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Stock prices, firm size, and changes in the federal funds rate target

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Abstract

The Fed targeted the federal funds rate during the period 1974–1979; they returned to that procedure in the late 1980s and have maintained it since then. For both periods, we find that stock prices reacted significantly to unanticipated changes in the federal funds rate target. Consistent with the prediction of imperfect capital market theories, the estimated impact of monetary shocks is significantly larger for small stocks than for big stocks in the late 1970s, when business conditions were typically bad. However, the "size effect" is not present in the 1990s, when business conditions were typically good.

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1. Introduction

Monetary authorities could have some influence on real economic activity through a credit channel if (1) internal funds don't suffice to meet the expense of new projects and (2) external funds are more expensive than internal funds. For example, some firms are dependent on banks for external funds because of asymmetric information between borrowers and creditors in capital markets. A monetary contraction, as argued by Bernanke and Blinder (1992) and many

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others, reduces the amount of credit that banks can extend to these firms and, therefore, lowers investment and production of these firms. Other authors, for example, Bernanke and Gertler (1989, 1995), emphasize the amplification effect of the premium on external funds, which is negatively related to firms' collateral or net worth. That is, a monetary tightening, by reducing firms' net worth, increases the cost of external financing and forces the liquidity-constrained firms to operate at lower scales. Both models predict that monetary policy has a greater impact on small firms than on big firms because small firms usually have less retained earnings and thus are more vulnerable to the adverse liquidity shocks. Also, the asymmetric effect of money is more pronounced during economic recessions, when liquidity is scarce, than during economic expansions, when liquidity is a less important concern to business firms. Many authors, for example, Gertler and Gilchrist (1994), have investigated these implications by looking at whether firms' real economic activity, such as inventory, investment, and short-term debt, respond differently to a monetary tightening. In general, these authors find support for an important role of capital market imperfection in propagating monetary shocks.[1]

Given that stock prices reflect investors' expectations about future earnings, imperfect capital market theories imply that a monetary tightening has a negative effect on stock prices and that such effects, especially during recessions, are stronger for small firms than for big firms. In this paper, we investigate how stock prices reacted to changes in the federal funds rate target in 1974–1979 and 1988–2000, respectively. During both periods, the Fed adopted the federal funds rate targeting procedure and controlled closely the federal funds rate through open market operations. The advantage of our approach, which has been widely used in the literature, is that it avoids the not innocuous identifying assumptions used in the VAR literature.[2] Also, while in the 1990s we experienced the longest economic expansion after World War II, the business conditions haven't been benign over the period 1974–1979: the U.S. economy suffered from severe recessions and high inflation after two major oil shocks and stock prices also fell steeply. These two periods thus provide a unique opportunity to analyze the asymmetric effect of monetary policy on equity prices.

We find that, in both periods, stock prices reacted negatively and significantly to unanticipated changes in the federal funds rate target, but not to anticipated ones.[3] Interestingly, consistent with the prediction of imperfect capital market theories mentioned above, the impact of monetary shocks is found to be significantly larger for small stocks than big stocks in the late 1970s, when business conditions were typically bad. The "size effect," however, is not present in the 1990s, when business conditions were typically good. We also document a similar pattern using portfolios formed according to the book-to-market value ratio.

Our evidence of the state-dependent monetary effect provides support for recent rationales about the anomalous size and value premiums, which pose a serious challenge to the capital asset pricing model (CAPM). That is, size and value stocks are much riskier—for example, they are more influenced by the liquidity supply, as documented in this paper—during economic downturns, when expected stock market returns are high, than during economic expansions, when expected stock market returns are low (e.g., Cochrane, 2000).[4] In other words, as stressed by Merton (1973), the static CAPM fails to explain the cross section of stock returns because betas don't reflect changing market conditions or time-varying investment opportunities. Consistent with this conjecture, recent authors, for example, Guo (2002), show that innovations in the short-term interest rate—proxies for monetary shocks—are a significantly priced risk factor in the intertemporal CAPM and loadings on this factor account for a substantial portion of the size and value premiums.

Early authors, for example, Thorbecke (1997), also provide empirical evidence that small stocks are more sensitive to monetary shocks than big stocks are. However, most of these authors don't look into the issue of whether such a difference is more pronounced during economic recessions than during economic expansions. One important exception is Perez-Quiros and Timmermann (2000), who use a regime-switching model to investigate the state-dependent effect of monetary policy. They also find that expected returns on small stocks are more strongly affected by credit market conditions than returns on big stocks during economic recessions, but not during economic expansions.

The remainder of this paper is organized as follows. Section 2 discusses the data and methodology and Section 3 presents empirical results. We offer some concluding remarks in Section 4.

2. Data and methodology

The Fed conducted monetary policy through a federal funds rate targeting procedure during the period 1974–1979. Although the Fed has never made a formal announcement, Thornton (1988, forthcoming) provides evidence that the Fed returned to the explicit federal funds rate targeting procedure in late 1980s. Under this procedure, an unanticipated target change signals a shift in the stance of monetary policy and, therefore, affects the course of future economic activity. Given that stock prices incorporate information about future earnings, they respond immediately after such a change is perceived. In this section, we discuss the data and methodology that we use to estimate the effect of changes in the federal funds rate target on stock prices in both periods.

2.1. Federal funds rate target changes in 1974–1979

During the period 1974–1979, at each monthly meeting the Federal Open Market Committee (FOMC) decided upon an appropriate range for the federal funds rate in accordance with developments in the economy. Under the direction of the FOMC, the Account Manager at the Federal Reserve Bank of New York (Desk) was responsible for maintaining the federal funds rate within the intended range through open market operations. In practice, the Desk set a target for the federal funds rate at the beginning of each statement week, either based on explicit instructions from the FOMC or based on the Desk's interpretation of directives from the FOMC in response to the monetary aggregates or exchange rates.[5] The Desk also periodically changed the target immediately following the regular FOMC meetings or periodic conference calls. After setting the target, the Desk then entered the market to drain (inject) reserves if the federal funds rate was trading below (above) the target.

The FOMC intentionally kept its operations secret and did not make public announcements of changes in the federal funds rate target. However, by observing open market operations, financial market participants could figure out such changes with reliable accuracy and report the perceived changes in the financial press shortly after. Using the *Wall Street Journal*, Cook and Hahn (1989a) compiled a record of 76 target changes over the period from September

1974 to September 1979 to investigate how yields on Treasury bills and bonds reacted to these changes. Following Cook and Hahn (1989a), among many others, we assume that there is a linear relationship between these target changes and corresponding changes in stock prices:

$$\Delta P_t = a + b \times \Delta \mathrm{FF}_t + \varepsilon_t, \tag{1}$$

where ΔP_t is the log difference between the close and open stock prices on the day when the target change, $\Delta \mathrm{FF}_t$, was reported to have happened. We can estimate Eq. (1) using ordinary least squares (OLS). If the credit channel of monetary transmission is important, the slope parameter, b, should be negative and its absolute value should be larger for small firms than for big firms.

