

IMF Working Paper

Trade Credit and the Effect of Macro-Financial Shocks: Evidence from U.S. Panel Data

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Authorized for distribution by Sunil Sharma

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Abstract

The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate.

Many studies examine why firms are financed by their suppliers, but few empirical studies look at the macroeconomic implications of such financial arrangements. Using disaggregated panel data, we examine how firms extend and use trade credit. We find that, controlling for the transactions or asset management motive, both accounts payable and receivable increase with tighter policy, implying that trade credit helps firms absorb the effect of a credit contraction. A comparison of S&P 500 firms with smaller firms, however, provides no evidence that when policy is tightened, large firms play the role of credit suppliers more actively than small firms.

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I. INTRODUCTION

The importance of trade credit has been recognized both at the microeconomic and the macroeconomic level. For instance, Ng, Smith, and Smith (1999) report: “During the 1990s vendor financing ... represented approximately 2.5 times the combined value of all new public debt and primary equity issues during a year. As a component of the money supply, trade credit, in the form of accounts payable, exceeds the primary money supply (M1) by a factor of 1.5 on average.” Nilsen (2002) reports that the share of accounts payable in total liability is about 13 percent for U.S. manufacturing firms. Such widespread use of trade credit poses questions about the reasons for using trade credit and the implication of trade credit for monetary policy.

Many theories have been advanced to explain why non-financial firms use trade credit when there are banks and other financial institutions. The financial assistance view of trade credit considers trade credit as a means of extending finance from financially stronger firms to their needy trade partners. This view focuses on explaining why trading partners can better play the financing role than third-party financial institutions. Other views of trade credit emphasize other purposes that can be served through trade credit, such as transaction cost saving, quality guarantee, and price discrimination. These views are not mutually exclusive, and each of them has some empirical support.

How does trade credit respond to monetary policy? Meltzer (1960) proposed the redistribution hypothesis that during tight money, large suppliers pass funds via trade credit (their accounts receivable) to less liquid customers (buyers). Empirical studies, however, have found mixed results regarding whether or not trade credit increases during monetary contractions (see Ramey 1992; Gertler and Gilchrist 1993; Nilsen 2002). Using semiaggregated data, Nilsen (2002) has found that during monetary contractions, both small and large firms use more accounts payable, controlling for the transactions motive by using the accounts payable-sales ratio. Small firms do not voluntarily cut back bank loans but increase accounts payable, as a substitute for bank loans. However, he thought puzzling that large firms also increase accounts payable, to a greater extent than small firms. To see how an individual firm’s position with trade credit responds to monetary policy, we need to look at both sides of the firm’s trade credit, accounts receivable and accounts payable.² They move differently, thereby altering the net position of trade credit, depending on firm characteristics such as market power and customer relationship. No existing studies nonetheless have examined the effects of monetary policy on trade credit at the firm level.

This paper examines the behavior of accounts receivable (trade credit extension) and accounts payable (trade credit use) at the firm level. It achieves two goals. First, it improves our understanding of the financing role of trade credit. If financial assistance is the primary reason for trade credit, there will be more trade credit offers from large firms to smaller firms when the financial market tightens, resulting in a decrease (increase) in “*net trade credit use*”—that is,

² Nadiri (1969) suggests that “the responses of accounts receivable and payable to their determinants are sufficiently different to warrant separate estimation of each of them.”

accounts payable minus accounts receivable—for large (small) firms. However, if trade credit promotes efficiency between trading partners, most firms will respond somewhat similarly to the financial market tightening. We also consider the possibility that, when the financial market tightens, even large firms may shrink from extending financial help to smaller firms, just as banks shrink from giving loans to smaller firms.

Second, it sheds light on the transmission of monetary policy via trade credit. The credit view suggests that a monetary tightening increases the external finance premium and exerts an adverse effect on firm activity, which is more severe for smaller firms owing to information asymmetry. This adverse effect plays an important role in the transmission of monetary policy. If trade credit can mitigate the information problems, however, it will dampen the policy effect through *interfirm* liquidity. Conversely, if trade credit also contracts in response to monetary shocks, it may not reduce or may even amplify the credit channel effect.

Using disaggregated data of *quarterly panels* for 1975–97 for two distinct groups of U.S. firms, S&P 500 firms and non-S&P 500 firms, we estimate panel regressions based on a reduced-form approach. Our regression models, which control for the motive of transaction or asset management, include macro-financial shock variables as well as the time-varying-firm characteristics motivated by micro-based studies on trade credit (see, for example, Long, Malitz, and Ravid, 1993; Petersen and Rajan, 1997). We find that both accounts payable and receivable are promoted with tighter policy for both S&P and non-S&P firms. This implies that trade credit helps firms absorb the impact of policy shocks, partly consistent with the financial assistance view of trade credit.³ Further, we find that tighter monetary policy increases accounts receivable more than accounts payable relative to assets, and the decrease is, if anything, more pronounced for smaller than for large firms. These results suggest that in the face of tighter policy, trade credit promotes interfirm liquidity flows, but with a possible redistributive effect.

The remainder of the paper is organized as follows. Section II provides a survey of the existing theories of trade credit and derives empirical implications. Section III describes the empirical specification and methodology that we use in the paper. Section IV presents data description and empirical findings. Section V concludes the paper.

II. THEORIES AND IMPLICATIONS

A. Financial Assistance View of Trade Credit

The *financial assistance* view, formalized by Schwartz (1974), posits that the basic motive for trade credit is the extension of finance from the financially stronger to the weaker. This view requires an explanation of why a trading partner can better perform the financing role than financial institutions, namely banks. Some argue that, compared to banks, trading partners are better informed about each other (Emery 1984; Smith 1987; Brennan, Maksimovic, and Zechner

³ We find that, in the face of tighter policy, both financially strong and weak firms extend finance to trade partners, increasing the intensity of trade credit flow, while the pure financing view suggests that only financially strong firms extend finance to trade partners.

1988). In the course of transactions that sometimes last a long period of time, trading partners learn about each other's business and financial strength. Therefore, they can make better judgment on whether the other firm is capable of servicing the debt. The seller can also use early payment discount on their trade credit offer, which may serve as an indirect screening device to inform the seller of the buyer's financial health.

Another explanation is that the seller is better able to liquidate the goods that are supplied, when the buyer defaults on the trade credit (Mian and Smith 1992). They can seize the goods and sell them to other customers, which is a part of their normal business. Although banks can also seize the defaulting borrower's assets, they would not have the expertise in selling them.

B. Transaction Cost View of Trade Credit

Ferris (1981) offers a *transaction cost theory* of trade credit, suggesting that trade credit helps reduce transaction costs of paying bills. In a long-term relationship, the seller and the buyer can cooperate with each other in scheduling the deliveries and the payments to optimize inventory and cash flow. With trade credit, they can achieve better cooperation by separating the payment cycle from the delivery schedule. Ferris further argues for trade credit even if trading partners can secure credit at lower costs from financial institutions, since each partner must secure bank credit separately, the cost of which will surpass that of one trade credit arrangement. Emery (1987) argues that trade credit can be used for coping with variable demand efficiently. When the demand is variable, the firm can adjust trade credit terms to control the demand instead of adjusting price or production, which are both highly costly.

C. Other Views of Trade Credit

Smith (1987) and Long, Malitz, and Ravid (1993) argue that trade credit can be used for *verifying quality*. When the quality of a product cannot be immediately verified, trade credit allows the buyer the time to learn the quality of the product before the final payment. Furthermore, Brennan, Maksimovic, and Zechner (1988) and Petersen and Rajan (1997) suggest that trade credit can be used as a means of *price discrimination*. If marginal buyers tend to be financially weaker, giving trade credit to everyone on the same terms and conditions amounts to giving favors to the marginal buyers. Thus a seller with monopoly power would be able to engage in indirect price discrimination without breaking the antitrust law. In the price discrimination story, financing is also an important aspect of the explanation.

D. Implications on Firm Reactions to Financial Shocks

How do the existing theories predict the firm's reaction to a change in the financial environment, such as a monetary tightening? The financial assistance view of trade credit suggests that the demand for trade credit will increase with a financial market tightening, because small and financially weaker firms are hit harder by such a change. Does the supply of trade credit also increase upon a monetary tightening? The financial assistance view suggests that financially stronger firms extend more trade credit to those customers who face more financial strains.

However, even strong firms may need to protect their balance sheets from the impact of a policy shock.⁴ They may not only demand more trade credit from (or supply less to) their current trading partners, but may also switch to the suppliers that can provide more trade credit or to the buyers that demand less trade credit. As a result, even large firms may increase trade credit use upon a monetary tightening. Furthermore, since a monetary tightening causes financial distress, especially for small and financially weak firms, large and financially strong firms may become more concerned about the default risk on their trade credit and thus become less willing to provide it. Although the firms may have better information about their trading partners than banks, they are not completely free from the default risk. Thus the flow of trade credit between financially strong firms and financially weak firms may show a pattern somewhat similar to “flight to quality” in bank loans in a tight financial market.

Nilsen (2002) examines the response of trade credit to monetary shocks as a test of the *bank lending channel* view. He considers accounts payable as a substitute for bank loans that is inferior to the loans, but always available to the financially challenged.⁵ So when banks cut loans upon a monetary shock, more trade credit should be used, with small firms using more trade credit and large and financially strong firms using less trade credit. However, he finds conflicting results that large firms use more trade credit than smaller firms. By contrast, we consider the possibility that the use of trade credit is not so readily available to smaller firms since large and financially strong firms seek to improve their own liquidity position to fend off future financial strains. As tighter policy raises the external finance premium, firms increase the demand for trade credit as a substitute for bank loans and commercial paper. As a result, the interfirm liquidity market will become more active. However, trade credit will become more costly or less available, depending on the firm’s creditworthiness and market power. Hence we argue that, in the face of tighter policy, it is possible for smaller firms to use less *net* trade credit than big firms.

What about the implications of existing theories that emphasize other motivations for trade credit? First, Ferris’ (1981) *transaction theory* predicts that both accounts receivable and accounts payable increase with the interest rate. This prediction differentiates the transaction theory from other theories. Ferris also presents empirical evidence supportive of his theory using industry-level aggregate data. Transaction theory views trade credit as a long-term arrangement between trading partners protecting both trading partners from the volatile cash flow and delivery. In that sense, it places more emphasis on the cooperative nature of the relationship between the partners than the conflicts arising from the short-term variability of the market environment. That’s why both trade credit extension and use increase with the interest rate.

⁴ Choi and Kim (2001) find evidence that large firms increase their liquidity holdings upon a monetary tightening.

⁵ The interest rates for trade credit are usually much higher than those for bank loans. Wilner (2000), however, argues that higher interest rates are compensation for the bigger concessions that trade creditors make in case of debt renegotiations.

Second, trade credit for *verifying quality* should not be strongly affected by changes in the financial market environment. For the sellers, guaranteeing the quality with trade credit involves more financial costs when monetary policy is tight. Nonetheless, lacking other means of guaranteeing quality, they will face the same strong demand for trade credit from the buyers.

Third, according to the *price discrimination theory*, firms with monopoly power extend trade credit as implicit discounts to marginal buyers. Under a tight policy, the credit to the marginal buyers becomes more valuable since they face a harsher environment. However, the cost of extending credit to the marginal buyers also increases as their default risk increases. Thus, the expected effect of tighter policy on trade credit for price discrimination is mixed.

