Leverage, Monetary Policy, and Firm Investment

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In this paper, I investigate whether the effects of monetary policy on firm investment can be transmitted through leverage. I find that monetary contractions reduce the growth of investment more for highly leveraged firms than for less leveraged firms. The results suggest that the broad credit channel for monetary policy exists, and that it can operate through leverage, as adverse monetary shocks aggravate real debt burdens and raise the effective costs of investment.

Although a number of empirical studies have suggested that changes in monetary policy have large impacts on real economic variables,[1] how the effects are transmitted is still a matter of debate. The money channel, one of the conventional views, stresses the ability of monetary policy to affect interest rates through banks' reserves. According to this view, a reduction of reserves lowers the stock of money, which leads interest rates to rise. Investment and aggregate demand then fall as a result of the higher cost of capital. The puzzle presented by this view is that monetary policy is believed to have a strong influence only on short-term interest rates but not on real long-term interest rates, which are closely associated with the cost of fixed capital investment.[2]

The bank lending channel, an alternative to the money channel, argues that by lowering reserves, a monetary contraction drains deposits from the banking system and hence reduces the supply of loans and aggregate spending. However, empirical studies have not found much evidence that changes in monetary policy cause significant changes in the supply of bank loans.[3] The importance of the bank lending channel, if it exists, may have diminished due to recent financial deregulation and innovations that make it possible for banks to replace their lost deposits with other sources of funds, such as certificates of deposit.

1. See Romer and Romer (1989), Bernanke and Blinder (1992), and Christiano, Eichenbaum, and Evans (1996).

2. Cook and Hahn (1989) find that changes in the federal funds rate caused small movements in long-term (nominal) rates. Their results, however, do not suggest that changes in the funds rate can cause movements in long-term real interest rates, which are the costs of fixed capital investment.

3. Kashyap, Stein, and Wilcox (1993) find that the ratio of bank loans to the sum of bank loans and commercial paper falls after a monetary contraction. However, the fall in the ratio can be explained by the increase in commercial paper issuance rather than by the fall in bank loans. Oliner and Rudebusch (1995) indicate that monetary policy changes do not affect the ratio once one controls for the general shift in lending toward larger firms, which rely less on bank debt than do smaller firms. One possible reason that the supply of bank loans is not responsive to changes in monetary policy is that loan commitments, together with other implicit arrangements, prevent banks from quickly shifting their portfolios in response to a monetary shock.

In short, the conventional theories have not yet provided a satisfactory explanation of how the effects of monetary policy are transmitted. Recently, a number of economists have started to explore the possible role played by capital market imperfections in transmitting and amplifying monetary policy shocks, and a literature on the broad credit channel has emerged.[4] According to the broad credit channel view, because of information asymmetries, lenders are not well informed about the quality of a firm, and they demand a premium on the debt or stock issued by the firm. As the premium on external finance is inversely related to the borrowers' financial conditions, such as net worth, an adverse monetary shock which causes the borrower's financial condition to deteriorate will lead to an increase in its costs of external finance and a decrease in its borrowing abilities. Consequently, the borrower's investment and output will fall.

Only a few empirical studies have been done which find support for the broad credit channel. The noteworthy ones are Gertler and Gilchrist (1994), Oliner and Rudebusch (1996), and Bernanke, Gertler, and Gilchrist (1996), who analyze how small and large firms respond differently to monetary shocks. The researchers are interested in firm size because larger firms have better access to credit markets than do smaller firms.[5] The studies that use data from the *Quarterly Financial Report for Manufacturing Corporations (QFR)* show that, after a monetary tightening, the relationship between internal funds and investment becomes stronger for smaller firms than for larger firms, and that small firms experience substantially more pro-cyclical variation in economic activity than do large firms. A major drawback of the *QFR* data set is that the data are not narrowed down to the firm level. Firms are grouped according to asset size, which prevents researchers from using firm-level indicators to capture firms' financial conditions.

In this paper, I use firm-level data to test whether the effects of the change in monetary policy on firm investment can be transmitted through leverage. The idea that debt transmits exogenous shocks was first proposed by Irving Fisher (1933) in explaining the Great Depression. According to Fisher's "debt deflation" theory, an unanticipated fall in the price level leads to a decline in borrowers' net worth and an increase in their real debt burdens, which results in a decrease in borrowing and investment.

