19 (0.13)	0.04 (0.12)	0.06 (0.13)	0.28 (0.09)	0.33 (0.07)	0.22 (0.07)
Prime $_{t-1}$	0.50 (1.20)	—	-1.50 (0.50)	-1.90 (1.30)	—	-0.80 (0.40)
Δ Prime	-1.18 (0.90)	—	4.70 (2.50)	1.36 (0.50)	—	4.10 (1.90)
Cov. ratio $_{t-1}$	1.80 (1.00)	1.40 (0.40)	—	-0.70 (0.90)	0.40 (0.20)	—
Δ Cov. ratio	2.22 (2.90)	0.30 (1.30)	—	-3.00 (2.00)	-3.50 (1.30)	—
P -val ^b	—	0.36	0.02	—	0.13	0.12

a. Sample period: 1960:1–1991:4. ΔX provides sum of coefficients for two lagged growth rates of X . All equations estimated using GMM with $S_{t-1} - I_{t-1}$, Prime $_{t-1}$, Cov. ratio $_{t-1}$ and two lags of ΔI , ΔS , Δ Prime, and Δ Cov. ratio, as instruments. All variables are in logs, except prime and coverage ratio, which are in units of 100log.

b. P -values on exclusion tests for omitted coverage ratio and prime rate terms.

for both small and large firms. The first column for each size class presents estimates of the general model described by equation (1). We use two lags of each of the differenced variables. The second column drops the interest rate, but lets the coverage remain. The third column reverses the experiment: dropping the coverage ratio but keeping the interest rate. The short-term interest rate we use is the prime lending rate.³⁶

The results from Table VII indicate that the coverage ratio is a highly significant predictor for small firm inventory behavior but not for large firms. For small firms the data favor the model of the third column, where the coverage ratio enters but the interest rate does not. The coefficients on the coverage ratio are tightly estimated and have the right sign (positive). Further, we cannot reject the hypothesis that the interest rate should be omitted from this equation (the P -value is 0.36). Conversely, if we let the interest rate enter the equation alone, we reject the hypothesis that the coverage should not be included at the 2 percent level.

36. The results are invariant to the choice of different short-term rates. Further, because we use a detrended nominal rate, the results do not change when we add inflation to control explicitly for real rate movements.

TABLE VIII
SMALL FIRM EQUATION ACROSS HIGH AND LOW GROWTH PERIODS

Sample:	All ($n = 130$)	High ($n = 97$) ^a	Low ($n = 33$)	Low-High ^b
$S_t - I_{t-1}$	0.22 (0.05)	0.19 (0.06)	0.27 (0.07)	0.08 (0.09)
ΔI_{t-1}	0.18 (0.07)	0.17 (0.09)	0.20 (0.09)	0.03 (0.13)
Cov. ratio _{$t-1$}	1.59 (0.38)	1.21 (0.43)	2.36 (0.64)	1.14 (0.77)
\bar{R}^2	0.51	0.36	0.67	—

a. High and low growth refer to periods when lagged GNP growth is above or below its twenty-fifth percentile. All equations are estimated using GMM with $S_{t-1} - I_{t-1}$, ΔI_{t-1} , Cov. ratio _{$t-1$} as instruments. High and low growth regimes estimated separately, allowing covariance matrices to vary across regimes.

b. Difference in coefficients between high and low growth states.

For large firms the coverage ratio is insignificant and enters with the wrong sign in the general model. Further, we cannot reject the general model in the decisive way we did for small firms. Nonetheless, when we eliminate the interest rate, the level of the coverage ratio enters significantly with the correct sign. But the point estimate is less than a third the size it is for small firms. Further, the difference in the coverage ratio is significantly negative, implying that the total short-run impact has the wrong sign. There is some weak evidence that the level of the interest rate has a negative effect on large firm inventory demand, particularly when we eliminate the coverage ratio. But the growth rate in the interest rate has positive effect, suggesting some kind of misspecification.