III. EMPIRICAL SPECIFICATIONS AND METHODS

A. Regression Models

We begin with simple models of trade credit. For accounts receivable regressions, we use sales as the scale variable since accounts receivable are incurred as a part of the sales operation. We consider a log level specification, for firm j at time t ,

$$(1a) \quad \ln(AR_{j,t}) = \alpha_t^R + \alpha_1^R \ln(S_{j,t}) + e_{j,t}^R,$$

where $AR_{j,t}$ and $S_{j,t}$ are accounts receivable and sales in real terms, respectively, and $e_{j,t}^R$ is an error term. The time-varying parameter, α_t^R , reflects seasonality and shifts in the macroeconomic environment such as policy shocks. The coefficient of $\ln S_{j,t}$ measures the sales elasticity of accounts receivable. For accounts payable regressions, we use the same specification as for accounts receivable, except that we use cost of goods sold.⁶

$$(1b) \quad \ln(AP_{j,t}) = \alpha_t^P + \alpha_1^P \ln(C_{j,t}) + e_{j,t}^P,$$

where $AP_{j,t}$ and $C_{j,t}$ are accounts payable and cost of goods sold in real terms, respectively, and $e_{j,t}^P$ is an error term.

To capture the effect of policy shocks on trade credit, we extend the above equations to include the variable of external financial shocks and other key variables. We consider two alternative specifications. The first specification pertains to the perception that trade credit changes proportionately with the operation scale (i.e., sales or the cost)—the *transactions motive*, as in Petersen and Rajan (1997) and Nilsen (2002)—and the two grow together over time. The proportion of trade credit in operation scale, however, can also be affected by macro-financial

⁶ Accounts payable arises mostly with purchasing of raw material and intermediate goods. Since this nonlabor direct cost is not separately reported at quarterly frequency, we use the cost of goods sold, which includes labor expenses as well as purchases, assuming that the fraction of nonlabor cost of goods sold is stable for each firm.

shocks and firm-specific factors. So we also employ a sales-normalized specification for accounts receivable as follows: for firm j at time t ,

$$(2a) \quad \frac{AR_{j,t}^N}{S_{j,t}^N} = c_0^R + \sum_{k=0}^8 c_{2,k}^R M_{t-k} + Q\tau^R + u_{j,t}^R,$$

where $AR_{j,t}^N$, and $S_{j,t}^N$ denote the nominal accounts receivable and the nominal sales, respectively, and $u_{j,t}^R$ is an error term. M_t represents the variable representing macro-financial shocks that affect all firms at time t . The $Q\tau$ term represents the linear combination of the effects of other firm-specific determinants that will be described later. Likewise, the cost-normalized accounts payable are given by

$$(2b) \quad \frac{AP_{j,t}^N}{C_{j,t}^N} = c_0^P + \sum_{k=0}^8 c_{2,k}^P M_{t-k} + Q\tau^P + u_{j,t}^P,$$

where $AP_{j,t}^N$ and $C_{j,t}^N$ denote the nominal accounts payable and the nominal cost of goods sold, respectively, and $u_{j,t}^P$ is an error term. This sales (cost)-normalized specification enables us to examine the effects of policy shocks and other variables on trade credit relative to sales (cost).

The second specification takes into account that accounts receivable and payable are subject to asset/liability management as balance sheet items—the *asset management motive* as employed by Petersen and Rajan (1997)—and that they grow over time. In this regard, we employ a ratio specification, normalizing variables by the beginning-of-period total assets: for firm j at time t ,

$$(3a) \quad \frac{AR_{j,t}^N}{\hat{A}_{j,t}^N} = b_0^R + b_1^R \frac{S_{j,t}^N}{\hat{A}_{j,t}^N} + \sum_{k=0}^8 b_{2,k}^R M_{t-k} + Q\tau^R + v_{j,t}^R,$$

where $\hat{A}_{j,t}^N$ denotes the beginning-of-period nominal total assets, and $v_{j,t}^R$ is an error term. Likewise, the asset-normalized accounts payable are given by

$$(3b) \quad \frac{AP_{j,t}^N}{\hat{A}_{j,t}^N} = b_0^P + b_1^P \frac{C_{j,t}^N}{\hat{A}_{j,t}^N} + \sum_{k=0}^8 b_{2,k}^P M_{t-k} + Q\tau^P + v_{j,t}^P,$$

where $v_{j,t}^R$ is an error term.

In addition, we include the market interest rate, R_t , when we examine the effect of the interest rate on trade credit to take account of the asset management view. Ferris (1981) argues that both accounts receivable and payable increase with the interest rate. Norrbin and Reffett (1995) suggest that the extension of trade credit is positively related with the interest rate because of the substitution between money and trade credit as alternative means of payment.

We estimate the four benchmark models (two for accounts receivable and two for accounts payable) with fixed-firm effects and quarter-industry dummies that control for industry-specific

seasonality. In addition, we estimate regressions for the asset- or the sales-denominated NTC. For all regressions in this paper, standard errors are corrected using White's method to account for heteroskedastic errors of unknown forms.

B. Firm-Specific Determinants of Trade Credit

The firm-specific explanatory variables for trade credit reflect various theories of trade credit, and we draw on Long, Malitz, and Ravid (1993) and Petersen and Rajan (1997) for these variables. Since we control for the fixed-firm effects, we include time-varying, firm-specific variables but not those firm-specific variables that are more or less time-invariant, such as the firm size.⁷ We use the beginning-of-period (lagged) value for a regressor when the use of its current value causes a possible endogeneity problem.

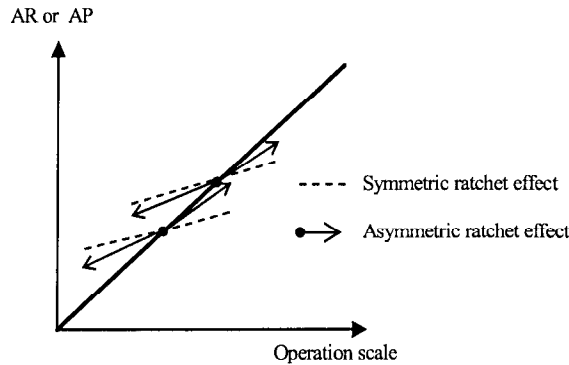
Accounts Receivable

Sales growth (SGROWTH: quarterly sales growth, $\Delta S_{j,t}^N / S_{j,t-1}^N$)—A firm may extend trade credit more aggressively to promote sales increase. Petersen and Rajan included this variable but distinguished between positive growth (*SGROWTH*^{plus}) and negative growth (*SGROWTH*^{minus}). They found that the positive-sales-growth variable had a small positive or insignificant effect on the AR-sales ratio, but the negative-sales-growth variable had a very strong negative effect on the ratio. They interpreted this result as evidence that customers delay payment to the supplier when the supplier is in trouble.

We interpret a negative effect of sales growth on the trade credit-sales ratio as a “ratchet effect,” reflecting a sluggish adjustment in trade credit: trade credit moves with the operation scale proportionately in the long run but less than proportionately in the short run. As shown in Figure 1, trade credit can move along a line passing through the origin in the long run. In the short run, it may move along a line flatter than the long-run line. At the aggregate level, this ratchet effect implies that the trade credit-sales ratio is *countercyclical*. Further, we propose an *asymmetry* in the ratchet effect, assuming more stickiness downward than upward in adjusting trade credit relative to sales. When sales growth is negative, accounts receivable decrease much less than proportionately, resulting in a much flatter locus above the long-run locus, whereas when sales growth is positive, accounts receivable increase along a slightly flatter line below the long-run locus. That is, on the margins, the trade credit offer per sales increases (more discount to induce purchase) when sales slides, whereas it falls when sales grow. Such asymmetric responses help moderate the adverse impact of a sharp drop in sales on firms' liquidity.

⁷ The effect of firm size, a proxy for market power, on trade credit is mixed both theoretically and empirically. The financial assistance view suggests that large firms will offer more trade credit. Conversely, the quality verification theory suggests that small firms have a greater need to guarantee their product quality than large and more established firms and so will offer trade credit. Long, Malitz, and Ravid (1993) report a negative effect of market power on accounts receivable, but Petersen and Rajan (1997) report a positive effect.

Figure 1. Ratchet Effects



Inventory stock (V : inventory-sales (asset) ratio, beginning-of-period value)—For inventory management purposes, firms with more inventories relative to sales extend more trade credit than other firms do. To account for this effect, we use the inventory-sales ratio, which is expected to have a positive coefficient. However, both inventory and accounts receivable are current assets and thus are substitutes in asset management.⁸ So when the inventory-asset ratio is too high, it may put negative pressure on accounts receivable relative to assets.

Retained earnings (RE : retained earnings-sales (assets) ratio, beginning-of-period value)⁹—From the transactions motive, firms with more retained earnings relative to sales have more internal capital and thus can better afford to offer trade credit. By contrast, from an asset management perspective, accounts receivable are not particularly preferred to other types of assets in which firms invest retained earnings.

Short-term debt ($SDEBT$: short-term debt over total assets, beginning-of-period value)—If this variable has a positive coefficient, it indicates that firms incur short-term debt to finance accounts receivable. If negative, it implies that firms provide trade credit only when they can afford it: that is, when internal capital is low and external financing is required, the firm extends less trade credit. Long, Malitz, and Ravid (1993) find that a similar variable (the short-term debt normalized by sales) had a very strong positive effect on accounts receivable. In regressions with policy shock variables, we use the short-term debt ratio adjusted for the cross-section averages to control for cyclical variations and policy effects. This variable is denoted by \overline{SDEBT} .

⁸ Petersen and Rajan (1997) used the ratio of variability of inventories to that of sales, which also had a positive and significant effect. They interpreted this result as evidence that trade credit is used as a part of inventory management.

⁹ Petersen and Rajan (1997) used net income and found a negative coefficient on net income when they also include *gross* income as an explanatory variable. The negative effect of net income may reflect the effect of selling, general, and administrative expense. Instead, we use retained earnings, a measure for the internal source of capital.

Accounts Payable

Since the providers of trade credit are concerned about the default risk of the buyer and the possibility of selling the repossessed supplies in case of a default, accounts payable are constrained by the willingness of the trade credit providers. So we should consider the determining factors of the supply side as well as the demand side of trade credit.

Cost growth (CGROWTH, quarterly growth of cost of goods sold, $\Delta C_{j,t}^N / C_{j,t-1}^N$)—Like accounts receivable, there can be a ratchet effect in the adjustment of the accounts payable-cost ratio. To allow for asymmetry in the ratchet effect, we include the positive-cost-growth ($CGROWTH^{plus}$) and the negative-cost-growth ($CGROWTH^{minus}$) variables.

Inventory stock (V: as defined in the above)—Inventories are easy to liquidate from the suppliers' point of view. So when this ratio is high, the supplier of trade credit has an advantage over other financial institutions and will be more willing to provide credit.

Retained earnings (RE, as defined in the above)—From the viewpoint of risk management by credit suppliers, the effect is positive since the suppliers will be more willing to extend trade credit to firms with more retained earnings and hence more likely lower default risk. On the other hand, the pecking order model (e.g., Graham and Harvey, 2001) posits that firms use external financing only when internal funds are insufficient. Thus, from the viewpoint of asset management by buyers, the effect of retained earnings is negative since firms with flush with money are less likely to tap external sources of finance.