More recent work on capital market imperfections has shed further light on the role of debt in transmitting monetary shocks. More specifically, because of conflicts of interest and informational asymmetries between lenders and borrowers, debt induces agency problems, which in turn lead to a premium on external funds.[6] Since a highly indebted borrower is more likely to default and has a greater incentive to opt for excessively risky projects, the premium on external finance will be higher for firms with lower net worth[7] or higher leverage. Lang, Ofek, and Stulz (1996) show that high leverage indeed slows down a firm's growth of investment and employment. As the premium is inversely related to net worth, Bernanke and Gertler (1989) show that exogenous shocks, such as a decline in productivity, will lower a firm's cash flow and boost the effective cost of investment (Bernanke and Gertler 1989). The fall in investment spending will lower the firm's output and cash flow in subsequent periods, leading to a propagation of the initial shock through credit cycles (Kiyotaki and Moore 1998).[8]

Like productivity shocks, monetary shocks can be amplified by affecting firms' net worth directly and indirectly. First of all, monetary policy has a direct impact on firms' expenses on short-term debt. As interest on firms' short-term debt is closely tied to short-term interest rates, a monetary contraction will increase interest expenses and reduce firms' net cash flows directly. Moreover, monetary contractions are typically associated with declining asset prices, which reduce the value of borrowers' collateral. Hence, changes in monetary policy are expected to have stronger effects on investment for highly leveraged firms than for less leveraged firms.

I test whether the changes in monetary policy can affect firm investment through leverage in Tobin's *Q*-investment model. Section I discusses the methodology and data used in this paper. Section II presents the results. Section III concludes.

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4. See Hubbard (1995) and Bernanke, Gertler, and Gilchrist (1996) for a review of the literature.

5. For example, as small firms tend to be younger firms with shorter track records and high idiosyncratic risks, they are more likely to face liquidity constraints.

6. For example, as Jensen and Meckling (1976) point out, because of limited liability, a firm with a high level of debt has an incentive to opt for excessively risky projects even if these investment projects are value-decreasing. Since lenders anticipate such behavior, they demand a premium on the debt they purchase or bond covenants that restrict the firm's use of debt.

7. The sum of internal funds and the collateral value of illiquid assets.

8. Empirical studies have found that macroeconomic shocks can affect not only investment but also firms' other activities. Sharp (1994) finds that employment growth at small and highly leveraged firms is more responsive to a decline in industrial production.

I. THE METHODOLOGY AND DATA

Under the assumptions of perfect competition, constant returns, and capital as the only quasi-fixed factor, the marginal Q of a firm, which is a sufficient statistic of the firm's investment opportunities, can be approximated by the average Q. The reduced equation for investment is given by[9]

$$\frac{I_{it}}{K_{it}} = \alpha_i + \beta Q_{it} + \lambda_t + u_{it} \ , \quad (1)$$

where I_{it} is capital expenditure, K_{it} is the capital stock, Q_{it} is average Q defined as the ratio of the market value of capital to its replacement cost, α_i accounts for unobserved firm-specific effects, which are assumed to be constant over time, λ_i captures cyclical factors that have common effects on all firms, and u_{it} is a stochastic disturbance term.

Numerous studies have found that cash flow and other financial variables have explanatory power for investment in addition to Q in equation (1), and that the sensitivity of investment to cash flow varies with a firm's age, size, dividend policy and other variables characterizing its financial condition.[10] This suggests that, given capital market imperfections, high premiums on debt and equity cause external funds and internal funds to be imperfectly substitutable. I test whether the changes in monetary policy can affect firm investment through leverage by including leverage and the interaction of leverage with an indicator of monetary tightness together with the other controlling variables in equation (1) and by examining the coefficient on the interaction term.