There are some identification issues with Eq. (1), which require further clarification. First, it is possible that changes in the federal funds rate target were the reaction to, rather than the cause of, changes in asset prices. However, Cook and Hahn (1989a) show that this reversed causality is unlikely to be the case in their data because most target changes were implemented with a delay. Moreover, given that the Fed doesn't *directly* react to the stock market, such a concern is irrelevant for stock prices.[6] It is also tempting to suggest that changes in stock prices may have moved systematically with target changes because they were reacting to the same nonmonetary shock. However, evidence shows that such a suspicion is not well grounded.[7] Of 76 changes compiled by Cook and Hahn (1989a), 51 were implemented by the Desk with delays of at least one day and 5 were not related to any actual changes (Cook & Hahn, 1989b); therefore, these 56 changes are not subject to the endogeneity problem. Of the remaining 20 changes, only the January 9, 1978, and October 31, 1978, changes were intended to strengthen the dollar in foreign exchange markets. The other 18 were made to maintain the projected growth rate of M1 and M2 within their tolerance ranges. Given that our results are not sensitive to whether we exclude the January 9, 1978, and October 31, 1978, changes, endogeneity doesn't explain our findings of a significant relationship between stock market movements and target changes either.

Early authors, for example, Smirlock and Yawitz (1985), find that stock prices respond only to unexpected changes in monetary policy and we confirm their result in this paper. Therefore, using raw target changes might bias the slope estimate in Eq. (1). To illustrate this point, we decompose a target change into the unanticipated component (shock_t) and the anticipated component ($\mathrm{anticipated}_t$): $\Delta \mathrm{FF}_t = \mathrm{shock}_t + \mathrm{anticipated}_t$. We assume that stock prices react only to the unanticipated component of target changes:

$$\Delta P_t = \alpha + \beta \times \mathrm{shock}_t + \varepsilon_t. \tag{2}$$

The OLS estimate of β in Eq. (2) is $\hat{\beta} = \mathrm{cov}(\mathrm{shock}_t, \Delta P_t)/\mathrm{var}(\mathrm{shock}_t)$. Given that, by construction, the two components of target changes are orthogonal to one another, it is straightforward to show that the OLS estimate of b in Eq. (1) is:

$$\hat{b} = \frac{\mathrm{cov}(\mathrm{shock}_t, \Delta P_t)}{\mathrm{var}(\mathrm{shock}_t) + \mathrm{var}(\mathrm{anticipated}_t)} = \frac{\hat{\beta}}{1+c}, \quad \text{where} \quad c = \frac{\mathrm{var}(\mathrm{anticipated}_t)}{\mathrm{var}(\mathrm{shock}_t)} \geq 0. \tag{3}$$

Eq. (3) suggests two things. First, the estimated effect of monetary policy on stock prices is biased toward zero in Eq. (1) if we use raw target changes, and the degree of the bias is positively related to the variance ratio of the anticipated component to the unanticipated component. Indeed, as shown below, we observe no effects of raw target changes on stock prices in the 1990s because target changes are mostly anticipated due to the increased transparency in monetary policy. Second, $\hat{b}$ is a linear function of $\hat{\beta}$ and thus has the same sign and, especially, the same order as $\hat{\beta}$. That is, if $\hat{\beta}$ is greater for big stocks than for small stocks, so is $\hat{b}$. Given that market participants frequently missed the timing and/or magnitude of target changes in this period (Thornton, forthcoming), it is reasonable to believe that there is a non-negligible unanticipated component in target changes compiled by Cook and Hahn (1989a). Therefore, although biased, Eq. (1) delivers qualitatively the same inference as Eq. (2).

2.2. Federal funds rate target changes in 1988–2000

Thornton (1988, forthcoming) provides evidence that the Fed has returned to the federal funds rate targeting procedure since the late 1980s. However, there are some noticeable differences between its current practice and its practice in 1974–1979. First, the FOMC changes the target less frequently now than it did in the 1970s: There were a total of 54 changes from October 1988 to February 2000 (Poole & Rasche, 2000), compared with 99 changes from September 1974 to September 1979 (Rudebusch, 1995). Second, the FOMC has decided all target changes at its regular meetings or periodic conference calls since the late 1980s, whereas about half of the target changes compiled by Cook and Hahn (1989a) were decided by the Desk according to its interpretation of directives from the FOMC. Third, the FOMC now sets a target level for the federal funds rate, as opposed to a target range, which was used in the late 1970s. Lastly, after February 1994, the FOMC began to announce the size and motivation of each target change at the conclusion of its meetings, whereas the FOMC did not disclose this information in the 1970s. To summarize, monetary policy is now more transparent and thus more predictable than it was in the 1970s.

As shown in Eq. (3), using raw target changes biases the slope coefficient of Eq. (1) toward zero if the stock market doesn't react to the anticipated component of target changes. This issue is especially pronounced in the 1990s because of the increased transparency and predictability in monetary policy. Therefore, it is important to use a proper measure of *shocks* in the federal funds rate target in the analysis of the effect of monetary policy on stock prices. Many authors use the federal funds rate futures, which have been traded on the Chicago Board of Trade since October 1988, to infer investors' expectations about the future federal funds rate target. In particular, Poole and Rasche (2000) use changes in federal funds rate futures on the day when the federal funds rate target is altered to proxy monetary innovations, and the anticipated component is thus the difference between the actual target change and these innovations. They find that the yields on Treasury bills and bonds respond only to unanticipated changes, but not anticipated ones over the period 1988–2000. Poole and Rasche's approach thus provides a fairly reliable identification of innovations in the federal funds rate target and we use their data in our empirical analysis.[8] Again, we assume a linear relation between changes in stock prices and changes in the federal funds rate target, as in Eq. (1).

2.3. Stock return data

We use the Center for Research in Security Prices (CRSP) daily returns on the value-weighted and equal-weighted market portfolios as proxies for stock market returns. The CRSP also constructs ten portfolios sorted by total value of market equity at the end of the previous month.

Following Perez-Quiros and Timmermann (2000), we use daily returns on these portfolios as proxies to analyze the size effect.[9] We focus on stocks listed on the New York Stock Exchange (NYSE) and the American Stock Exchange (AMEX) but find essentially the same results by including NASDAQ stocks. For robustness, we also analyze six size and book-to-market portfolios constructed by Kenneth French at Dartmouth College.[10] These portfolios, which are constructed at the end of each June, are the intersections of two portfolios formed on size (market capitalization) and three portfolios formed on the book-to-market value ratio. The size breakpoint for year t is the median NYSE market equity at the end of June of year t. Book-to-market value ratio for June of year t is the book equity for the last fiscal year end in $t-1$ divided by market equity for December of $t-1$. The book-to-market breakpoints are the 30th and 70th NYSE percentiles.