IV. EMPIRICAL RESULTS

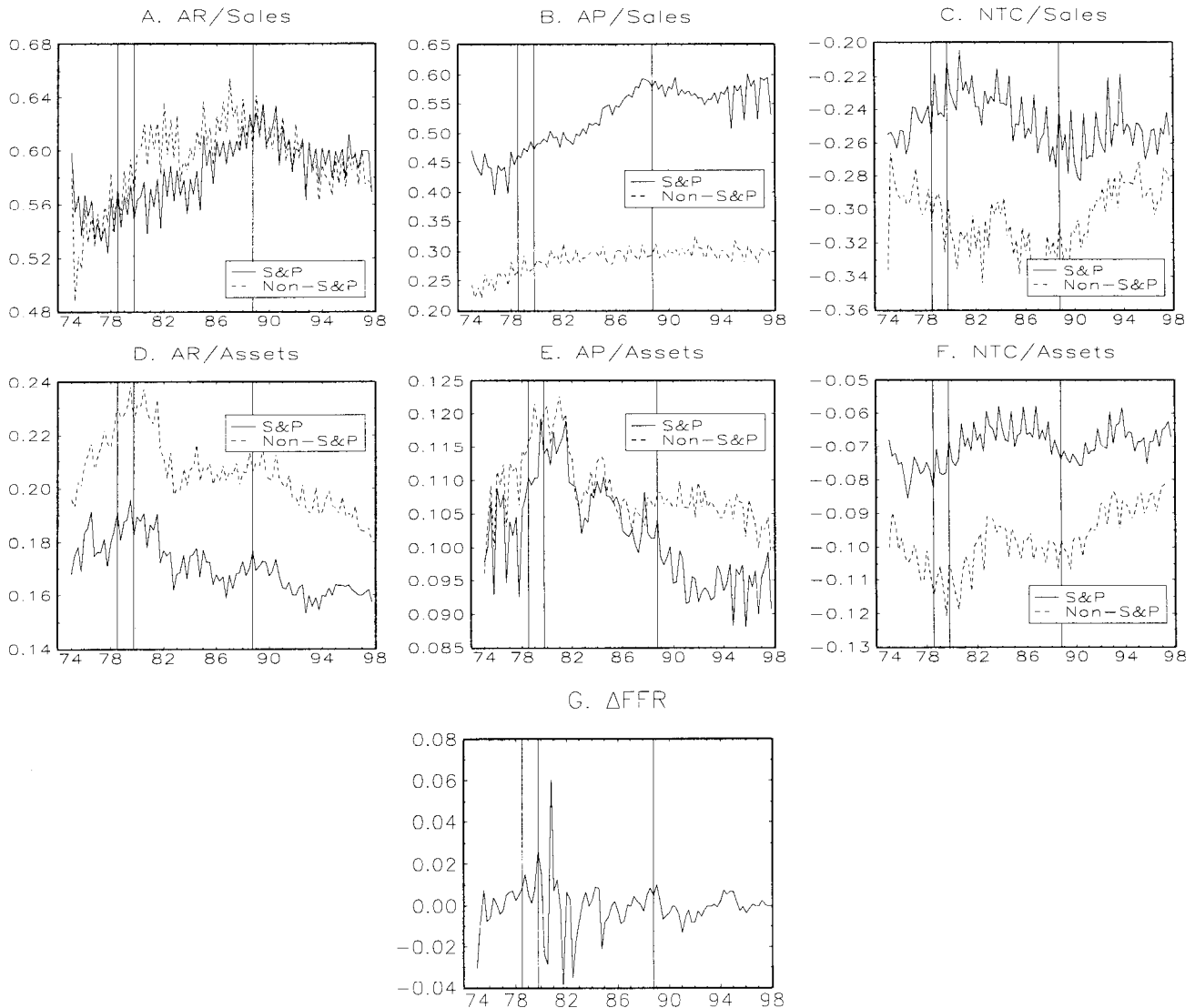
A. The Data and Summary Statistics

We use two different panel data sets of listed U.S. companies. The data sets are at *quarterly* frequency and were retrieved from Compustat Quarterly files for 1975:1–1997:4. The first data set is for S&P 500 firms from the S&P industrial or transportation index list (Compustat annual item no. 276=10 or 49) in any of the three years 1978, 1987 and 1997. We exclude financial and utility firms, which do not produce physical products. After the screenings, we are left with an unbalanced panel that contains a total of 659 firms in 53 industries as indicated by the two-digit standard industrial classification (SIC) code. The second data set is for smaller firms, comprised of 689 non-S&P firms in 46 industries, which are selected to match the S&P firms as closely as possible except that they are medium-sized firms. In this paper, we call them “smaller” firms (for details, see Choi and Kim, 2001).

The macroeconomic variables are the market interest rate and macro-financial shocks. The market interest rate, R_t , is measured by the three-month treasury bill rate. To measure macro-financial shocks, we consider two alternative monetary policy shock variables: one is the change in the Federal funds rate, ΔFFR_t , considering the Federal funds rate as a good indicator for the monetary policy stance (Bernanke and Blinder, 1992; Christiano, Eichenbaum, and Evans, 1996), and the other is $ROMERS_t$, a dummy variable for the dates when Federal Reserve policy

became explicitly disinflationary, as identified by Romer and Romer (1993). To link the panel data and the macro time series consistently, the *calendar* (not fiscal) year date for each firm is used.

Figure 2. Movements in Variables



Note: AR, AP, and NTC indicate the cross-section mean of accounts receivable, accounts payable, and *net* trade credit use, respectively. The vertical lines indicate the Romer dates.

Table A1 in the appendix displays the summary statistics of the main variables used in the regressions. Since some of the variables have outliers with extreme values, the medians seem to represent each group better than the means.¹⁰ Noteworthy is that smaller (non-S&P) firms extend at least as much trade credit as S&P firms. Whether we scale accounts receivable with sales or with total assets, the median and mean accounts receivable for non-S&P firms (0.61 and 0.70; or 0.21 and 0.21) are greater than those for S&P firms (0.56 and 0.62; or 0.16 and 0.17).¹¹ At the same time, S&P firms use at least as much trade credit as their counterparts. When scaled by the cost figure, the median and mean accounts payable are even greater for S&P firms. Also observe that *net trade credit use*, NTC, is greater for S&P than for non-S&P, regardless of the denominator. When scaled by assets, we also observe that sales are more variable than accounts receivable, which is more variable than accounts payable. Also note that S&P firms have much more retained earnings and short-term debt, relative the operation scale or assets, than do non-S&P firms.

Figure 2 shows movements of the cross-section means of trade credit to operation scale ratios along with ΔFFR , and $ROMERS_t$. The AR-sales ratio is in the range of 0.50–0.60, similar for S&P and non-S&P firms, whereas the AP-sales ratio of S&P is twice that of non-S&P firms. As a result, the NTC-sales ratio is much higher for S&P firms than non-S&P firms. The relationship is reversed when scaled by assets, but considering that larger firms are more capital-intensive, the extent of trade credit use by S&P firms seems at least comparable with that of non-S&P firms. The figure shows that the AR-asset ratio is much higher for non-S&P firms than for S&P firms, whereas the AP-assets ratio is similar for both groups of firms, indicating that non-S&P firms extend more net credit than do S&P firms.

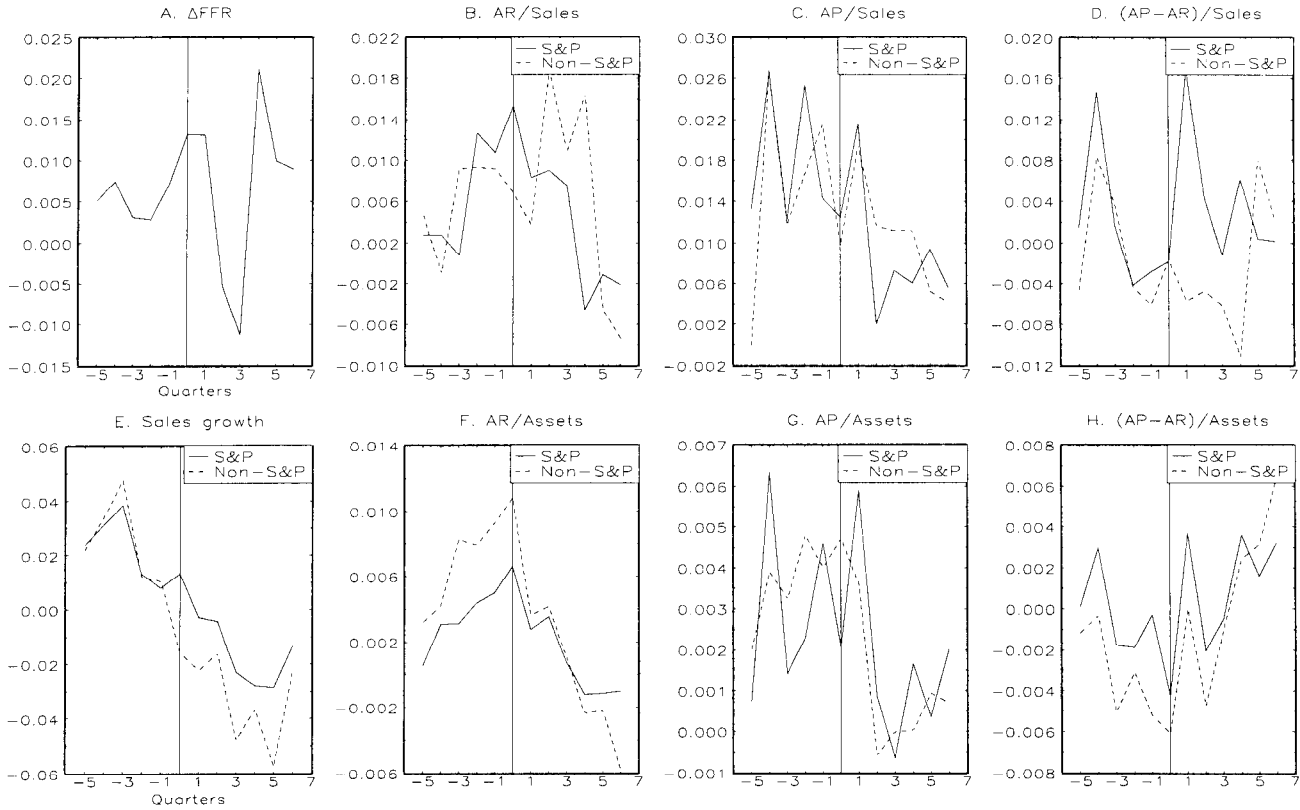
This result is inconsistent with the pure financial assistance view that large and financially strong firms extend more credit to their trade partners to meet their financial need. The result fits the transaction cost theory better in that large and smaller firms engage in trade credit to the same extent. It is also consistent with the quality guarantee story in that smaller firms incur more accounts receivable than large firms.

Figure 3 shows annualized changes in the cross-section means of variables near the Romer dates. To account for seasonal movements, year-on-year changes in variables are used. Of special interest is that after tighter monetary policy, the *net trade credit use* increases relative to (declining) sales for large firms but falls for smaller firms. For S&P 500 firms, accounts receivable slow down but accounts payable speed up shortly after tighter monetary policy. For non-S&P firms, accounts receivable relative to accounts payable increase. However, these changes are the gross effects of monetary policy before controlling for other factors.

¹⁰ When we estimate sales-normalized regressions, we exclude observations in the 1 percent tails for each of the sales-normalized variables, because such extreme outliers may unduly affect the estimates.

¹¹ These statistics are calculated excluding firms that report zero for accounts receivable or payable.

Figure 3. Movements of Variables Near the Romer Dates



Note: The horizontal axes represent the number of quarters before (with a negative sign) and after the Romer dates; 78:Q3, 79:Q4, and 88:Q4. Panel A depicts the Federal funds rate change, and Panels B–H depict *annualized changes* in the cross-section mean of firm-level variables. The curve for a group of firms is the locus of group mean of j -quarter-ahead variable.

B. Pretest Regressions for Trade Credit

To see whether trade credit and the operation scale variable are closely linked, we regress the log of accounts receivable (accounts payable) on the log of sales (cost of goods sold), both measured in real terms using the consumer price index (CPI). We control for seasonality, the time-varying effect of the progress in asset management technology, and other trend components at the aggregate level either by time (quarter-year) dummies or by defining variables as deviations from cross-section averages.

Table 1 shows the results of regressions with the S&P 500 firm data (columns 2–5) and with the non-S&P firm data (columns 6–9), respectively. The adjusted R^2 's are high being greater than 0.45 for most models. The coefficients on the scale variables are in the range of 0.75–0.96, suggesting a close link between trade credit and the operation scale, and accounts payable are more closely linked to the operation scale than accounts receivable. The operation scale is more important for S&P 500 firms—as shown by a higher operation scale elasticity and a higher adjusted R^2 in both accounts receivable and payable regressions—than for non-S&P firms.