Several measures of the stance of monetary policy have been proposed. Since there is no consensus about which one is superior, I use several indicators that have been widely used. The first one is the "Romer Date," suggested by Romer and Romer (1990), which is based on the minutes of the Federal Open Market Committee. Seven Romer Dates have been identified from October 1947 to December 1988.[11] On each of these dates, there is a strong indication that the Fed shifted its policy to a more contractionary stance. Although intuitively appealing, the Romer Dates may sacrifice valuable information by focusing only on several extreme episodes. I use the changes in the federal funds rate and the spread between the funds rate and the 10-year T-note rate as the continuous measures of monetary tightness. Bernanke and Blinder (1992) suggest that the federal funds rate, or alternatively, the spread, has been a good indicator of monetary policy for the past 30 years, particularly prior to 1979, as the Fed then implemented its policy primarily through changes in the federal funds rate. All the macro data are monthly and are from the CITIBASE database.

It has been argued that the federal funds rate, as well as Romer Dates, cannot distinguish exogenous from endogenous components (Dotsey and Reid 1992; Hoover and Perez 1994). A change in monetary policy could be a result of the Federal Reserve's response to the change in economic conditions. Therefore, the effects of monetary policy cannot be identified unless we know for sure that the change in policy is due to exogenous shocks. To examine the effects of monetary policy, several studies (e.g., Leeper and Gordon 1994 and Christiano and Eichenbaum 1995) have tried to distinguish between the two components using VAR. However, the success of this approach is somewhat questionable because the VAR reaction functions frequently mischaracterize the Federal Reserve information set and exhibit unstable coefficient estimates (Rudebusch 1998). It is doubtful that using this technique will provide more reliable results in this study. Hence, in this paper I do not use the VAR approach to identify the exogenous component of the funds rate. On the other hand, while the Federal Reserve's actions, to some extent, are based on economic conditions, they are more likely to be responsive to macro-level variables than to firm-level variables, such as firm investment. The endogeneity problem of monetary policy is not a cause for concern in this study.

Firm-level data are drawn from the Manufacturing Sector Master File constructed by Hall (1990) from the Compustat and Over-the-Counter Files. Hall's dataset is based on a broader sample than Compustat. Furthermore, the market value of debt has been calculated. The dataset covers the period from 1959–1987.

In calculating the denominator of Tobin's Q, I have summed up fixed assets at replacement cost with the adjusted value of inventories. The market value of the firm is equal to the sum of the value of preferred stock, the value of common stock, short-term debt, and long-term debt adjusted for its age structure.[12] Investment expenditures include the amount spent for the construction and/or acquisition of property, plant, and equipment. Investment is scaled by the beginning-of-period capital stock, which

9. See Hayashi (1982) for the derivation.

10. One of the variables is cash flow. It was interpreted as the evidence that when a firm is financially constrained, the firm's investment is sensitive to the firm's internal funds, such as cash flow. Another interpretation is that cash flow proxies the firm's internal net worth that is not captured by Q (Fazzari, Hubbard, and Petersen 1988).

11. The four Romer Dates in our sample period are December 1968, April 1974, August 1978, and October 1979.

12. Because the relevant capital gain tax rates and corporate tax rates are not available, I do not use the tax-adjusted Q.

equals the net replacement value of plant and equipment, plus the value of investments in unconsolidated subsidiaries, properties, intangibles, and others, plus the value of inventories adjusted for inflation. The leverage ratio is defined as the ratio of the market value of long-term and short-term debt to the market value of the firm. Market leverage is used because it is a more accurate measure of a firm's indebtedness than book leverage. Cash flow is defined as income before extraordinary items plus depreciation. Cash flow and sales are also scaled by capital stock.

In order to select a clean sample, I deleted any firms that have missing or inconsistent data. I further trimmed the data by deleting the observations below the 1st percentile and above the 99th percentile for each variable. The final sample has 23,055 observations. Table 1 reports the summary statistics for the firm sample.

Since both macro- and firm-level data are used in the same regression, data frequency and timing are important. The macro-level data are monthly, while the firm-level data are annual. Moreover, firms in the sample end their fiscal years in different months. To match up the macro data with the micro data, I construct the indicators of monetary tightness as follows: for Romer Dates, I create a dummy variable which equals one for 24 months after each Romer Date. For the federal funds rate or the spread, I calculate the changes in their averages over a twelve-month period that ends in the firm's fiscal year starting month. In either case, the indicators created will interact with leverage in the investment equation.