3. Empirical results

3.1. Cook and Hahn's data: 1974–1979

Table 1 presents the OLS estimate of Eq. (1) using target changes compiled by Cook and Hahn (1989a). To conserve space, we don't report the intercept. Throughout the paper, we report White's (1980) heteroskedasticity-corrected t-statistics in parentheses with bold denoting significance at the 5 percent level and report the adjusted R^2 in brackets. VW and EW are returns on the value-weighted and equal-weighted market portfolios, respectively. The first through tenth deciles are 10 portfolios sorted according to market capitalization with the order from the smallest stocks (first decile) to the largest stocks (tenth decile).

Column 2 of Table 1 reports the estimation results using all 75 changes in the federal funds rate targets.[11] As expected, the slope estimate is negative for all portfolios. Also, it is statistically different from zero at the 5 percent significance level for all portfolios except the tenth decile, which is significant at the 10 percent level. Fig. 1 plots returns on the equal-weighted market portfolio against target changes, and the solid line is the fitted value from the regression.[12] It

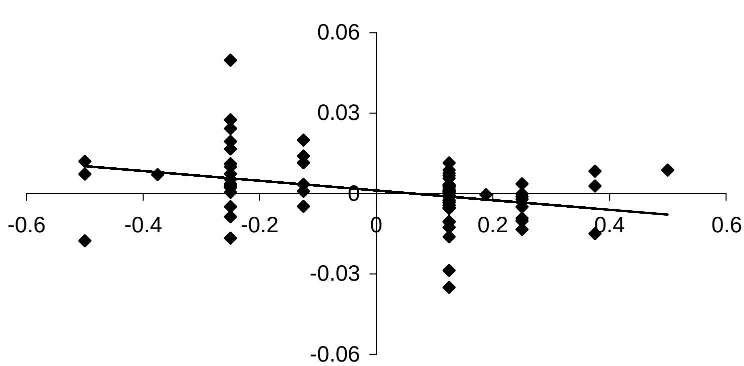

Fig. 1. Returns versus target changes in the 1970s. The figure plots equal-weighted stock market returns against the 75 changes in the federal funds rate target complied by Cook and Hahn (1989a). The solid line is the fitted value based on the regression results in Column 2 of Table 1. See note of Table 1 for details.

Table 1
Effect of target changes on stock prices in the 1970s

Portfolio	All changes	Anticipated changes	Unanticipated changes
VW	**−0.012** (−2.04) [0.07]	−0.000 (−0.02) [−0.03]	**−0.019** (−3.09) [0.24]
EW	**−0.018** (−2.65) [0.11]	0.000 (0.06) [−0.03]	**−0.026** (−3.72) [0.40]
First decile (smallest)	**−0.027** (−3.92) [0.12]	−0.005 (−0.64) [−0.03]	**−0.039** (−3.14) [0.39]
Second decile	**−0.023** (−2.62) [0.09]	0.001 (0.14) [−0.03]	**−0.032** (−2.65) [0.30]
Third decile	**−0.021** (−2.58) [0.09]	0.002 (0.28) [−0.03]	**−0.026** (−2.76) [0.29]
Fourth decile	**−0.020** (−2.64) [0.10]	0.002 (0.23) [−0.03]	**−0.029** (−3.52) [0.39]
Fifth decile	**−0.020** (−2.79) [0.11]	−0.001 (−0.08) [−0.03]	**−0.030** (−3.98) [0.43]
Sixth decile	**−0.018** (−2.54) [0.09]	0.002 (0.19) [−0.03]	**−0.028** (−3.57) [0.39]
Seventh decile	**−0.016** (−2.31) [0.08]	0.003 (0.29) [−0.03]	**−0.026** (−3.49) [0.38]
Eighth decile	**−0.016** (−2.68) [0.11]	0.001 (0.09) [−0.03]	**−0.022** (−4.01) [0.39]
Ninth decile	**−0.016** (−2.70) [0.11]	−0.002 (−0.21) [−0.03]	**−0.020** (−3.24) [0.27]
Tenth decile (biggest)	−0.011 (−1.78) [0.05]	−0.000 (−0.00) [−0.03]	**−0.018** (−2.76) [0.19]

Note. The table reports the OLS regression results of the stock price change, ΔP_t, on changes in the federal funds rate target compiled by Cook and Hahn (1989a), ΔFF_t,

$$\Delta P_t = a + b \times \Delta FF_t + \varepsilon_t.$$

We exclude the November 1, 1978, change from all regressions. Column 2 uses all 75 changes, Column 3 uses 31 changes that were decided by the FOMC and were implemented with at least one-day delays, Column 4 uses 20 changes that were decided and implemented on the same day. VW and EW are the value-weighted and equal-weighted market portfolios, respectively. The first to tenth deciles are 10 portfolios sorted by size (market capitalization). All portfolios are constructed using stocks listed on NYSE and AMEX and are obtained from the CRSP. We report the heteroskedasticity-corrected t-statistics in parentheses and the adjusted R^2 in brackets. Bold denotes significance at the 5 percent level.

shows that stock returns tend to move in the opposite directions of target changes and that there are no obvious outliers. Therefore, monetary tightening had strong negative effects on stock prices in the late 1970s.[13] Moreover, consistent with the theory of imperfect capital markets, the estimated slope decreases monotonically with size from −0.011 for the biggest stocks (tenth decile) to −0.027 for the smallest stocks (first decile) in Column 2 of Table 1. Similarly, the equal-weighted market portfolio is more sensitive to target changes than the value-weighted market portfolio is because the former gives more weight to small stocks.

Cook and Hahn (1989b) provide details about each target change, which enable us to sort out changes that are likely or unlikely to have been anticipated. Of all target changes, 31 were decided by the FOMC at regular meetings or periodic conference calls and the Desk implemented them with at least one-day delays. For the following reasons, these 31 changes are likely to have been well anticipated before market participants detected them by observing open market operations: First, the FOMC changed the target mainly as a response to developments in the economy, which investors might have known before the FOMC meetings. Second, even if some of these target changes were reactions to the economic news that came out during the FOMC meetings, the public might have known the news before the Desk implemented target changes days later. Third, because there might be information leaks from the policymaking process (Waud, 1970), implementation delays further reduced uncertainties of these changes. In Column 3 of Table 1, we report the regression results using these 31 target changes. As expected, the slope estimate is insignificant for all portfolios at the conventional level. Therefore, we confirm that anticipated changes in monetary policy have no effect on stock prices.[14]

There are 20 target changes that were implemented with no delays. In particular, the Desk set 15 of them under its interpretation of the directive from the FOMC in response to the incoming data of monetary aggregates; the other 5 were set under the explicit instructions from the FOMC (4 of which were decided at a periodic conference call). These 20 target changes are likely to have had a large unanticipated component for the following reasons. First, because only one of these changes was decided at a regular FOMC meeting, the private sector did not know in advance whether these changes would have taken place or not. Second, the private sector could not have known the monetary aggregates data before the Fed. Third, the influence of information leaks should not be as severe as the changes that were implemented with delays.[15] Column 4 of Table 1 reports regression results based on these 20 changes, which, as expected, provide strong support for imperfect capital market theories. For example, the slope estimate is negative and is different from zero at the 5 percent significance level for all portfolios. The slope estimate also increases with size from −0.037 for the smallest stocks (first decile) to −0.014 for the biggest stocks (tenth decile). Moreover, the adjusted R^2 and the absolute value of the slope estimate are much larger than their counterparts in Column 2, which are estimated using all target changes.