Table 1. Pretest Regressions for Trade Credit

A. Accounts receivable: dependent variable = $\ln AR_{j,t}$

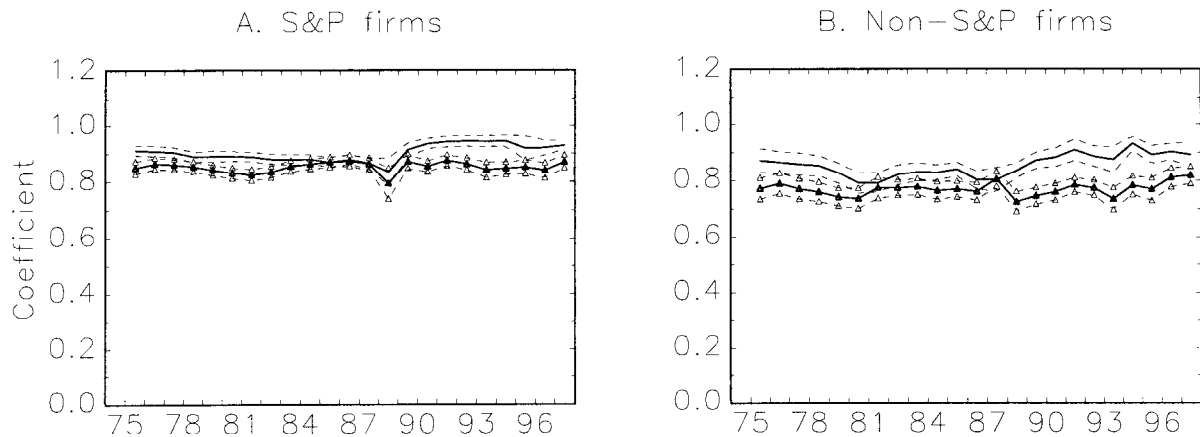
Independent Variable	S&P 500 firms				Non-S&P 500 firms			
	Level		Deviation		Level		Deviation	
$\ln S_{j,t}$	0.910** (450.0)	0.900** (128.6)	0.909** (303.0)	0.897** (128.1)	0.749** (149.8)	0.858** (95.33)	0.748** (149.6)	0.860** (95.56)
Time dummies	Yes	Yes	No	No	Yes	Yes	No	No
Fixed-firm effects	No	Yes	No	Yes	No	Yes	No	Yes
\bar{R}^2	0.719	0.719	0.713	0.713	0.450	0.450	0.440	0.440
N	45,938	45,938	45,938	45,938	38,616	38,616	38,616	38,616

B. Accounts payable: dependent variable = $\ln AP_{j,t}$

Independent Variable	S&P 500 firms				Non-S&P 500 firms			
	Level		Deviation		Level		Deviation	
$\ln C_{j,t}$	0.960** (320.0)	0.852** (106.5)	0.947** (236.8)	0.896** (99.67)	0.808** (202.0)	0.770** (96.25)	0.869** (173.8)	0.804** (100.5)
Time dummies	Yes	Yes	No	No	Yes	Yes	No	No
Fixed-firm effects	No	Yes	No	Yes	No	Yes	No	Yes
\bar{R}^2	0.827	0.827	0.705	0.705	0.686	0.686	0.697	0.697
N	44,264	44,254	45,815	45,815	37,826	37,826	39,125	37,826

Note: The regressions are performed for the 1975:1–97:4 period. \bar{R}^2 excludes variance explained by the fixed-firm effects. The t -values in parentheses are based on standard errors computed using White's correction for heteroskedasticity. **, *, [†] coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Figure 4. Time-Varying Coefficients in the Trade Credit and Operation Scale Relationship



Note: The lines without symbols are the (year-on-year) time-varying coefficients of log of sales in the AR-sales relationship and those with symbols are the time-varying coefficients of the log of cost of goods in the AP-sales relationship. Dashed lines are 95 percent confidence intervals. Both time dummies and fixed-firm effects are included in regressions.

In addition, we estimate regressions allowing the scale coefficient to vary from year to year. The results, summarized in Figure 4, suggest a stable link between trade credit and sales over time. The estimated coefficients for S&P firms (non-S&P firms) are in the range of 0.83–0.95 (0.79–0.93) with accounts receivable and 0.79–0.87 (0.72–0.81) with accounts payable.

C. Accounts Receivable Regressions

Tables 2A and 2B report the results of regressions in which the dependent variable is the accounts receivable (AR) scaled by sales and by total assets, respectively, as in equations (2a) and (3a). All regressions henceforth, unless otherwise indicated, control for the industry-specific seasonality, allowing seasonality to vary across industries, and fixed firm effects. We discuss the results by firm-characteristic variables and then by macro-financial variables.

Sales-asset ratio—This variable, appearing only in the asset-normalized specification, has a strong positive coefficient in Table 2B for both S&P and non-S&P firms. Consistent with Table 1, the link between sales and accounts receivable is stronger for S&P firms (estimates in the range of 0.15–0.17 with t -value around 22) than for non-S&P firms (estimates in the range of 0.09–0.12 with t -value around 4). This may suggest that smaller firms do not adjust accounts receivable to the operation scale as much as large firms.

Sales growth—As shown in Table 2A, sales growth significantly lowers the AR-sales ratio, suggesting that the short-run response of accounts receivable to sales is less than its long-run response, as implied by a ratchet effect. The negative coefficient of sales growth also implies that the AR-sales ratio could be countercyclical at the aggregate level. We find a substantial asymmetry between the effect of negative sales growth (minus 0.30–0.31 with t -value < -15) and that of positive sales growth (minus 0.05–0.07 with t -value < -5). That is, the increase in the AR-sales ratio induced by a sales decrease is much greater than its decrease induced by a sales increase. This applies equally to S&P and non-S&P firms. A stronger effect of negative sales growth is consistent with Petersen and Rajan's (1997) finding that only the negative-sales-growth variable had a significant effect on the AR-sales ratio.

In the asset-normalized specification (Table 2B), after controlling for the level effect of sales by the sales-asset ratio, a positive effect of sales growth may reflect that firms with growing sales extend trade credit to promote sales, while those with falling sales deny trade credit when parting with customers. The finding that a positive sales growth has a significant coefficient only for S&P firms is consistent with the price discrimination story of trade credit, since large firms (often with monopoly power) offer more trade credit to new customers. The effect of negative sales growth for non-S&P firms is about four times as strong as that for S&P firms (0.03–0.04 vs. 0.13–0.14). This result is consistent with Ferris' (1981) transaction cost theory in that sellers extend trade credit to customers only when they expect a continuing relationship, which applies especially to smaller firms since many small firms have long-term supply relationships.

Table 2A. Accounts Receivable (AR) over Sale

Independent Variables	S&P 500 firms					Non-S&P firms				
	(a)	(b)	(c)	(d)	(e)	(a)	(b)	(c)	(d)	(e)
$SGROWTH_{j,t}$	-0.156** (21.235)	—	—	—	—	-0.135** (-18.429)	—	—	—	—
$SGROWTH_{j,t}^{plus}$	—	-0.070** (-6.632)	-0.073** (-6.931)	-0.072** (-6.711)	-0.072** (-6.786)	—	-0.054** (-5.719)	-0.054** (-5.719)	-0.056** (-5.899)	-0.053** (-5.654)
$SGROWTH_{j,t}^{minus}$	—	-0.306** (-17.050)	-0.313** (-17.581)	-0.308** (-17.106)	-0.308** (-17.161)	—	-0.303** (-15.472)	-0.302** (-15.451)	-0.307** (-15.691)	-0.305** (-15.640)
$V_{j,t-1}^N / S_{j,t-1}^N$	0.049** (6.549)	0.050** (6.605)	0.072** (9.129)	0.055** (7.079)	0.056** (7.300)	0.100** (12.953)	0.100** (12.868)	0.100* (12.917)	0.103** (13.272)	0.101** (13.148)
$RE_{j,t-1}^N / S_{j,t-1}^N$	0.065** (23.878)	0.065** (24.056)	0.073** (26.803)	0.072** (26.033)	0.072** (25.646)	0.046** (16.236)	0.046** (16.248)	0.046** (15.655)	0.045** (15.497)	0.044** (15.116)
$SDEBT_{j,t-1}$	—	—	0.086** (16.785)	—	—	—	—	-0.000 (-0.081)	—	—
$\overline{SDEBT}_{j,t-1}$	—	—	—	0.051** (8.188)	0.051** (8.091)	—	—	—	-0.006 (-1.148)	-0.007 (-1.418)
$\{\Delta FFR_{t-k}\}_{k=0}^8$	—	—	—	[Fig.5(1)A]	—	—	—	—	[Fig.5(1)B]	—
$\{ROMERS_{t-k}\}_{k=0}^8$	—	—	—	—	[Fig.5(2)A]	—	—	—	—	[Fig.5(1)B]
\bar{R}^2	0.353	0.354	0.438	0.435	0.435	0.462	0.465	0.465	0.466	0.466
N	35,625	35,625	35,112	35,112	35,112	30,408	30,408	30,399	30,399	30,399

Note: The regressions are performed for the 1975:4–97:4 period. The dependent variable is $AR_{j,t}^N / S_{j,t}^N$. All regressions control for the fixed-firm effects and the quarter-industry effects. \bar{R}^2 excludes variance explained by the fixed-firm effects. The t -values in parentheses are based on standard errors computed using White's correction for heteroskedasticity. **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Table 2B. Accounts Receivable (AR) over Asset

Independent Variables	S&P 500 firms					Non-S&P firms				
	(a)	(b)	(c)	(d)	(e)	(a)	(b)	(c)	(d)	(e)
$SGROWTH_{j,t}$	0.023** (8.519)	—	—	—	—	0.000 (0.493)	—	—	—	—
$SGROWTH_{j,t}^{plus}$	—	0.021** (6.187)	0.022** (6.179)	0.022** (6.129)	0.022** (6.289)	—	0.013** (2.799)	0.000 (0.085)	-0.000 (-0.006)	0.000 (0.053)
$SGROWTH_{j,t}^{minus}$	—	0.031** (5.603)	0.039** (6.818)	0.039** (6.813)	0.039** (6.748)	—	0.133** (13.134)	0.135** (12.984)	0.132** (12.721)	0.133** (12.778)
$S_{j,t}^N / A_{j,t-1}^N$	0.173** (23.850)	0.171** (23.711)	0.160** (22.127)	0.157** (21.537)	0.156** (21.279)	0.117** (4.337)	0.090** (4.014)	0.097** (3.988)	0.097** (3.962)	0.098** (3.980)
$V_{j,t-1}^N / A_{j,t-1}^N$	-0.076** (-7.944)	-0.076** (-7.990)	-0.085** (-8.547)	-0.090** (-9.436)	-0.102** (-10.640)	-0.016 (-0.863)	-0.012** (-2.798)	-0.045** (-2.953)	-0.032* (-2.504)	-0.040** (-2.669)
$RE_{j,t-1}^N / A_{j,t-1}^N$	0.003 (0.787)	0.003 (0.821)	0.007† (1.785)	0.011** (2.829)	0.011** (2.764)	-0.001 (-1.020)	-0.001 (-0.970)	-0.001 (-0.924)	-0.000 (-0.752)	-0.000 (-0.488)
$SDEBT_{j,t-1}$	—	—	0.016** (9.374)	—	—	—	—	0.012** (3.833)	—	—
$\overline{SDEBT}_{j,t-1}$	—	—	—	0.021** (10.420)	0.022** (10.888)	—	—	—	0.010** (2.979)	0.011** (3.208)
R_t	—	—	0.145** (15.080)	—	—	—	—	0.219** (11.364)	—	—
$\{\Delta FFR_{t,k}\}_{k=0}^8$	—	—	—	[Fig.5(1)C]	—	—	—	—	[Fig.5(1)D]	—
$\{ROMERS_{t,k}\}_{k=0}^8$	—	—	—	—	[Fig.5(2)C]	—	—	—	—	[Fig.5(2)D]
\bar{R}^2	0.468	0.468	0.479	0.480	0.480	0.356	0.367	0.374	0.374	0.374
N	38,575	38,575	38,051	38,051	38,051	31,916	31,916	31,909	31,909	31,909

Note: The regressions are performed for the 1975:4–97:4 period. The dependent variable is $AR_{j,t}^N / A_{j,t}^N$. All regressions control for the fixed-firm effects and the quarter-industry effects. \bar{R}^2 excludes variance explained by the fixed-firm effects. The t -values in parentheses are based on standard errors computed using White's correction for heteroskedasticity. **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Inventory stock—When normalized by sales, the lagged inventory has a strong positive effect with its estimate in the range of 0.05–0.10, implying that when inventories accumulate, the firm increases the portion of sales on credit. This supports the view that trade credit reduces the transaction cost of managing inventory and cash flow. The effect is twice as strong for smaller firms as for large firms, consistent with that small firms tend to have long-term relationship with important customers. Conversely, when normalized by asset, it has strong negative effects with its estimate ranging between –0.01 and –0.10. This negative effect reflects that inventories, as a buffer for internal finance, are substitutes for accounts receivable in liquidity management (Carpenter, Fazzari, and Petersen, 1994; and Choi and Kim, 2001).