TABLE 1

SUMMARY STATISTICS OF SAMPLE VARIABLES

	MEAN	MEDIAN	25TH PERCENTILE	75TH PERCENTILE
(*I/K*)	0.109 (0.001)	0.082	0.050	0.132
Q	3.194 (0.169)	0.981	0.667	1.541
(*CF/K*)	0.120 (0.001)	0.116	0.081	0.158
(*S/K*)	1.875 (0.007)	1.712	1.262	2.234
(*D/V*)	0.398 (0.002)	0.343	0.173	0.566

NOTE: The total number of observations is 23,055. *I/K* is the ratio of investment expenditures to the beginning-of-period capital stock, *Q* is defined as the ratio of the market value of capital to its replacement cost, *CF/K* is the ratio of cash flow to capital stock, *S/K* is the ratio of sales to capital stock, and *D/V* is market leverage. The numbers in parentheses below the means are standard deviations.

II. ESTIMATION RESULTS

The basic investment equation to be estimated is:

$$(2)\quad \frac{I_{it}}{K_{it-1}} = \alpha + \beta_1 Q_{it-1} + \beta_2\left(\frac{CF}{K}\right)_{it-1} + \beta_3\left(\frac{S}{K}\right)_{it-1} + \beta_4\left(\frac{D}{K}\right)_{it-1} + \beta_5\left(\frac{D}{V}\right)_{it-1} * IND_{t-1} + YD_t + ID_i \,.$$

The dependent variable is capital expenditure scaled by beginning-of-period capital stock (investment rate). In addition to beginning-of-period *Q*, the explanatory variables include beginning-of-period ratios of cash flow to capital stock (*CF/K*) and sales to capital stock (*S/K*), beginning-of-period market leverage (*D/V*), and the interaction between the market leverage and an indicator of monetary tightness (*IND*). The lagged value of macroeconomic and firms' financial variables are used because several studies have found that changes in monetary policy have lagged effects on firms' activities (Romer and Romer 1989, Bernanke and Blinder 1992). Using the lagged value also allows me to minimize the endogeneity problem.[13] In all equations, industrial and year dummies are included. My main interest lies in the interaction between market leverage and the indicator of monetary tightness.

Using the Romer Date dummy variable (*RD*) as an indicator of monetary tightness, I obtained the following estimated equation:

$$(3)\quad I_{it}/K_{it-1} = \underset{(5.187)}{0.022} - \underset{(1.766)}{0.005}\,(D/V)_{it-1} - \underset{(2.486)}{0.008}\,(D/V)_{it-1} * RD_t + \underset{(15.86)}{0.009}\,Q_{it-1} + \underset{(41.27)}{0.451}(CF/K)_{it-1} + \underset{(6.624)}{0.005}\,(S/K)_{it-1},\ R^2 = 0.207.$$

The estimates for the coefficients on leverage and the interaction term are both negative and significant at the 10 percent and 5 percent level, respectively. The estimates imply that a 10 percent increase in the leverage ratio reduces the investment rate by 0.05 percent, and by an additional 0.08 percent if a monetary contraction follows. Since the equation includes the year dummy variable, which has captured direct cyclical effects including the effects of monetary policy shocks, I interpret this additional decrease in investment

13. If the contemporaneous value of cash flow, sales, and leverage are used, the estimates for the coefficients of the equation will be biased because those variables are endogenous.

as evidence of a change in monetary policy affecting investment through leverage. In the equation, Q, cash flow, and sales have positive effects on investment, as expected.

As discussed earlier, Romer Dates may miss valuable information about monetary policy by focusing only on several extreme episodes. I replace the Romer Date dummy variable with the changes in the federal funds rate and the spread between the federal funds rate and the 10-year T-note rate as continuous measures of the change in monetary policy and re-estimate the investment equations. In order to control the direct effects of the changes in monetary policy and non-monetary cyclical factors on investment, I also replace the year dummy variable with the lagged changes in the funds rate and industrial production index (ΔIPI) in the investment equation.[14] The investment equation estimated using the lagged change in the federal funds rate (ΔIPI) is:

$$
\begin{aligned}
(4)\quad I_{it}/K_{it-1} &= \underset{(17.58)}{0.046} + \underset{(1.178)}{0.003}\,(D/V)_{it-1} - \underset{(3.341)}{0.252}\,(D/V)_{it-1} \\
&\quad {}^{*}\Delta FR_{t-1} + \underset{(18.52)}{0.010}\,Q_{it-1} + \underset{(43.70)}{0.466}\,(CF/K)_{it-1} \\
&\quad + \underset{(4.815)}{0.003}\,(S/K)_{it-1} - \underset{(3.006)}{0.113}\,\Delta FR_{t-1} + \underset{(6.232)}{0.001}\,\Delta IPI_{t-1} \\
&\qquad R^2 = 0.204.
\end{aligned}
$$

The estimates for the coefficients on the funds rate and the interaction term $[(D/V)_{t-1}{}^{*}\Delta(FFR)_{t-1}]$ are both negative and significant at the 5 percent level, suggesting the change in the funds rate has significant direct and indirect impacts on investment. More specifically, the estimates imply that a 1 percentage point increase in the lagged funds rate reduces the investment rate by 0.113 percent, and by an additional 0.086 percent (0.252*0.343) through leverage for a firm with a median leverage for the sample. For firms with lower- and upper-quartile leverage, the additional decreases in the investment growth are 0.045 percent and 0.142 percent, respectively. As expected, Q, cash flow, sales, and the growth in industrial production have positive effects on investment. However, the coefficient on the leverage ratio becomes positive and insignificant. Since the direct effects of both leverage and change in the funds rate on investment have been controlled for in the equation, the effect of the interaction term on investment does not approximate those direct effects. Hence, equation (4) provides stronger evidence that the effect of the change in monetary policy on investment can operate through leverage than equation (3) does.

14. The change in industrial production index is used to capture the non-monetary cyclical effects. It is a common practice to use the changes, rather than the levels, in macroeconomic variables to indicate business cycles. Hence the change in industrial production index is used here.

The estimation of the investment equation using the spread between the federal funds rate and the 10-year T-note rate (ΔFTR) provides similar results:

$$
\begin{aligned}
(5)\quad I_{it}/K_{it-1} &= \underset{(19.28)}{0.051} + \underset{(1.123)}{0.003}\,(D/V)_{it-1} - \underset{(3.030)}{0.297}(D/V)_{it-1} \\
&\quad {}^{*}\Delta FTR_{t-1} + \underset{(15.13)}{0.008}\,Q_{it-1} + \underset{(44.40)}{0.474}\,(CF/K)_{it-1} \\
&\quad + \underset{(8.122)}{0.005}\,(S/K)_{it-1} - \underset{(2.461)}{0.131}\,\Delta FTR_{t-1} + \underset{(5.148)}{0.001}\,\Delta IPI_{t-1} \\
&\qquad R^2 = 0.186.
\end{aligned}
$$

The estimates for the coefficients on the spread and the interaction term are both negative and significant at the 5 percent level. The estimates for the coefficients on other variables also have similar values and significance levels as those in equation (4).

The results presented above provide evidence that changes in monetary policy can affect investment through leverage. The results are robust regardless of which measure of the change in monetary policy is used. However, since I did not introduce the fixed effects (firm specific effects) in the estimation, the estimated coefficients might be biased. To account for the fixed effects, firm dummy variables may be included in the investment equation. Given the large number of firms, this approach requires estimating more than 800 coefficients, which may produce imprecise results. Therefore, I take an alternative approach and replace all firms' level variables with their first differences in the investment equation. This specification will produce unbiased estimates without introducing firm-specific factors and will allow me to examine the effects of the change in monetary policy on the growth of investment.

Table 2 presents the estimates of the regression of the growth of investment on the lagged change in leverage, the interaction of the change in leverage with the Romer Date dummy variable, the lagged changes in Q, leverage, cash flow and sales, and a constant. For the whole sample, the estimates for the coefficients on the change in leverage and the interaction term are both negative and significant at the 5 percent level, implying that an increase in leverage reduces the growth of investment and will reduce investment more if a monetary contraction follows. In the equation, Q, cash flow, and sales have positive effects on investment, as expected.