To investigate whether the different reaction to target changes between small and big stocks is statistically significant, we estimate an equation system of two portfolios using the seemingly unrelated regression (SUR):

$$\Delta P_{t,i} = a_i + b_i \times \Delta \mathrm{FF}_t + \varepsilon_{i,t} \qquad \Delta P_{t,j} = a_j + b_j \times \Delta \mathrm{FF}_t + \varepsilon_{j,t} \tag{4}$$

where $\Delta P_{t,i}$ ($\Delta P_{t,j}$) is the return on the ith (jth) decile portfolio. Table 2 reports the heteroskedastic-consistent Wald statistics of the null hypothesis $b_i = b_j$, with the p-value in parentheses

Table 2
Wald test of different effect of target changes on stock prices in the 1970s

	First decile	Second decile	Third decile	Fourth decile	Fifth decile	Sixth decile	Seventh decile	Eighth decile	Ninth decile	Tenth decile
First decile (smallest)										
Second decile	1.34 (0.25)									
Third decile	2.76 (0.09)	0.94 (0.33)								
Fourth decile	2.69 (0.10)	0.86 (0.35)	0.07 (0.80)							
Fifth decile	2.61 (0.11)	0.56 (0.45)	0.09 (0.76)	0.03 (0.86)						
Sixth decile	3.56 (0.06)	1.58 (0.21)	0.88 (0.35)	1.46 (0.23)	1.96 (0.16)					
Seventh decile	**5.11** **(0.02)**	2.49 (0.12)	2.02 (0.16)	**3.85** **(0.05)**	**6.68** **(0.01)**	2.51 (0.11)				
Eighth decile	**4.28** **(0.04)**	2.05 (0.15)	1.83 (0.18)	2.36 (0.12)	**3.97** **(0.05)**	0.87 (0.35)	0.12 (0.73)			
Ninth decile	**3.82** **(0.05)**	1.79 (0.18)	1.51 (0.22)	1.81 (0.18)	2.66 (0.10)	0.76 (0.38)	0.00 (0.95)	0.14 (0.71)		
Tenth decile (biggest)	**5.34** **(0.02)**	3.01 (0.08)	2.71 (0.10)	3.73 (0.05)	**5.12** **(0.02)**	3.28 (0.07)	2.53 (0.11)	2.98 (0.08)	3.72 (0.05)	

Note. We run the SUR regression of the price changes of *i*th and *j*th decile portfolios, $\Delta P_{t,i}$ and $\Delta P_{t,j}$, on changes in the federal funds rate target compiled by Cook and Hahn (1989a), ΔFF_t,

$$\Delta P_{t,i} = \alpha_i + b_i \times \Delta \text{FF}_t + \varepsilon_{i,t}$$

$$\Delta P_{t,j} = \alpha_j + b_j \times \Delta \text{FF}_t + \varepsilon_{j,t}.$$

We exclude the November 1, 1978, change and use a total of 75 target changes in regressions. The first through tenth deciles are 10 portfolios sorted by size (market capitalization). All portfolios are constructed using stocks listed on NYSE and AMEX and are obtained from the CRSP. The table reports the heteroskedastic-consistent Wald statistics of the null hypothesis $b_i = b_j$, which has a $\chi^2(1)$ distribution. The *p*-value is in parentheses and bold denotes significance at the 5 percent level.

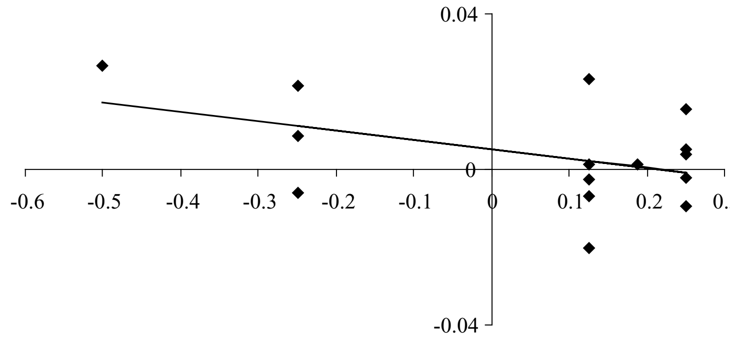

Fig. 2. Accumulated returns versus target changes in the 1970s. The figure plots the accumulated value-weighted stock market returns over three trading days immediately after the target change was reported in the financial press against 15 unanticipated changes in the federal funds rate target compiled by Cook and Hahn (1989a). The solid line is the fitted value based on the regression results in Column 5 of Table 3. See note of Table 3 for details.

and bold denoting significance at the 5 percent level.[16] Column 2 shows that the smallest stocks (first decile) are significantly more sensitive to target changes than big stocks (seventh through tenth deciles) at the 5 percent level. Similarly, the last row indicates that the biggest stocks (tenth decile) are significantly less sensitive than stocks in most other deciles at the 10 percent level. Therefore, consistent with the prediction of imperfect capital market theories, small firms were more sensitive to monetary shocks than big firms were in the late 1970s.

Lastly, Table 3 shows how quickly stock prices adjusted to target changes. We focus on the 20 changes used in Column 4 of Table 1, which are unlikely to have been fully anticipated.[17] Following Cook and Hahn (1989a), we drop changes that are within four business days of one another and the number of observations is reduced to 15. Column 2 shows that the second through eighth deciles responded significantly at the 5 percent level to these changes one day after market participants detected them. While no portfolios responded two days after (Column 3), the value-weighted and equal-weighted market portfolios as well as the tenth decile reacted significantly on the third day following the report in the *Wall Street Journal* (Column 4). Column 5 presents results of the accumulated returns over the three days immediately following the report of target changes, and we find that the value-weighted market portfolio and the tenth decile are significant. As an example, we plot in Fig. 2 the three-day return on the value-weighted market portfolio against target changes. While the accumulated return is positive and large in 3 of 4 target cuts, the response to a target increase is mixed. These results seems to be consistent with underreaction/overreaction of stock prices to news documented by some early authors, for example, Abarbanell and Bernard (1992), Bernard and Thomas (1989, 1990), and Brown, Harlow, and Tinic (1988). However, they should be interpreted with caution because of our relatively small sample size.