Retained earnings—Retained earnings have a highly significant positive effect (t -value > 15) on the AR-sales ratio for both groups of firms, suggesting that a high internal financing capability promotes trade credit offers. However, there are insignificant effects on the accounts receivable-asset ratio for non-S&P firms, while some significant effects for S&P firms only in regressions (d) and (e). This suggests that, from the asset management view, accounts receivable are not particularly preferred to other types of assets, in which firms invest retained earnings.

Short-term debt—Regressions (c)–(e) show that the short-term debt ratio has a positive effect on accounts receivable in most cases except for non-S&P firms in the sales-normalized specification. The positive effect implies firms use short-term debt to finance accounts receivable. A weaker or insignificant effect for non-S&P firms may reflect that smaller firms are less willing to finance trade credit offers through short-term borrowings since these can be more costly to smaller firms than to bigger firms.

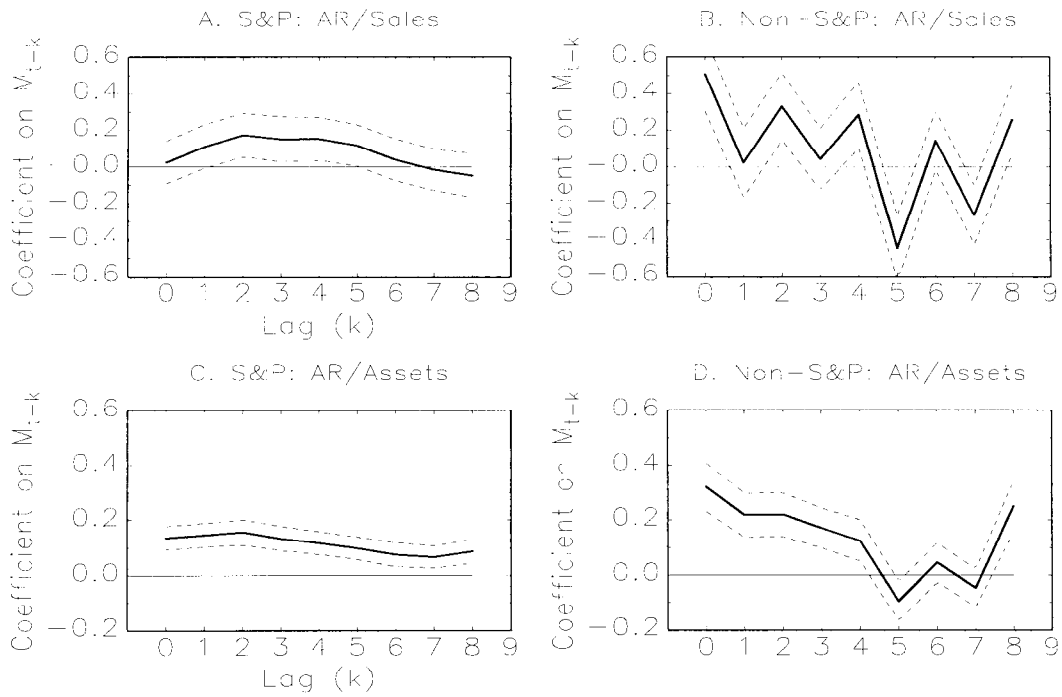
Interestingly, non-S&P firms' accounts receivable are much less sensitive to financial variables such as retained earnings and short-term debt. The coefficients are either insignificant or much smaller. This implies that, for smaller firms, accounts receivable are not driven by their financial situation (i.e., asset management or capital structure) but by other factors such as the relationship with their customers. By contrast, S&P firms seem to determine trade credit in line with their financial situation.

Macro aggregate variables—Regression (c) in Table 2B shows that the market interest rate, R_t , has a strong positive effect on the accounts receivable-asset ratio and that its coefficient is higher for non-S&P (0.219) than for S&P firms (0.145). As will be seen later, it also has strong positive effects on the AP-asset ratio. This result supports Ferris' (1981) theory of transaction cost, which predicts that both accounts receivable and payable increase with the interest rate. A stronger effect of the interest rate for non-S&P firms implies that, for smaller firms, trade credit is more sensitive to the cost of borrowing. This is also consistent with the theory considering that smaller firms have long-term customer relationships more than large firms.

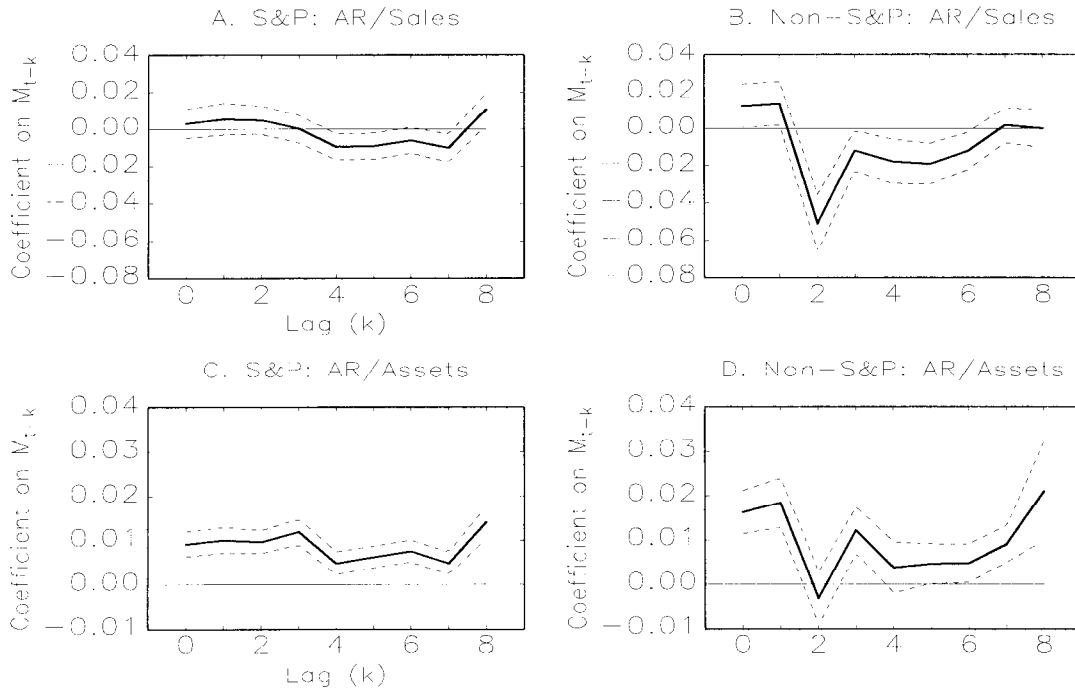
Finally, we examine how accounts receivable respond to policy shocks. Figure 5 depicts the estimated coefficients of current and lagged policy shocks for both specifications. A tighter monetary policy—measured by ΔFFR_t (top panel) or by $ROMERS_t$ (bottom panel)—has positive effects on the AR-sales ratio: for example, for S&P firms, the effects are significant after one-period lag and remain significant for four quarters. This implies that tighter policy shocks increase firms' trade credit offer relative to their sales. The coefficient of $ROMERS_t$ turns

Figure 5. Effects of Policy Shocks on Accounts Receivable (AR)

(1) Changes in the Federal funds rate



(2) The Romer dates



Note: The top half depicts the coefficients of the current and lagged changes of the Federal funds rate, and the bottom half depicts the coefficients of the current and lagged Romer dates. Dashed lines are 95 percent confidence intervals. Related regression results are reported in Table 2.

negative after a few quarters: more quickly for non-S&P firms (from the third quarter, $k=2$) than for S&P firms (from the fifth quarter, $k=4$). By contrast, policy shocks have significant and persistent positive impacts on the AR-asset ratio. Both S&P and non-S&P firms respond to tighter policy by increasing accounts receivable. Notably, the positive effects are stronger initially for non-S&P firms, especially when normalized by assets—implying that more trade credit is offered by smaller firms than by big firms immediately after policy tightening.

D. Accounts Payable Regressions

Tables 3A and 3B report the results of accounts payable (AP) regressions in which accounts payable are normalized by sales and by total assets, respectively, as in equations (2b) and (3b).

Cost of goods-asset ratio—This variable has a strong positive effect on the AP-asset ratio, and its estimate is higher for S&P firms than for non-S&P firms (0.20 vs. 0.07 as shown in Table 3B). The explanation should be similar to that for the relationship between the sales-asset ratio and the AR-asset ratio.

Cost growth—The AP-cost ratio (Table 3A) shows a similar pattern to the AR-sales ratio in the effect of cost growth. Since the short-run response of AP to a change in the scale of operation is less than its long-run response, as implied by a ratchet effect, the ratio decreases with cost growth. Here also, we find asymmetry in the ratchet effect in that the cost growth has a stronger negative effect when cost growth is negative than when it is positive. Note that this asymmetry is stronger for S&P firms (−0.12 vs. −0.41) than for non-S&P firms (−0.10 vs. −0.30). That is, when business contracts, large firms use trade credit more intensively than smaller firms.

The AP-asset ratio (Table 3B) shows a different pattern from the AR-asset ratio. For non-S&P firms, cost growth has a positive effect on the AP-asset ratio, meaning that firms get more trade credit to finance a growing operation. Again, there is asymmetry between positive and negative growth, with the latter having a stronger effect. For S&P firms, cost growth has a significant effect only in the negative range, and the coefficient ranges from −0.016 to −0.018. That is, S&P firms use relatively more accounts payable when their operation scale slides, implying that they have the market power to squeeze more trade credit from their suppliers when their business shrinks.

Inventory stock—The lagged inventory always has a positive effect on accounts payable, which appears to be about two times larger for non-S&P firms for normalizations by costs and assets. This result is consistent with the explanation that accounts payable can be issued against inventories, especially for smaller firms, since inventories can be easily liquidated.

Retained earnings—For S&P firms, this variable has a strong positive effect on the AP-cost ratio and a negative effect on the AP-asset ratio. This may reflect that firms with more retained earnings relative to production cost tend to receive more trade credit from the suppliers owing to a lower credit risk. The negative effect on the AP-asset ratio makes sense since firms with more internal capital would need less external short-term financing for liquidity management. For non-S&P firms, however, retained earnings have insignificant effects on accounts payable for both specifications.