The last two columns in Table 2 report the estimates of the investment equations for the two subsamples in which Q is less than and greater than one respectively. As lower Q implies fewer investment opportunities and lower expected net worth, which may aggravate agency problems of debt, I expect that an adverse monetary change will have stronger effects on investment for firms with Q less than one than for firms with Q greater than one. The results show that while the estimates for the coefficients on the interaction terms are both negative, only the one for the sample in which $Q < 1$ is actually significant.

As in estimating equation (2), I once again replace the Romer Date dummy variable with the changes in the federal funds rate and the spread between the funds rate and the 10-year T-note rate as continuous measures of the change in monetary policy and re-estimate the investment equations. To control the direct effects of the change in monetary policy and non-monetary cyclical factors on investment, I also replace the year dummy variable with the lagged changes in the funds rate and industrial production index (ΔIPI) in the investment equation. Table 3 reports the estimates of the investment equation when the lagged change in the nominal federal funds rate is used. For the whole sample, the estimates for the coefficients on the change in the federal funds rate and the interaction term are both negative and significant at the 5 percent and 10 percent levels, respectively, suggesting that the change in monetary policy has larger effects on the investment growth for firms with faster growing leverage. As expected, Q, cash flow, sales, and growth in industrial production have positive effects on investment. The estimate for the coefficient on leverage turns out to be negative and significant as it is supposed to be.

For the sample in which Q is less than one, the estimates for the coefficients on the funds rate and the interaction term are both negative and significant at the 5 percent level. For the sample in which Q is greater than one, the estimates

TABLE 2

ESTIMATES OF INVESTMENT EQUATIONS USING THE ROMER DATE DUMMY

	ALL FIRMS (23,055 OBS)	FIRMS WITH Q<1 (10,638 OBS)	FIRMS WITH Q>1 (8,845 OBS)
Intercept	0.000 (0.010)	0.000 (0.019)	0.047 (1.335)
$\Delta(D/V)_{t-1}$	−0.087* (18.45)	−0.088* (18.57)	−0.079** (2.144)
$\Delta(D/V)_{t-1}$ $*RD_t$	−0.019* (2.159)	−0.016** (1.810)	−0.038 (0.370)
ΔQ_{t-1}	0.008* (8.368)	0.007* (6.604)	0.003 (0.538)
$\Delta(CF/K)_{t-1}$	0.221* (12.72)	0.215* (12.24)	0.270* (2.368)
$\Delta(S/K)_{t-1}$	0.045* (22.51)	0.046* (22.47)	0.048* (3.201)
R^2	0.138	0.135	0.110

NOTES: The dependent variable is the first difference of the ratio of investment to beginning-of-period capital. The sample period is from 1960–1987. *RD* is the Romer episode dummy variable which equals one for the 24 months after each Romer Date; *t*-ratios are given in parentheses below the coefficients. All regressions include industrial and year dummy variables.

* Significantly different from zero at the 5 percent level.

** Significantly different from zero at the 10 percent level.

TABLE 3

ESTIMATES OF INVESTMENT EQUATIONS USING THE CHANGE IN THE FEDERAL FUNDS RATE

	ALL FIRMS (23,055 OBS)	FIRMS WITH $Q < 1$ (10,638 OBS)	FIRMS WITH $Q > 1$ (8,845 OBS)
Intercept	−0.001 (0.675)	−0.002 (1.079)	−0.001 (0.322)
$(D/V)_{t-1}$	−0.087* (20.62)	−0.091* (16.40)	−0.113* (13.13)
$(D/V)_{t-1}$ $*\Delta(FFR)_{t-1}$	−0.565** (1.723)	−0.761* (4.634)	−0.185 (1.299)
ΔQ_{t-1}	0.008* (9.078)	0.016* (4.851)	0.010* (8.383)
$\Delta(CF/K)_{t-1}$	0.247* (14.28)	0.239* (9.656)	0.280* (9.384)
$\Delta(S/K)_{t-1}$	0.047* (22.78)	0.047* (16.12)	0.044* (13.26)
$\Delta(FFR)_{t-1}$	−0.150* (6.189)	−0.183* (6.335)	−0.171* (–3.533)
$\Delta(IPI)_{t-1}$	0.001* (7.240)	0.001* (5.073)	0.002* (4.990)
R^2	0.140	0.141	0.157

NOTES: The dependent variable is the first difference of the ratio of investment to beginning-of-period capital. The sample period is from 1960–1987. $\Delta(FFR)_{t-1}$ is the lagged change in the year average of the federal funds rate; *t*-ratios are given in parentheses below the coefficients. All regressions include industrial dummy variables.