3.2. Poole and Rasche's data: 1988–2000

Table 4 reports the OLS estimation results using target changes compiled by Poole and Rasche (2000) over the period 1988–2000. Column 2 shows that, although prices of all portfolios reacted

Table 3
Post-announcement effect of target changes on stock prices in the 1970s

Portfolio	1st day	2nd day	3rd day	Sum of three days
VW	−0.009	0.007	**−0.022**	**−0.024**
	(−1.16)	(1.74)	(5.74)	(−2.15)
	[0.04]	[0.06]	[0.37]	[0.14]
EW	−0.012	0.007	**−0.013**	−0.018
	(−1.24)	(1.61)	(−3.83)	(−1.35)
	[0.08]	[0.06]	[0.16]	[0.04]
First decile (smallest)	−0.003	0.000	−0.015	−0.018
	(−0.291)	(0.04)	(−1.64)	(−0.81)
	[−0.07]	[−0.08]	[0.13]	[0.00]
Second decile	**−0.014**	−0.004	−0.008	−0.026
	(−3.44)	(−0.51)	(−0.82)	(−1.33)
	[0.06]	[−0.04]	[0.03]	[0.08]
Third decile	**−0.013**	−0.008	−0.013	−0.034
	(−2.82)	(−0.80)	(−1.03)	(−1.51)
	[0.04]	[0.04]	[0.11]	[0.16]
Fourth decile	**−0.016**	−0.002	−0.006	−0.024
	(−3.51)	(−0.20)	(−0.56)	(−1.18)
	[0.11]	[−0.07]	[−0.03]	[0.16]
Fifth decile	**−0.019**	−0.002	−0.008	−0.028
	(−3.82)	(−0.18)	(−0.79)	(−1.54)
	[0.13]	[−0.07]	[0.03]	[0.10]
Sixth decile	**−0.016**	−0.001	−0.006	−0.023
	(−2.90)	(−0.12)	(−0.76)	(−1.48)
	[0.07]	[−0.07]	[−0.01]	[0.04]
Seventh decile	**−0.016**	−0.005	−0.008	−0.028
	(−2.19)	(−0.49)	(−0.91)	(−1.95)
	[0.07]	[−0.04]	[0.03]	[0.10]
Eighth decile	**−0.016**	−0.004	−0.002	−0.022
	(−1.97)	(−0.47)	(−0.28)	(−1.84)
	[0.07]	[−0.05]	[−0.07]	[0.05]
Ninth decile	−0.012	−0.005	−0.002	−0.020
	(−1.52)	(−0.56)	(−0.35)	(−1.78)
	[0.03]	[−0.03]	[−0.06]	[0.03]
Tenth decile (biggest)	−0.008	0.006	**−0.025**	**−0.027**
	(−1.11)	(1.43)	(−5.70)	(−2.30)
	[0.03]	[0.02]	[0.40]	[0.17]

Note. The table reports the OLS regression results of the post-announcement stock return, ΔP_{t+k}, on target changes compiled by Cook and Hahn (1989a), $\Delta \mathrm{FF}_t$,

$$\Delta P_{t+k} = a + b \times \Delta \mathrm{FF}_t + \varepsilon_t,$$

where k is number of days after the target change. We focus on the 20 changes that were decided and implemented on the same days. After excluding five changes that are within four business days to one other, we obtain a sample of 15 observations. Column 2 is the first day's return, Column 3 is the second day's return, Column 4 is the third day's return, and Column 5 is the total return over three days after target changes were reported to have happened. VW and EW are the value-weighted and equal-weighted market portfolios, respectively. The first through tenth deciles are 10 portfolios sorted by size (market capitalization). All portfolios are constructed using stocks listed on the NYSE and the AMEX and are obtained from the CRSP. We report the heteroskedasticity-corrected t-statistics in parentheses and the adjusted R^2 in brackets. Bold denotes significance at the 5 percent level.

Table 4
Effect of target changes on stock prices in the 1990s

Portfolio	All changes	Anticipated component	Unanticipated component
VW	−0.003	0.001	**−0.029**
	(−0.71)	(0.30)	(−1.98)
	[−0.01]	[−0.02]	[0.08]
EW	−0.004	−0.002	**−0.026**
	(−1.77)	(−0.75)	(−2.69)
	[0.02]	[−0.01]	[0.17]
First decile (smallest)	−0.003	−0.002	−0.019
	(−1.24)	(−0.61)	(−1.95)
	[0.00]	[−0.01]	[0.05]
Second decile	**−0.007**	−0.005	**−0.033**
	(−2.46)	(−1.50)	(−4.09)
	[0.09]	[0.02]	[0.25]
Third decile	−0.004	−0.002	**−0.025**
	(−1.62)	(−0.86)	(−2.72)
	[0.02]	[−0.01]	[0.15]
Fourth decile	−0.003	−0.001	**−0.019**
	(−1.06)	(−0.31)	(−1.99)
	[0.00]	[−0.02]	[0.07]
Fifth decile	−0.003	−0.001	**−0.021**
	(−1.04)	(−0.19)	(−2.28)
	[−0.00]	[−0.02]	[0.10]
Sixth decile	−0.003	−0.001	**−0.023**
	(−1.30)	(−0.26)	(−2.39)
	[0.00]	[−0.02]	[0.12]
Seventh decile	−0.002	−0.000	**−0.021**
	(−1.05)	(−0.13)	(−2.04)
	[−0.00]	[−0.02]	[0.09]
Eighth decile	−0.003	−0.000	**−0.025**
	(−1.20)	(−0.14)	(−2.09)
	[−0.00]	[−0.02]	[0.11]
Ninth decile	−0.004	−0.001	**−0.031**
	(−1.37)	(−0.37)	(−2.21)
	[0.01]	[−0.02]	[0.12]
Tenth decile (biggest)	−0.002	0.002	−0.030
	(−0.61)	(0.35)	(−1.92)
	[−0.01]	[−0.02]	[0.08]

Note. The table reports the OLS regression results of the stock price change, ΔP_t, on changes in the federal funds rate target compiled by Poole and Rasche (2000), ΔFF_t, which are updated through the end of 2000 with a total of 56 observations:

$$\Delta P_t = a + b \times \Delta FF_t + \varepsilon_t.$$

Column 2 uses actual target changes, Column 3 uses the anticipated component of target changes, and Column 4 uses the unanticipated component of target changes. VW and EW are the value-weighted and equal-weighted market portfolios, respectively. The first through tenth deciles are 10 portfolios sorted by size (market capitalization). All portfolios are constructed using stocks listed on NYSE and AMEX and are obtained from the CRSP. We report the heteroskedasticity-corrected *t*-statistics in parentheses and the adjusted R^2 in brackets. Bold denotes significance at the 5 percent level.