Table 3A. Accounts Payable (AP) over Cost

Independent Variables	S&P 500 firms				Non-S&P firms			
	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
$CGROWTH_{j,t}$	-0.222** (-22.431)	—	—	—	-0.160** (-21.609)	—	—	—
$CGROWTH_{j,t}^{plus}$	—	-0.119** (-8.511)	-0.120** (-8.553)	-0.120** (-8.539)	—	-0.096** (-9.257)	-0.096** (-9.293)	-0.096** (-9.279)
$CGROWTH_{j,t}^{minus}$	—	-0.407** (-17.709)	-0.408** (-17.690)	-0.406** (-17.665)	—	-0.299** (-16.286)	-0.301** (-16.293)	-0.300** (-16.293)
$V_{j,t-1}^N / C_{j,t-1}^N$	0.035** (5.474)	0.034** (5.428)	0.034** (5.420)	0.035** (5.607)	0.069** (12.279)	0.069** (12.304)	0.070** (12.357)	0.070** (12.348)
$RE_{j,t-1}^N / C_{j,t-1}^N$	0.038** (19.246)	0.038** (19.395)	0.038** (19.381)	0.038** (19.059)	0.000 (0.228)	0.000 (0.231)	0.001 (0.263)	0.000 (0.132)
$\{\Delta FFR_{t-k}\}_{k=0}^8$	—	—	[Fig.6(1)A]	—	—	—	[Fig.6(1)B]	—
$\{ROMERS_{t-k}\}_{k=0}^8$	—	—	—	[Fig.6(2)A]	—	—	—	[Fig.6(2)B]
\bar{R}^2	0.181	0.185	0.185	0.185	0.197	0.205	0.204	0.205
N	34,222	34,222	34,222	34,222	28,595	28,595	28,595	28,595

Note: The regressions are performed for the 1975:4–97:4 period. The dependent variable is $AP_{j,t}^N / C_{j,t}^N$. All regressions control for the fixed-firm effects and the quarter-industry effects. \bar{R}^2 excludes variance explained by the fixed-firm effects. The t -values in parentheses are based on standard errors computed using White's correction for heteroskedasticity. **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

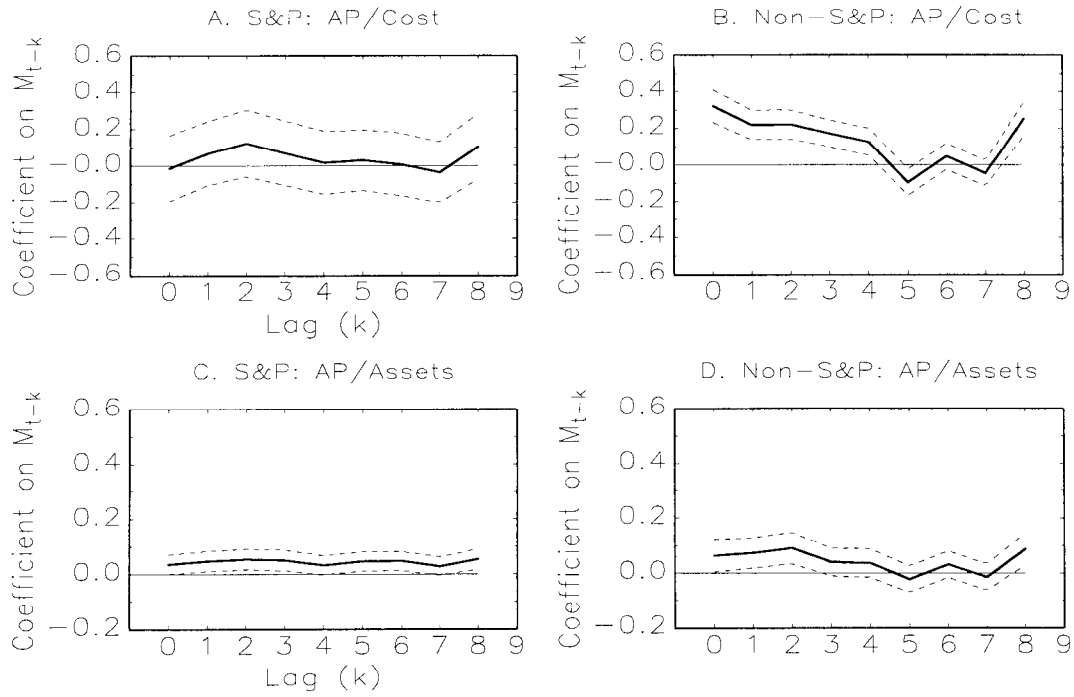
Table 3B. Accounts Payable (AP) over Asset

Independent Variables	S&P 500 firms					Non-S&P firms				
	(a)	(b)	(c)	(d)	(e)	(a)	(b)	(c)	(d)	(e)
$CGROWTH_{j,t}$	-0.001 (-1.131)	—	—	—	—	0.008** (3.225)	—	—	—	—
$CGROWTH_{j,t}^{plus}$	—	0.000 (-0.827)	0.000 (-0.739)	-0.000 (-0.831)	0.000 (-0.817)	—	0.007* (2.571)	0.007** (2.583)	0.007** (2.588)	0.007** (2.589)
$CGROWTH_{j,t}^{minus}$	—	-0.018** (-6.023)	-0.016** (-5.564)	-0.018** (-5.997)	-0.018** (-6.007)	—	0.021** (3.902)	0.022** (4.043)	0.021** (3.864)	0.021** (3.891)
$C_{j,t}^N / A_{j,t-1}^N$	0.200** (33.775)	0.204** (33.229)	0.199** (32.201)	0.199** (32.890)	0.203** (32.760)	0.071** (3.623)	0.070** (3.586)	0.070** (3.589)	0.070** (3.573)	0.070** (3.580)
$V_{j,t-1}^N / A_{j,t-1}^N$	0.032** (5.085)	0.032** (5.118)	0.023** (3.652)	0.029** (4.676)	0.027** (4.320)	0.062** (5.788)	0.061** (5.878)	0.055** (5.427)	0.060** (5.829)	0.059** (5.781)
$RE_{j,t-1}^N / A_{j,t-1}^N$	-0.023** (-8.918)	-0.023** (-9.088)	-0.025** (-9.807)	-0.023** (-9.161)	-0.024** (-9.239)	-0.002 (-1.074)	-0.002 (-1.076)	-0.003 (-1.136)	-0.002 (-1.095)	-0.002 (-1.076)
R_t	—	—	0.090** (11.447)	—	—	—	—	0.109** (8.692)	—	—
$\{\Delta FFR_{t-k}\}_{k=0}^8$	—	—	—	[Fig.6(1)C]	—	—	—	—	[Fig.6(1)D]	—
$\{ROMERS_{t-k}\}_{k=0}^8$	—	—	—	—	[Fig.6(2)C]	—	—	—	—	[Fig.6(2)D]
\bar{R}^2	0.412	0.413	0.414	0.413	0.413	0.404	0.404	0.404	0.404	0.404
N	36,832	36,832	36,832	36,832	36,832	30,412	30,412	30,412	30,412	30,412

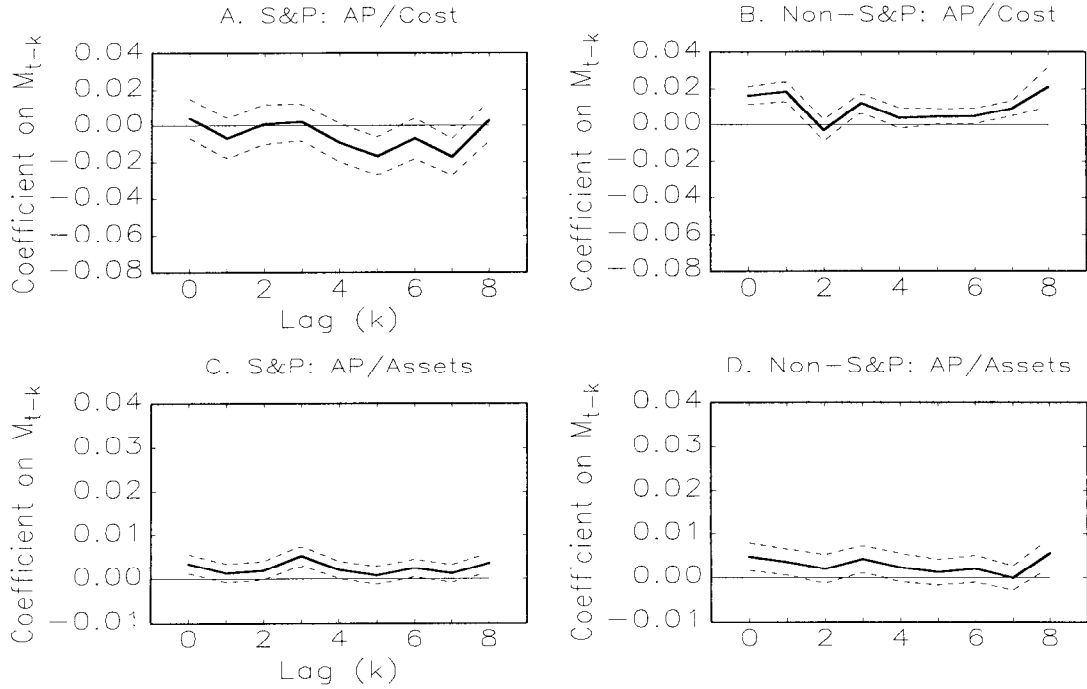
Note: The regressions are performed for the 1975:4–97:4 period. The dependent variable is $AP_{j,t}^N / A_{j,t}^N$. All regressions control for the fixed-firm effects and the quarter-industry effects. \bar{R}^2 excludes variance explained by the fixed-firm effects. The t -values in parentheses are based on standard errors computed using White's correction for heteroskedasticity. **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Figure 6. Effects of Policy Shocks on Accounts Payable (AP)

(1) Changes in the Federal funds rate



(2) The Romer dates



Note: The top half depicts the coefficients of the current and lagged changes of the Federal funds rate, and the bottom half depicts the coefficients of the current and lagged Romer dates. Dashed lines are 95 percent confidence intervals. Related regression results are reported in Table 3.

Macro aggregate variables—The interest rate has strong positive effects on accounts payable for both S&P and non-S&P firms. As discussed, this is consistent with the transaction cost theory. Finally, Figure 6 shows how firms adjust accounts payables relative to sales or assets in response to tighter monetary policy. The effects of policy shocks show a similar pattern, regardless of the choice of policy shock measures. Tighter policy increases the AP-cost ratio significantly for several quarters for non-S&P firms but not significantly for S&P firms. It is notable that the initial effects of tighter policy on the AP-cost ratio are much larger for smaller firms and for big firms, somewhat similar to the pattern observed for the AR-cost ratio. In contrast, there is little difference between big and smaller firms in their adjustment of the AP-asset ratio in response to tighter policy. Tighter policy increases the AP-asset ratio significantly for several quarters and by a similar magnitude for both S&P and non-S&P firms.¹²

E. Net Trade Credit Use Regressions

To see how monetary policy affects *net trade credit use* ($NTC = AP - AR$), we regress the NTC-sales ratio and the NTC-asset ratio on the current and past policy shocks along with some firm-specific variables, controlling for the fixed-firm effects along with industry-specific seasonal effects. The results are summarized in Figure 7 and Table 4. We discuss first the effect of monetary policy shocks. Discussions on several control variables are in order.

Figure 7 shows the effects of *macro-financial shocks* on NTC. When normalized by sales, neither ΔFFR nor *ROMERS* seems to have a particular effect on NTC, implying that the responses of the AP- and AR- sales ratios to policy shocks largely offset each other, in most cases with one exception. The exception is that *ROMERS* has a significant positive effect in the third quarter ($k=2$) for non-S&P firms.¹³ When normalized by assets, however, tighter policy shows strong negative effects on NTC, and the effects last for more than a year. These negative effects reflect that, upon tighter policy, firms manage their assets by increasing accounts receivable more than accounts payable—consistent with larger positive initial responses in the AR-asset ratio than in the AP-asset ratio, which is more pronounced for non-S&P firms (see Figures 5-6, (c) and (d)). Interestingly, non-S&P firms have to bear at least similar, or possibly even more adverse effects of tighter policy on NTC, compared to S&P firms.¹⁴ Thus, tighter policy induces more net credit supply from smaller firms than from big firms.