* Significantly different from zero at the 5 percent level.

** Significantly different from zero at the 10 percent level.

for the two coefficients are negative, but the one on the interaction term is not significant at the conventional levels. The results once again show that firms with poor investment opportunities are more vulnerable to monetary shocks than those with good investment opportunities.

To check the robustness of the results, I replace the change in the nominal funds rate with the spread between the funds rate and 10-year T-note rate and re-estimate the investment equations. Table 4 shows that, for the whole sample, when the change in the funds rate is replaced by the spread, the estimates for the coefficients on the spread and the interaction term are both negative and significant at the 5 percent level. The results for the two subsamples are also similar to those in Table 3.

TABLE 4

Estimates of Investment Equations Using the Change in the Spread between the Funds Rate and the 10-Year T-note

	All firms (23,055 obs)	Firms with $Q<1$ (10,638 obs)	Firms with $Q>1$ (8,845 obs)
Intercept	–0.001	–0.003	–0.001
	(0.803)	(1.406)	(0.155)
$\Delta(D/V)_{t-1}$	–0.089*	–0.095*	–0.110*
	(21.23)	(17.34)	(12.73)
$\Delta(D/V)_{t-1}$ $*\Delta(FTR)_{t-1}$	–0.361*	–0.899*	–0.640
	(1.997)	(4.663)	(–1.479)
ΔQ_{t-1}	0.007*	0.016*	0.009*
	(8.595)	(4.828)	(8.100)
$\Delta(CF/K)_{t-1}$	0.235*	0.239*	0.238*
	(13.68)	(9.735)	(8.682)
$\Delta(S/K)_{t-1}$	0.045*	0.046*	0.043*
	(22.30)	(15.89)	(13.35)
$\Delta(FTR)_{t-1}$	–0.155*	–0.186*	–0.159*
	(4.303)	(4.454)	(2.146)
$\Delta(IPI)_{t-1}$	0.001*	0.001*	0.002*
	(6.937)	(4.767)	(4.729)
R^2	0.131	0.137	0.139

Notes: The dependent variable is the first difference of the ratio of investment to beginning-of-period capital. The sample period is from 1960–1987. $\Delta(FTR)_{t-1}$ is the lagged change in the year average of the spread between the funds rate and the 10-year T-note; *t*-ratios are given in parentheses below the coefficients. All regressions include industrial dummy variables.

* Significantly different from zero at the 5 percent level.

** Significantly different from zero at the 10 percent level.

III. Conclusion

Recent work on capital market imperfections suggests that, because of conflicts of interest and information asymmetry between lenders and borrowers, debt introduces agency problems which in turn induce a premium for firms seeking external finance. Adverse monetary policy shocks increase firms' costs of investment by reducing their net worth and aggravating their real debt burdens. Using several indicators of monetary tightness, I have found that monetary contractions reduce investment more for highly leveraged firms than for less leveraged firms. The evidence is stronger for firms with poor investment opportunities than for firms with good investment opportunities.

The results provided in this study are subject to the ongoing debate about whether the correlation between a change in monetary policy and real economic variables merely represents the response of monetary policy to the changes in real economic activity. Since an effective approach does not exist, I did not specifically deal with the endogeneity problem of monetary policy. However, since monetary policy is more likely to be responsive to macro-level variables than to firm-level variables, such as firm investment as analyzed in this paper, the endogeneity problem of monetary policy should not be a cause for concern. Moreover, because the lagged value of the change in the federal funds rate was used in the estimations, the endogeneity problem has been minimized. Therefore, it is reasonable to conclude from this study that a credit channel for monetary policy may exist, and it can operate through leverage, in addition to firm size, as found in previous studies.

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