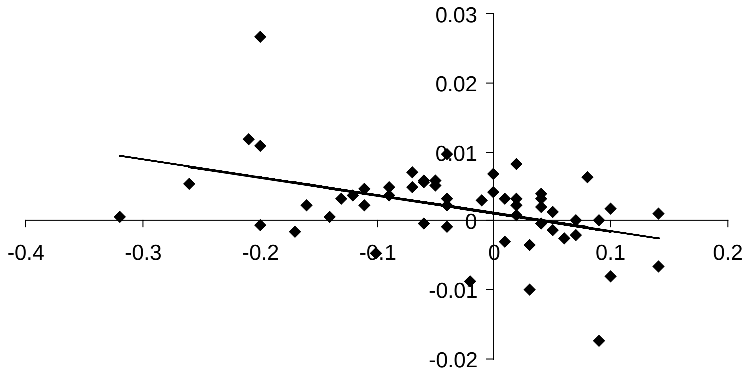

Fig. 3. Returns versus target changes in the 1990s. The figure plots the equal-weighted stock market returns against the unexpected component of the 56 changes in the federal funds rate target complied by Poole and Rasche (2000). The solid line is the fitted value based on the regression results in Column 4 of Table 4. See note of Table 4 for details.

negatively to the actual target changes, only the second decile is significant at the 5 percent level. This result is quite different from that in Column 2 of Table 1, in which all portfolios except the tenth decile are significant at the 5 percent level. This difference reflects the fact that, as mentioned above, target changes have a larger anticipated component in the 1990s than in the 1970s because monetary policy has become more transparent.

Table 4 shows that stock prices did not respond to the anticipated component of target changes either (Column 3). However, an unexpected increase in the federal funds target lowered stock prices, and such an effect is significant at the 5 percent level for all portfolios except the first and tenth deciles, which are significant at the 10 percent level (Column 4). Fig. 3 plots the equal-weighted market returns against shocks in the federal funds rate target, and the solid line is the fitted value from the regression. As in Fig. 1, it shows that a negative (positive) shock is usually associated with a stock price increase (decrease) and that there are no obvious outliers. We find very similar patterns for all other portfolios, which are not reported here to conserve space. Therefore, unexpected changes in the federal funds rate target, but not expected changes, had significant effects on stock prices in the 1990s.

There is a striking difference between Tables 1 and 4: The slope estimate doesn't increase with size in the 1990s. We investigate this issue formally using the Wald test and report the results in Table 5. Consistent with the casual observation, Column 2 shows that the slope estimate of the smallest stocks (first decile) is not significantly different from that of stocks in the other deciles at the conventional level. Similarly, the last row indicates that the slope estimate of the biggest stocks (tenth decile) is not significantly different from that of stocks in the other deciles either. Therefore, consistent with the prediction of a credit channel of monetary transmission, the asymmetric effect of money is less pronounced during economic upturns than during economic downturns.[18]

Lastly, Table 6 reports how stock prices responded to innovations in the federal funds rate target one or more days after the target was changed. Again, we drop target changes that are within four business days of each other and obtain a sample of 45 observations. Column 2

Table 5
Wald test of different effect of target changes on stock prices in the 1990s

	First decile	Second decile	Third decile	Fourth decile	Fifth decile	Sixth decile	Seventh decile	Eighth decile	Ninth decile	Tenth decile
First decile (smallest)										
Second decile	3.36 (0.07)									
Third decile	0.41 (0.52)	2.02 (0.16)								
Fourth decile	0.01 (0.94)	**4.90** **(0.03)**	2.80 (0.09)							
Fifth decile	003 (0.87)	3.76 (0.05)	2.52 (0.11)	0.35 (0.55)						
Sixth decile	0.14 (0.71)	2.10 (0.15)	0.57 (0.45)	1.26 (0.26)	0.70 (0.40)					
Seventh decile	0.03 (0.87)	2.48 (0.12)	1.08 (0.30)	0.15 (0.70)	0.00 (0.97)	0.29 (0.59)				
Eighth decile	0.35 (0.56)	0.83 (0.36)	0.00 (0.96)	0.79 (0.37)	0.69 (0.41)	0.29 (0.59)	1.54 (0.21)			
Ninth decile	0.98 (0.32)	0.06 (0.81)	0.61 (0.43)	1.70 (0.19)	1.86 (0.17)	1.48 (0.22)	3.38 (0.07)	**4.02** **(0.04)**		
Tenth decile (biggest)	0.61 (0.43)	0.06 (0.80)	0.24 (0.62)	0.91 (0.34)	0.86 (0.35)	0.63 (0.43)	1.14 (0.28)	0.68 (0.41)	0.02 (0.88)	

Note. We run the SUR regression of the price changes of *i*th and *j*th decile portfolios, $\Delta P_{t,i}$ and $\Delta P_{t,j}$, on shocks in the federal funds rate target compiled by Poole and Rasche (2000), shock_t, which are updated through the end of 2000 with a total of 56 observations:

$$\Delta P_{t,i} = \alpha_i + b_i \times \text{shock}_t + \varepsilon_{i,t}$$
$$\Delta P_{t,j} = \alpha_j + b_j \times \text{shock}_t + \varepsilon_{j,t}.$$

The first through tenth deciles are 10 portfolios sorted by size (market capitalization). All portfolios are constructed using stocks listed on NYSE and AMEX and are obtained from CRSP. The table reports the heteroskedastic-consistent Wald statistics of the null hypothesis $b_i = b_j$, which has a $\chi^2(1)$ distribution. The *p*-value is in parentheses and bold denotes significance at the 5 percent level.