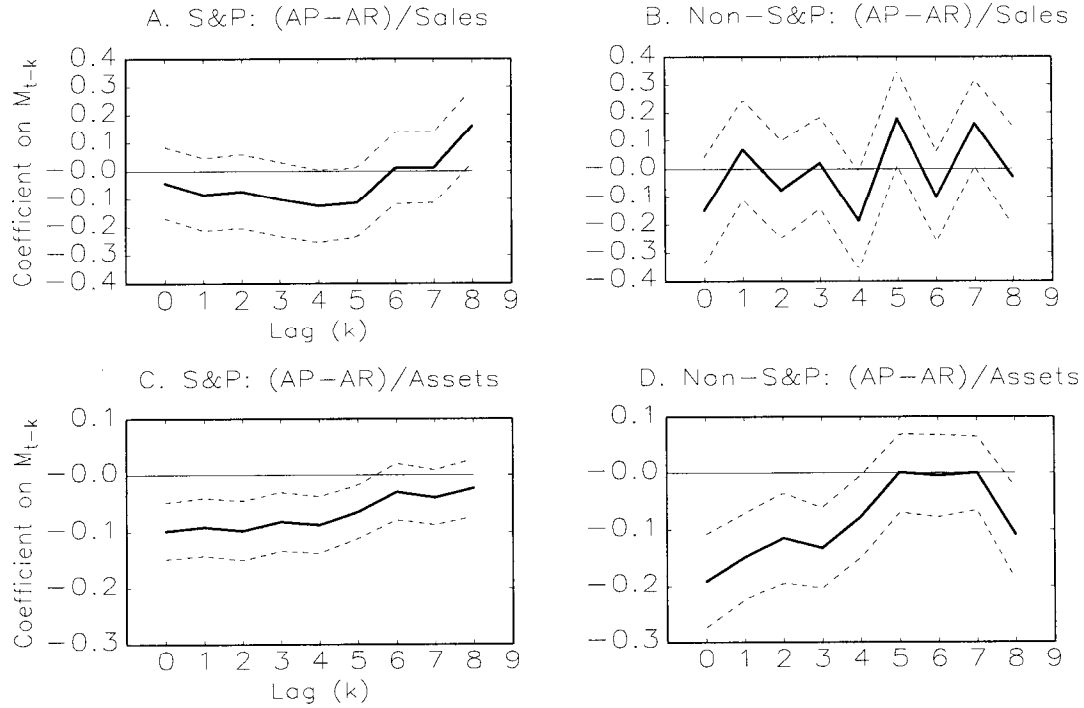
¹² The policy shock coefficients become imprecise when the market interest rate is included, because a combination of the current and lagged changes in the funds rate can be highly correlated with the market interest rate.

¹³ In the aggregate level, AR nets out AP. However, policy shock coefficients can be positive or negative because NTC is weighted by the inverse of sales or assets in regressions—as a result, more weight is given to per dollar adjustment of NTC by smaller firms than to that by large firms—and because NTC may go to consumers and firms not listed on public exchanges.

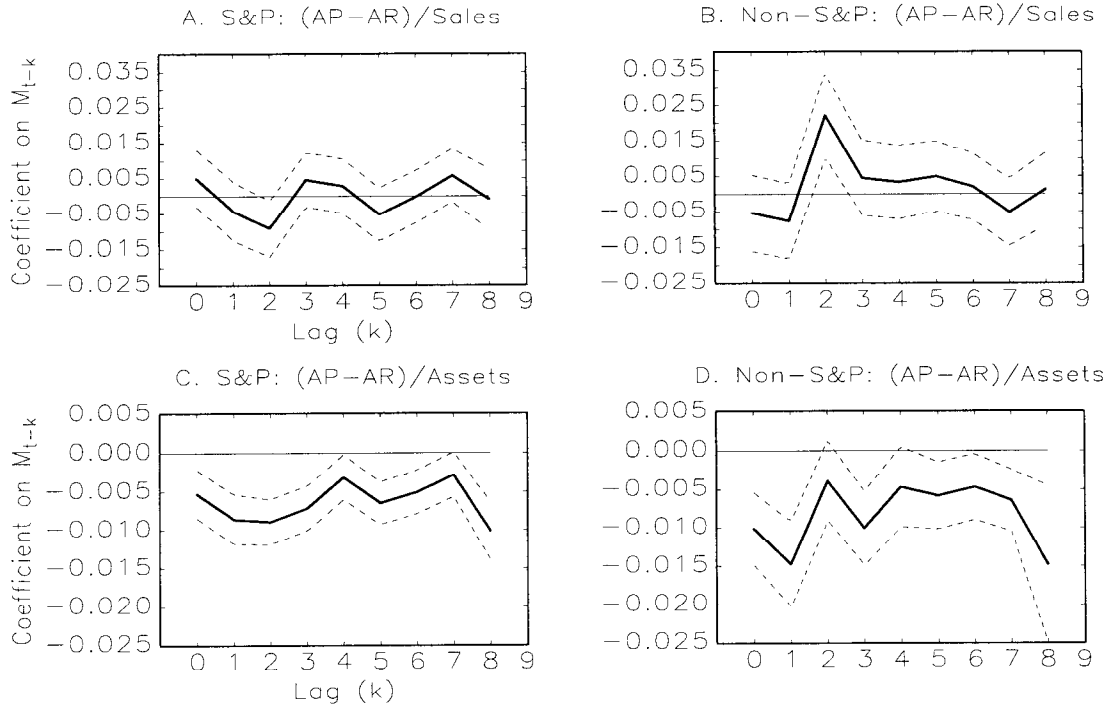
¹⁴ This result is consistent with both AP and AR regressions. Tighter policy initially raises the AR-asset ratio by a similar or even greater magnitude for non-S&P firms than for S&P firms, whereas it does the AP-asset ratio by a similar magnitude to both groups of firms (Figures 5-6).

Figure 7. Effects of Policy Shocks on Net Trade Credit Use

(1) Changes in the Federal funds rate



(2) The Romer dates



Note: The top half depicts the coefficients of the current and lagged changes of the Federal funds rate, and the bottom half depicts the coefficients of the current and lagged Romer dates. Dashed lines are 95 percent confidence intervals. Related regression results are reported in Table 4.

Table 4. Net Trade Credit Use (NTC)

Independent variable	S&P 500 firms				Non-S&P firms			
	NTC/Sales		NTC/Assets		NTC/Sales		NTC/Assets	
$SGROWTH_{j,t}^{plus}$	-0.006 (-0.592)	-0.006 (-0.548)	-0.024** (-5.084)	-0.024** (-5.166)	0.003 (0.336)	0.002 (0.257)	0.000 (0.900)	0.000 (0.840)
$SGROWTH_{j,t}^{minus}$	0.058** (3.233)	0.059** (3.284)	-0.053** (-8.375)	-0.053** (-8.364)	0.129** (7.325)	0.129** (7.343)	-0.143** (-18.090)	-0.105** (-18.265)
$V_{j,t-1}^N / S_{j,t-1}^N$	-0.032** (-4.303)	-0.032** (-4.364)	—	—	-0.055** (-7.926)	-0.054** (-7.942)	—	—
$RE_{j,t-1}^N / S_{j,t-1}^N$	-0.044** (-15.077)	-0.043** (-14.940)	—	—	-0.050** (-17.896)	-0.049** (-17.803)	—	—
$S_{j,t}^N / A_{j,t-1}^N$	—	—	0.004 (0.520)	0.006 (0.701)	—	—	-0.020* (-2.575)	-0.020** (-2.584)
$V_{j,t-1}^N / A_{j,t-1}^N$	—	—	0.117** (11.042)	0.126** (11.838)	—	—	0.069** (6.532)	0.076** (7.164)
$RE_{j,t-1}^N / A_{j,t-1}^N$	—	—	-0.030** (-6.870)	-0.029** (-6.740)	—	—	-0.002 (-1.014)	-0.002 (-1.061)
$\{\Delta FFR_{t-k}\}_{k=0}^8$	[Fig.7(1)A]	—	[Fig.7(1)C]	—	[Fig.7(1)B]	—	[Fig.7(1)D]	—
$\{ROMERS_{t-k}\}_{k=0}^8$	—	[Fig.7(2)A]	—	[Fig.7(2)C]	—	[Fig.7(2)B]	—	[Fig.7(2)D]
\bar{R}^2	0.362	0.362	0.417	0.417	0.443	0.443	0.431	0.432
N	35,184	35,184	37,922	37,922	30,183	30,183	31,916	31,916

Note: The dependent variable is $NTC_{j,t}^N / S_{j,t}^N$ in first two columns and $NTC_{j,t}^N / A_{j,t}^N$ in the next two columns for each type of firms. All regressions, for 1975:4–97:4, control for the fixed-firm effects and the quarter-industry effects. \bar{R}^2 excludes variance explained by the fixed-firm effects. The t -values in parentheses are based on standard errors computed using White's correction for heteroskedasticity. **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

As shown in Table 4, the sales-asset ratio variable has little effect on the NTC-asset ratio for S&P firms but significant negative effects for non-S&P firms. When sales increase relative to assets, accounts payable and receivable increase by similar amounts for S&P firms, but for non-S&P firms, accounts payable increase less than accounts receivable. This implies that smaller firms tend to have less NTC when increasing the scale of operations, compared to large firms.

With respect to sales growth, the NTC-sales ratio shows a greater sensitivity to negative than to positive sales growth, consistent with asymmetric ratchet effects found from both AP- and AR-sales regressions. The NTC-asset ratio also shows a stronger sensitivity to negative than to positive sales growth. This is consistent with the finding for S&P firms that sales growth has a negative effect on the AP-asset ratio and a positive effect on the AR-asset ratio, with a greater sensitivity to negative than positive sales growth. For non-S&P firms, sales growth has a strong, negative effect on the NTC-asset ratio only when sales growth is negative, reflecting that its positive effect on the AR-asset ratio dominates its positive effect on the AP-asset ratio. The

effect of negative sales growth on the NTC-asset ratio is stronger for non-S&P than for S&P firms, which is attributable to its strong effect on the AR-asset ratio of non-S&P firms.

Retained earnings have a significant, negative effect on *net* trade credit use, NTC, in most regressions, except for non-S&P firms when normalized by asset. This is consistent with our AR and AP regression results (Tables 2 and 3): when normalized by sales, retained earnings have a larger, positive effect on AR than on AP for both groups of firms; and when normalized by assets, retained earnings have a negative effect on AP, significant only for S&P firms, but a positive or little effect on AR for both group of firms. Next the inventory stock has negative effects on NTC when normalized by sales but positive effects when normalized by assets. As shown in Tables 2 and 3, inventory affects both AR and AP positively when normalized by sales. However, the positive effect on AP is weaker than that on AR. The positive effect of inventory on the NTC-asset ratio is the result of its positive effect on AP and its negative effect on AR.

F. Creditworthiness and Other Factors

If a firm is more creditworthy, it will have better access not only to financial markets but also to the interfirm liquidity supply. So we examine the effect of creditworthiness on both the extension and the use of trade credit. The credit rating of a firm is an objective measure of creditworthiness or inverse of credit risk. First, firms with credit ratings would be able to offer more trade credit since they have better access to financial markets. Long, Malitz, and Ravid (1993) found a positive (but insignificant) effect of credit rating on accounts receivable. Petersen and Rajan (1997) found that the firm's maximum line of credit, as a proxy for access to financial markets, had a positive and significant effect on accounts receivable. Second, the supply of trade credit decreases with credit risk, as the sellers are concerned about getting their money back. However, riskier firms need more trade credit since banks are reluctant to lend money to them. Thus, the net effect of credit rating on accounts payable is ambiguous.

