Monetary Policy and the Bond Market

Tore Ellingsen   Ulf Söderström*

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Abstract

When the Federal Reserve adjusts its target for the federal funds rate, market interest rates usually move, but not always in the same direction as the target. Ellingsen and Söderström (2001) have suggested that long and short interest rates should move in the same direction whenever monetary policy responds to economic developments (endogenous policy), but in opposite directions whenever policy responds to changes in policy preferences (exogenous policy). The current paper interprets the verbal statements of bond market specialists, reported in the financial press, following monetary policy actions by the Federal Reserve. The resulting classification of policy actions successfully explains the response of market interest rates to monetary policy.

Keywords: Event studies, term structure of interest rates, central bank private information.

JEL Classification: E43, E52.

**Ellingsen*: Stockholm School of Economics, Box 6501, 113 83 Stockholm, Sweden, tore.ellingsen@hhs.se, phone: +46 8 736 9260. *Söderström*: IGIER, Università Bocconi, Via Salasco 5, 20136 Milano, Italy, ulf.soderstrom@uni-bocconi.it. Parts of this paper were first circulated as the second half of our working paper "Monetary policy and market interest rates" (the first half of which is now published as Ellingsen and Söderström, 2001) and have also briefly appeared under the title "Classifying Monetary Policy." We are grateful for comments from Jonas Agell, Annika Alexius, Pierluigi Balduzzi, Hans Dillén, Øyvind Eitrheim, Nils Gottfries, Torsten Persson, Weshah Razzak, Asbjørn Rødseth, Glenn Rudebusch, Patrik Säfvenblad, Peter Sellin, Paul Söderlind, Lars Svensson, Jouko Vilmunen, and Anders Vredin, as well as seminar participants at the Stockholm School of Economics, the Institute for International Economic Studies, Uppsala University, the Norwegian School of Economics and Business, Norges Bank and Sveriges Riksbank. We also thank Gisela Waisman and Daniel Hammarsten for research assistance, and the Jan Wallander and Tom Hedelius Foundation, the Tore Browaldh Foundation and Sveriges Riksbank for financial support. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Executive Board of Sveriges Riksbank.

1 Introduction

On average the U.S. Federal Reserve changes its target for the federal funds rate three to four times a year. Some target changes are fully anticipated. Other changes take the financial markets by surprise, and bond prices move substantially as a result. In this paper we shall try to make sense of market interest rate responses to monetary policy, focusing in particular on the movements at the long end of the yield curve.

For obvious reasons, all short-term market rates co-move closely with the target rate. The Fed has usually not allowed the overnight interest rate (which it controls) to depart very much from target, and since the target rate does not change continually the one-month interest rate must stay quite close to the target as well. For the price of long-term bonds the response to current policy is less obvious. On the one hand, long-term interest rates should be linked to short-term rates due to arbitrage considerations. On the other hand, even a temporary change in interest rates might entail a lasting opposite change in expected inflation. The conventional wisdom is that the latter effect ought to be strongest in the long run. Sufficiently long interest rates should fall when the central bank increases its policy rate.

Practitioners have long been aware that macroeconomists' conventional wisdom is wrong. Whenever monetary policy is conducted through interest rate targeting, on average all interest rates tend to move in the same direction as the target rate. Even the interest rates on 10-year and 30-year bonds move quite strongly in the same direction as the target. Cook and Hahn (1989) documented the average positive co-movement in the U.S. bond markets in the 70's. Similar shifts in the yield curve have later been documented for a variety of other countries as well. See, e.g., Battellino et al. (1997) for Australia; Buttiglione et al. (1997) for Italy; and Lindberg et al. (1997) for Sweden. At the same time, there is more to the data than just the average response. As pointed out by Skinner and Zettelmeyer (1995), there are indeed quite a number of occasions where the yield curve tilts, i.e., long and short rates move in opposite directions following a change in the target rate.