Table 6
Post-announcement effect of target changes on stock prices in the 1990s

Portfolio	1st day	2nd day	3rd day	Sum of three days
VW	**−0.026**	−0.014	**−0.028**	**−0.068**
	(−2.01)	(−1.08)	(−2.42)	(−2.45)
	[0.08]	[0.01]	[0.11]	[0.15]
EW	**−0.022**	−0.019	**−0.021**	**−0.062**
	(−1.99)	(−1.71)	(−2.21)	(−2.21)
	[0.11]	[0.07]	[0.14]	[0.16]
First decile (smallest)	−0.008	−0.025	−0.016	−0.049
	(−0.74)	(−1.57)	(−1.71)	(−1.85)
	[−0.01]	[0.03]	[−0.01]	[0.02]
Second decile	−0.010	−0.015	−0.015	−0.040
	(−1.02)	(−1.58)	(−1.73)	(−1.65)
	[0.01]	[0.04]	[0.05]	[0.06]
Third decile	−0.015	−0.010	**−0.017**	−0.042
	(−1.45)	(−1.28)	(−2.11)	(−1.82)
	[0.05]	[0.01]	[0.13]	[0.10]
Fourth decile	−0.014	−0.010	**−0.021**	−0.045
	(−1.27)	(−0.99)	(−2.33)	(−1.79)
	[0.03]	[0.01]	[0.19]	[0.10]
Fifth decile	−0.015	−0.015	−0.018	−0.048
	(−1.65)	(−1.34)	(−1.87)	(−1.84)
	[0.05]	[0.04]	[0.12]	[0.10]
Sixth decile	−0.013	−0.023	−0.020	−0.056
	(−1.24)	(−1.80)	(−1.80)	(−1.83)
	[0.02]	[0.08]	[0.11]	[0.11]
Seventh decile	**−0.025**	−0.020	**−0.023**	**−0.068**
	(−1.99)	(−1.51)	(−2.17)	(−2.09)
	[0.12]	[0.06]	[0.15]	[0.16]
Eighth decile	**−0.029**	−0.026	**−0.026**	**−0.081**
	(−2.29)	(−1.93)	(−2.26)	(−2.45)
	[0.14]	[0.11]	[0.13]	[0.20]
Ninth decile	−0.028	−0.023	**−0.030**	**−0.081**
	(−1.96)	(−1.65)	(−2.36)	(−2.36)
	[0.10]	[0.06]	[0.14]	[0.18]
Tenth decile (biggest)	−0.026	−0.011	**−0.029**	**−0.065**
	(−1.89)	(−0.83)	(−2.38)	(−2.43)
	[0.07]	[0.02]	[0.10]	[0.14]

Note. The table reports the OLS regression results of the post-announcement stock return, ΔP_{t+k}, on shocks in the target compiled by Poole and Rasche (2000), shock_t, which are updated through the end of 2000:

$$\Delta P_{t+k} = a + b \times \text{shock}_t + \varepsilon_t,$$

where k is number of days after target changes were implemented. After excluding changes that are within four business days to one other, we get a sample of 45 observations. Column 2 is the first day's return, Column 3 is the second day's return, Column 4 is the third day's return, and Column 5 is the total return over three days after the target change was reported to have happened. VW and EW are the value-weighted and equal-weighted market portfolios, respectively. The first through tenth deciles are 10 portfolios sorted by size (market capitalization). All portfolios are constructed using stocks listed on the NYSE and AMEX and are obtained from the CRSP. We report the heteroskedasticity-corrected t-statistics in parentheses and the adjusted R^2 in brackets. Bold denotes significance at the 5 percent level.

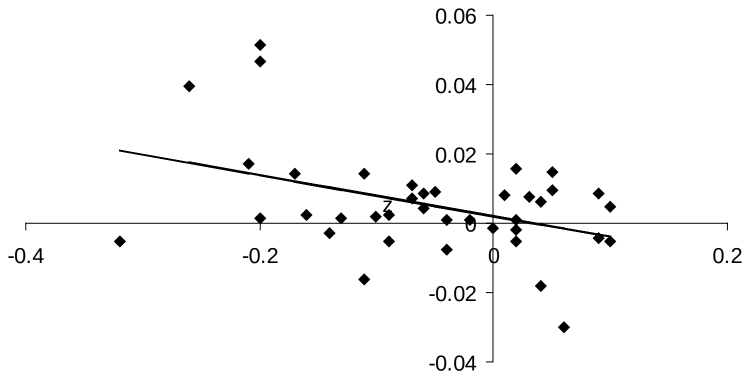

Fig. 4. Accumulated returns versus target changes in the 1990s. The figure plots the accumulated equal-weighted stock market returns over three trading days immediately after the target change was made against the unexpected component of the 45 changes in the federal funds rate target compiled by Poole and Rasche (2000). The solid line is the fitted value based on the regression results in Column 5 of Table 5. See note of Table 5 for details.

shows that the value-weighted and equal-weighted market portfolios, as well as seventh and eighth deciles, responded significantly to monetary shocks one day after target changes were made. While no portfolios reacted on the second day (Column 3), 8 of 12 portfolios responded significantly on the third day (Column 4). Column 5 presents the results using the accumulated return over the three days immediately after target changes. Again, 6 of 12 portfolios, including the value-weighted and equal-weighted market portfolios, are significant at the 5 percent level. Fig. 4 plots the accumulated return on the equal-weighted portfolio against shocks in target changes and the solid line is the fitted value from the regression. As in Fig. 2, while the number of positive returns is much larger than the number of negative returns after negative shocks, the pattern is not clear for returns following a positive shock. Fig. 4 also reveals that our results might be influenced by the three observations at the upper-left corner: We find no sluggish adjustments for any portfolios if we exclude them from the regression.[19] Therefore, again, we need to interpret with caution the evidence of sluggish stock price adjustment documented in Table 6.

3.3. Evidence from book-to-market portfolios

Fama and French (1995) argue that firms with a high book-to-market value ratio are usually the firms that have been in distress for a substantial period. These firms, therefore, are more likely credit-constrained and thus more sensitive to monetary policy than firms with low book-to-market value ratio. Table 7 reports the effect of target changes on prices of six portfolios formed according to size and book-to-market value ratio. The letter S denotes small stocks and L denotes big stocks. B1 is the bottom 30 percentile of book-to-market value ratio, B2 is the next 40 percentile, and B3 is the top 30 percentile. Panel A presents the OLS estimation results using 75 target changes in 1974–1979. Consistent with the conjecture of Fama and French (1995), for both small and big stocks, monetary innovations have larger effects on portfolios of high book-to-market value ratio (B2 and B3) than portfolios of low book-to-market value ratio

Table 7
Effect of target changes on size and book-to-market portfolios

SB1	SB2	SB3	LB1	LB2	LB3
Panel A: Cook and Hahn's (1989a) data: 1974–1979					
−0.013	**−0.014**	**−0.015**	−0.010	**−0.015**	**−0.013**
(−2.06)	(−2.52)	(−2.50)	(−1.55)	(−2.65)	(−2.05)
[0.05]	[0.09]	[0.09]	[0.04]	[0.11]	[0.08]
Panel B: Poole and Rasche's (2000) data: 1988–2000					
−0.021	**−0.020**	**−0.020**	−0.030	**−0.028**	**−0.028**
(−1.702)	(−2.48)	(−2.81)	(−1.60)	(−2.01)	(−2.41)
[0.07]	[0.12]	[0.15]	[0.06]	[0.10]	[0.13]

Note. The table reports the OLS regression results of stock returns, ΔP_t, on changes in the federal funds rate target, $\Delta \mathrm{FF}_t$, compiled by Cook and Hahn (1989a) for the period 1974–1979 and by Poole and Rasche (2000) for the period 1988–2000:

$$\Delta P_t = a + b \times \Delta \mathrm{FF}_t + \varepsilon_t.$$

We use raw target changes for the late 1970s and innovations in target changes in the 1990s. We use returns on the six portfolios formed according to two independent sorts, size and the book-to-market value ratio. For the first letter, S denotes small stocks and L denotes big stocks. For the second letter, B1 denotes lowest 30 percentiles of book-to-market, B2 denotes next 40 percentiles, and B3 denotes the highest percentiles. We report the heteroskedasticity-corrected t-statistics in parentheses and the adjusted R^2 in brackets. Bold denotes significance at the 5 percent level.