Using a dummy variable for credit rating, *CRATING*, which takes the value one if firm j has a S&P senior debt rating of BBB or higher at time t , we examine how firms with bond ratings differ in their trade credit position for 1985:1–97: 4. The starting date of this period is dictated by the data availability of bond ratings. Table 5 summarizes the coefficient estimate of *CRATING* in regressions that control for the fixed-two digit industry effects. For S&P firms, it is significant and positive in both AR and AP regressions, regardless of the sales- and asset-normalization specification. This implies that high-quality firms extend more credit since they have better access to financial markets. They also receive more trade credit owing to lower credit risk. With regard to *net* trade credit use, *CRATING* has a significant positive effect on the NTC-sales ratio—suggesting that high-quality firms use trade credit more than they offer—but this has little effect on the NTC-asset ratio. For non-S&P firms, however, *CRATING* has little effect on trade credit. The insignificant effect of bond ratings on non-S&P firms' trade credit position is consistent with the result that financial variables such as retained earnings and short-term debt have little effect on their trade credit position. Note that the positive effect of *CRATING* on accounts receivable for both group of firms is consistent with earlier findings by Long, Malitz, and Ravid (1993) and Rajan (1997).

Table 5. Creditworthiness and Trade Credit

Specification	S&P 500 firms			Non-S&P firms		
	AR	AP	NTC	AR	AP	NTC
Operation scale-normalized specification	0.043** (5.913)	0.028** (5.058)	0.024** (5.663)	0.032* (2.242)	-0.012 (-1.008)	-0.014 (-1.093)
Asset-normalized specification	0.002† (1.782)	0.006** (6.383)	0.002 (1.176)	0.004 (0.350)	-0.003 (-1.377)	-0.009 (-0.910)

Note: Regressions with the credit rating dummy variable (*CRATING*) are estimated for the 1985:1–97:4 period, controlling for sales (in asset-normalized case only), positive sales growth, negative sales growth, inventory, retained earnings, and changes in the funds rate, as well as the industry-seasonality and the fixed-industry effects. The coefficient estimates of *CRATING* are reported with *t*-values (in parentheses) that are computed using White's correction for heteroskedasticity. **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

We also consider factors responsible for the firm-specific behavior of trade credit. First, it takes more time to verify the quality of *high-tech products*. If quality guarantee is the main reason for trade credit, firms in high-tech industries will extend more trade credit. Also, consistent with Long, Malitz, and Ravid's (1993) hypothesis, firms with a longer production cycle will extend more trade credit than those with a shorter cycle. We find that a dummy variable of high-tech industries (SIC code 3400–3999) for both S&P and non-S&P firms has a significantly positive coefficient in AR regressions without fixed-firm effects, implying that high-tech industries extend more trade credit.¹⁵

Second, the operational theory (Emery, 1987; Long, Malitz, and Ravid, 1993) argues that firms with *variable demand* extend more trade credit than firms with stable demand. To see how demand uncertainty affects trade credit, we include a sales volatility variable, measured by standard deviation of the firms' sales. We find that volatility of sales increases the AR-sales ratio when fixed-firm effects are not controlled for, consistent with the operational theory. Not surprisingly, when the fixed-firm effects are controlled for, the effect of sales volatility, being swamped by the fixed-firm effects, becomes largely insignificant.

V. CONCLUSION

Trade credit is an important source of corporate financing and exceeds even the money stock M1. This paper shows that trade credit responds to monetary policy shocks, adding to the endogeneity of credit supply. Accounts payable relative to assets increase significantly with the

¹⁵ Using the ratio of R&D expenses to sales as a proxy of high-tech product in AR regressions, we found a significant, positive coefficient on R&D for S&P firms, consistent with Long, Malitz, and Ravid's hypothesis. However, we found the reverse for the non-S&P firms. Unsurprisingly, the R&D variable becomes insignificant, after controlling for fixed-firm effects.

interest rate, supporting the argument that trade credit is used as a substitute for bank loans to reduce transaction costs of business. We find that firms increase both accounts receivable and payable (relative to their operation scale or total assets)—meaning that the interfirm liquidity market becomes more active—in the face of tighter monetary policy.

We also find that tighter monetary policy increases accounts receivable more than accounts payable, resulting in decreases in *net* trade credit *use* relative to assets. However, we find no evidence that large firms play the role of credit suppliers more actively upon policy shocks than smaller firms. To the contrary, smaller firms may extend trade credit proportionately more than large firms upon tighter policy. Thus, trade credit may temper the propagation of tighter policy by increasing interfirm liquidity per trade or asset, but smaller firms may get less benefit from the increased trade credit.

In estimating reduced-form panel regressions for trade credit, we have controlled for several time-varying firm characteristics. Some noteworthy findings include first an asymmetric ratchet effect between trade credit and the operation scale, while the trade credit-operation scale ratio is stable over longer periods. The results suggest that in the short run, trade credit responds to the operation scale more sluggishly downward than upward. This trade credit response helps moderate the adverse impact of a sharp drop in sales on the liquidity of firms in part buffering the propagation of a precipitous decline in sales at the onset of recessions. Second, inventory and retained earnings affect trade credit but the sign and significance of their effects vary, depending on whether regressions are based on the sales- or the asset-normalized specification. Further, financial variables, such as retained earnings and the short-term debt, and bond ratings, are not key determinants of trade credit for smaller firms as they are for large firms.

The growth of securitization of accounts receivable can increase substitutability between accounts receivable and liquidity. In particular, lower-rated firms may have increased their accounts receivable to gain benefits of commercial paper with the development of asset-backed commercial paper programs (Kavanagh, Boemio, and Edwards, 1992). The resulting shift in financing sources may make the behavior of trade credit vary over time, a topic worthy of further investigation.

Summary Statistics for S&P and Non-S&P Firm Data Sets

Table A1. Summary Statistics of the Main Variables

A. S&P firms

Variable	N (no. of obs.)	Mean	Standard deviation	Minimum (1%) ^a	1st quarter	Median	3rd quarter	Maximum (99%) ^a
$AR_{j,t}^N / S_{j,t}^N$	44,729	0.622	1.455	0.000 (0.021)	0.388	0.560	0.733	147.1 (2.156)
$AP_{j,t}^N / C_{j,t}^N$	43,030	0.573	1.087	0.000 (0.124)	0.298	0.425	0.639	158.7 (2.530)
$NTC_{j,t}^N / S_{j,t}^N$	43,798	-0.249	1.877	-81.75 (-1.509)	-1.509	-0.226	-0.044	243.4 (0.511)
$AR_{j,t}^N / A_{j,t-1}^N$	44,252	0.172	0.107	0.000 (0.011)	0.011	0.162	0.231	1.766 (0.505)
$AP_{j,t}^N / A_{j,t-1}^N$	44,152	0.102	0.072	0.000 (0.013)	0.013	0.085	0.134	0.968 (0.349)
$NTC_{j,t}^N / A_{j,t-1}^N$	43,343	-0.070	0.114	-1.254 (-0.405)	-0.405	-0.063	-0.009	0.697 (0.232)
$SGROWTH_{j,t}$	45,492	0.044	0.261	-0.999 (-0.416)	-0.045	0.027	0.104	16.187 (0.733)
$V_{j,t-1}^N / S_{j,t-1}^N$	44,739	0.614	3.590	0.004 (0.034)	0.302	0.516	0.516	460.8 (1.923)
$SDEBT_{j,t-1}^b$	44,417	-1.132	0.360	-3.251 (-2.099)	-1.347	-1.114	-1.114	1.913 (-0.329)
$RE_{j,t-1}^N / S_{j,t-1}^N$	39,429	1.301	1.100	0.000 (0.065)	0.730	1.118	1.118	67.26 (4.939)
$S_{j,t}^N / A_{j,t-1}^N$	45,086	0.330	0.210	0.001 (0.061)	0.208	0.296	0.296	3.133 (1.190)
$V_{j,t-1}^N / A_{j,t-1}^N$	44,769	0.180	0.133	0.001 (0.006)	0.071	0.159	0.261	0.795 (0.560)
$RE_{j,t-1}^N / A_{j,t-1}^N$	39,187	0.340	0.170	0.000 (0.018)	0.209	0.339	0.339	1.081 (0.751)
$CGROWTH_{j,t}$	43,108	0.048	0.630	-0.996 (-0.410)	-0.044	0.026	0.026	116.6 (0.741)
$V_{j,t-1}^N / C_{j,t-1}^N$	43,068	0.947	1.540	0.004 (0.051)	0.429	0.757	0.757	138.7 (3.538)
$RE_{j,t-1}^N / C_{j,t-1}^N$	37,733	2.373	3.920	0.000 (0.089)	1.001	1.656	1.656	503.14 (14.823)
$C_{j,t}^N / A_{j,t-1}^N$	43,657	0.230	0.170	0.001 (0.028)	0.121	0.194	0.194	2.589 (0.971)

Table A1. Summary Statistics of the Main Variables (Continued)

B. Non-S&P firms

Variable	N (no. of obs.)	Mean	Standard deviation	Minimum (1%) ^a	1st quarter	Median	3rd quarter	Maximum (99%) ^a
$AR_{j,t}^N / S_{j,t}^N$	38,169	0.700	7.283	0.000 (0.000)	0.371	0.605	0.792	998.1 (2.068)
$AP_{j,t}^N / C_{j,t}^N$	36,910	0.510	1.067	0.000 (0.042)	0.255	0.383	0.569	89.6 (2.427)
$NTC_{j,t}^N / S_{j,t}^N$	38,169	-0.318	2.999	-397.8 (-1.439)	-0.516	-0.313	-0.063	237.0 (0.636)
$AR_{j,t}^N / A_{j,t-1}^N$	37,308	0.210	0.130	0.000 (0.000)	0.123	0.208	0.284	4.416 (0.559)
$AP_{j,t}^N / A_{j,t-1}^N$	37,308	0.114	0.087	0.000 (0.006)	0.059	0.092	0.144	3.666 (0.411)
$NTC_{j,t}^N / A_{j,t-1}^N$	37,308	-0.097	0.140	-3.983 (-0.432)	-0.177	-0.105	0.289	1.510 (0.289)
$SGROWTH_{j,t}$	37,984	0.099	5.277	-1.000 (-0.558)	-0.065	0.028	0.128	1021.4 (1.300)
$V_{j,t-1}^N / S_{j,t-1}^N$	37,062	0.752	5.928	0.000 (0.029)	0.353	0.609	0.899	1124.8 (3.000)
$SDEBT_{j,t-1}^b$	37,298	-1.219	0.471	-3.690 (-2.433)	-1.497	-1.223	-0.945	2.214 (0.038)
$RE_{j,t-1}^N / S_{j,t-1}^N$	32,130	1.065	10.397	0.000 (0.000)	0.339	0.719	1.268	1516.0 (4.611)
$S_{j,t}^N / A_{j,t-1}^N$	37,308	0.414	0.285	0.000 (0.058)	0.271	0.368	0.483	15.746 (1.411)
$V_{j,t-1}^N / A_{j,t-1}^N$	37,103	0.243	0.154	0.000 (0.007)	0.129	0.226	0.333	0.930 (0.703)
$RE_{j,t-1}^N / A_{j,t-1}^N$	31,438	0.309	0.372	0.000 (0.000)	0.145	0.288	0.445	55.261 (0.822)
$CGROWTH_{j,t}$	36,237	0.077	0.726	-0.992 (-0.536)	-0.064	0.027	0.131	70.386 (1.293)
$V_{j,t-1}^N / C_{j,t-1}^N$	35,922	1.117	2.094	0.000 (0.040)	0.525	0.922	1.443	246.15 (4.244)
$RE_{j,t-1}^N / C_{j,t-1}^N$	30,948	1.642	3.029	0.000 (0.000)	0.473	1.053	2.059	191.97 (8.839)
$C_{j,t}^N / A_{j,t-1}^N$	36,294	0.290	0.255	0.001 (0.031)	0.160	0.247	0.349	15.651 (1.158)

Note: Distributions of variables for the 1975:1–97:4 period are computed with the S&P 500 data (659 firms in 53 industries) in panel A and the non-S&P 500 data (689 firms in 46 industries) in panel B. *NTC* denotes *net trade credit use* ($AP-AR$). The CPI is used to convert all current dollars into 1992 dollars.

^a Figures in parentheses are 1 percentile (99 percentile) values for the minimum (maximum) column.

^b *SDEBT* is measured by the log of the short-term debt–total assets ratio.

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