We next consider how the structural estimates line up with the evidence of asymmetries in the previous section. For reasons outlined earlier we should expect the coverage effect to be stronger in bad times than in good times. To explore this possibility, we first estimate a restricted version of the model that eliminates the insignificant terms. We then allow the coefficients to switch across high and low growth states. Some suggestive results for small firms emerge when we split GNP growth above and below the twenty-fifth percentile.³⁷ As Table VIII shows, the coefficient on the coverage ratio doubles as the economy moves from the high to low growth state, but the evidence for asymmetry is not overwhelming. We reject the hypothesis that the coefficients are similar across the two states only at the 20 percent level for all coefficients, and at the

37. We also tried splitting the sample using the median GNP growth rate as a cutoff. We obtain similar, but weaker results, with the coefficient on the coverage ratio varying from 1.1 in the high growth state to 1.6 in the low growth state.

13 percent level for the coverage ratio. One possibility is that nonlinear movements in the coverage ratio over the cycle may be accounting for some of the asymmetry we find in the reduced-form estimates of the previous section. We in fact obtained some indirect evidence in support of this hypothesis by testing for asymmetries while excluding the coverage ratio. For this case, we rejected constant coefficients across high and low growth states at the 0.02 level. Thus, the coverage ratio appears to capture much of the asymmetry.

The coverage ratio effect on small firms is quantitatively meaningful. The point estimate from the restricted linear model in Table VIII implies that a one-standard-deviation drop in the coverage ratio reduces the annual growth rate of small firm inventories by 2.25 percentage points, everything else constant.³⁸ To place this number in perspective, a one-standard-deviation annual growth rate of inventories for small firms is 8 percent and for large firms is 6 percent. Further, the peak-to-trough drop in the coverage ratio over a normal business cycle is on the order of three to four standard deviations. Obviously, fleshing out the full impact of the coverage ratio effect requires a complete system of structural relationships. This is on the agenda for future research.

V. CONCLUDING REMARKS

We find that small firms contract substantially relative to large firms after tight money and that they account for a significantly disproportionate amount of the ensuing decline in manufacturing. We took several measures to show that financial factors may be at work. Nonetheless, we believe that it is best to view our results in the context of the many firm-level studies that have presented evidence of liquidity constraints on small firms. Particularly pertinent are those that have focused on inventory demand [Kashyap, Lamont, and Stein 1992; Milne 1991]. Our analysis complements this work by providing a rough feel for the potential quantitative significance for business fluctuations.

Several recent papers have confirmed our results that, after tight money and at the onset of recessions, credit flows to small firms contract relative to credit flows to large firms (even after controlling for possible differences in demand). This evidence comes not only from the QFR [Oliner and Rudebusch 1992], but

38. The standard deviation of the log of the coverage ratio on an annual basis is 1.4 percent. This number times the coefficient 1.6 is approximately 2.24.

also from other data sets [Morgan 1992; Lang and Nakumura 1992]. The results, further, tie into a much earlier literature that argued that smaller borrowers bear the brunt of tight money (e.g., Galbraith [1957]).

Also, Sharpe [1993] has recently confirmed our results on the differences across the size classes in the cyclical behavior of sales and inventories. His evidence comes from a long panel of Compu-stat data. He shows, further, that the results extend to similar relative differences in employment demand.

Whether it is mainly financial or technological factors (or both) that are at work, further study of the role of small firms in business fluctuations clearly seems warranted. While firms with less than 500 employees account for about a third of manufacturing employment, they account for roughly half of total employment. In this regard, it would be very useful to gather evidence from other cyclically sensitive sectors such as retail and wholesale trade and construction. By the metric used in our paper, small firms account for about 75 percent of sales in trade and 90 percent of sales in construction (see Gertler and Hubbard [1988]). And, of course, these firms carry inventories, purchase durable inputs, and hire workers. By looking outside manufacturing, therefore, we may be better able to gauge the importance of small firms for aggregate activity.

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