(B1). However, in panel B, the case of the unanticipated target changes in 1988–2000, the effect is actually slightly larger for stocks with low book-to-market value ratio (B1) than stocks with high book-to-market value ratio (B2 and B3). Therefore, we find qualitatively similar results using book-to-market portfolios.[20]

4. Conclusion

In this paper, we document a state-dependent effect of monetary policy on stock prices. In particular, small stocks were more sensitive to monetary innovations than big stocks in the late 1970s, when business conditions were typically bad; however, we don't observe such a "size effect" in the 1990s, when business conditions were typically good. While these results are broadly consistent with a credit channel of monetary transmission, a probably more direct reason is that firms are more dependent on debt in the late 1970s than in the 1990s. That is, given that debt is more sensitive to interest rates than equity, a high debt-to-equity ratio further amplified the asymmetry between small firms and big firms in their reaction to monetary shocks in the late 1970s.[21] In contrast, small firms have more retained earnings during the expansionary 1990s and are thus less dependent on external funds, i.e., debt.

We also find support for the conventional wisdom that monetary policy has become more transparent since the 1980s. That is, while stock prices reacted to raw target changes in the 1970s, they did not do so in the 1990s because of the increased transparency and predictability in monetary policy.

Our results shed light on the on-going debate about the size and value premiums. Schwert (2002) argues that the size and value premiums have substantially attenuated in the past decade.

This is possibly because, as shown in this paper, small and value stocks have been less vulnerable to liquidity constraints in recent years and investors thus require a smaller "liquidity" premium on these stocks.

Notes

1. Bernanke, Gertler, and Gilchrist (1996) provide a survey in this literature. Some other authors, for example, Kaplan and Zingales (1997), however, argue that the sensitivity of firms' investment to cash flows is not related to firms' liquidity conditions.
2. Some early authors also analyzed stock market reactions to the innovation in aggregate money (M1). However, as pointed out by Cornell (1983), we cannot draw any conclusive inference from those results because they are consistent with a host of hypotheses. Not surprisingly, we find little evidence that small firms were more sensitive to the unanticipated increase in M1 than big firms in 1980–1982, during which Fama and French (1995) argue that small firms suffered larger losses than big firms did. In contrast, the unexpected change in the federal funds rate target has a natural interpretation as an innovation in monetary policy. There is a caveat though: Stock prices fall after a monetary tightening may also reflect the fact that investors interpret the money tightening as a rise in future inflation (Romer & Romer, 2000). However, we find that a monetary tightening strengthened the U.S. dollar in the foreign exchange markets during both periods, which is inconsistent with the anticipated inflation hypothesis. Also, it is not clear why inflation has asymmetric effects on stocks of different sizes.
3. Smirlock and Yawitz (1985), among many others, also find that stock market indices responded significantly to unexpected changes in monetary policy instruments such as discount rates, but not expected ones.
4. Recent authors, for example, Campbell and Cochrane (1999) and Guo (forthcoming), provide examples in which time-varying expected stock market returns are consistent with rational asset pricing.
5. The Desk usually set the target on Friday morning, the second day in a statement week, after the release of aggregate money supply data. Occasionally, it set the target on Thursday in response to "preliminary indications" of strength or weakness in the aggregates (Cook & Hahn, 1989b).
6. The official objective of the FOMC is to maintain the stability of commodity prices and output. It is thus unlikely that the FOMC reacts to stock prices on a daily basis, although they might react *indirectly* at the business cycle frequency given that stock prices are a leading indicator. More importantly, we find no hint in the FOMC minutes that the changes in the federal funds rate target analyzed in this paper have been intended to react to the development in the stock market.
7. The reasoning below is what Cook and Hahn (1989a) use to rule out the reversed causality, as we mentioned above.
8. We update Poole and Rasche's (2000) data from February 2000 through the end of 2000.
9. Using market capitalization as proxies for size might bias toward finding no difference between small and big stocks because a firm with small market equity might actually

be a big firm. However, given that firms rely more on equity to raise funds in the 1990s than in the 1970s, such a bias cannot explain our main results that monetary policy has larger effects on small stocks than on big stocks in the 1970s but not in the 1990s.

10. We downloaded the data from his website http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.
11. On November 1, 1978, the government announced that it would intervene in the foreign exchange market to support the dollar. This announcement had a large and confounding impact on the financial market. Treasury bill rates increased, intermediate- and long-term rates fell, and stock prices increased sharply. Following Cook and Hahn (1989a), we exclude this observation from our analysis throughout the paper, although the result is qualitatively unchanged if we include it. As mentioned above, the January 9, 1978, and October 31, 1978, changes were also intended to strengthen the dollar. We don't exclude these two observations in the regressions because doing so would not affect our results in any significant ways.
12. We find very similar patterns for all other portfolios.
13. Thorbecke and Alami (1994) also find that stock market indices responded negatively to Cook and Hahn's (1989a) changes in the federal funds rate target.
14. However, yields on Treasury bills and bonds responded significantly to these 31 target changes possibly because, as reported by Cook and Hahn (1989a), bond prices reacted to target changes with delays.
15. However, there is some evidence that these changes may have been anticipated. After excluding five target changes that were within four business days of one another, we find that all portfolios sorted by size except the ninth and tenth deciles reacted significantly to the remaining 15 changes one day before the changes were implemented.
16. We use all 75 target changes in the estimation of Eq. (4) and we find qualitatively the same results using 20 unanticipated changes, as in Column 4 of Table 1.
17. We find no evidence of sluggish adjustment using all 75 target changes possibly because many of these changes have been well anticipated, as shown in Column 3 of Table 1.
18. Interestingly, if we limit our sample to the period 1990–1991, the only recession in the 1990s, we again find that the first decile has the largest response to monetary shocks, although the cross-portfolio difference is not statistically significant.
19. These target changes took place on February 1, 1991, December 20, 1991, and October 15, 1998.
20. However, the Wald test indicates that the difference across portfolios is not statistically significant at the conventional level in both panels.
21. Thorbecke and Alami (1994), for example, find that financial stocks are more sensitive to target changes than stocks of other industries.

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