In Ellingsen and Söderström (2001) we proposed a simple model that accommodates both the shifts and the tilts of the yield curve. Assuming that the monetary authorities make some rational trade-off between output and inflation volatility, we argued that a policy change can have two distinct origins. Either the policy change is *endogenous*, reflecting that monetary authorities have obtained new information about the state of the economy, or it is *exogenous*, reflecting a change in policy preferences. Upon seeing the target change, bond market participants update their expectations about the state of the economy and the policy preferences, infer what the expected future interest rate targets will be, and price these changes into the yield curve. The model's main prediction is that endogenous target changes should shift the yield curve whereas exogenous target changes should tilt it. A second prediction is that short and long rates move in the same way following an endogenous target change as on an ordinary day when interest rate movements are predominantly driven by non-policy news.

Under Alan Greenspan the U.S. Federal Reserve has consistently used the overnight interest rate (the federal funds rate) as the instrument for monetary policy. Transparency of monetary policy has also increased, and changes in the funds rate target are immediately recognized by market participants. These circumstances make the last decade's U.S. monetary policy a good testing ground for our theory. Two measures are crucial to the test: a measure of the monetary policy change and a measure of whether the policy change is taken to be exogenous or endogenous. Because only an unexpected change in the target rate should move the yield curve, we take the change in the 3-month T-bill rate as our measure of unexpected monetary policy. (Our choice is justified in more detail below.) The measure of exogeneity/endogeneity is perhaps more controversial. In order to determine whether a policy change is interpreted as being exogenous or endogenous, we analyze reports in the financial press. More precisely, we classify each event using reports in the *Wall Street Journal*'s "Credit Markets" column. The column typically reports interviews with both traders and analysts as well as statements from the Fed. For our purposes the opinions of traders is particularly valuable, because it is the traders' opinions that move the bond prices.[1]

The evidence supports the theory. Target changes that market participants classify as exogenous (endogenous) tilt (shift) the yield curve, and endogenous target changes affect the yield curve in much the same way as economic news does. Another and more methodological contribution of our paper is to devise an estimation procedure by which one can use the whole sample of daily interest rate movements to distill the effect of unexpected policy changes from other factors affecting the interest rate on the same day.

Before presenting our analysis in more detail, let us briefly mention some limitations. Since the newspapers primarily report traders' opinions a couple of hours

[1]Some of our readers have asked whether we should not also try to document the intentions of the central bank, but in our view it is irrelevant whether a target change is in fact driven by policy preferences or by economic events. At any given point in time it is traders, and not the Fed, that determine the price of long-term bonds.

after the fact, our measure of exogeneity/endogeneity will not be quite perfect. The cleanest test of our theory would be to ask bond traders in the seconds following the target change how they interpret the policy move and then link this interpretation to the very first movements of the yield curve. This test, which is unfortunately impossible to implement, would be clean for two reasons. First, in the moments following a major economic event it is indeed professional bond traders who move the yield curve, because ultimate investors haven't yet had time to react. Second, immediately after the policy change individual bond traders haven't yet observed the bond price movement caused by the trading of others, and so will have to report their own interpretations rather than a rationalization of the observed yield curve change.

The main problem associated with our test, besides any subjectivity in the classification, is that traders and analysts in trying to make sense of the yield curve movement ex post fail to report their immediate reactions. They might ascribe a tilt to a change in policy preferences and a shift to a change in the economy, even though they themselves initially interpreted the target change differently. However, we think the problem is mild. At the very least our evidence indicates that bond market participants' general understanding of the relationship between Federal Reserve actions and bond prices is in line with the model.

Peersman (2002), using monthly German data, conducts an alternative test of our theory. Changes in monetary policy preferences as well as changes in economic conditions are inferred from macroeconomic data through a structural VAR analysis of monetary policy, and the yield curve movement following a shock to policy preferences is compared to yield curve movements following other economic shocks. Peersman's analysis unambiguously supports the theory. Especially, 3-month and 10-year interest rates move in opposite directions following a monetary policy shock. We are not aware of identical studies for other countries. Evans and Marshall (1998) investigate the effects of exogenous shocks using monthly U.S. data. In two of their three VAR models, the impact on the 10-year interest rate is around 0.05, while in the third model, the impact is close to zero. Thus, the VAR analysis of U.S. data does not appear to support a negative relationship between long and short rates following a change in monetary policy preferences. By comparison, our narrative approach suggests that an unanticipated change in monetary policy has a sizeable impact on long-term interest rates in the U.S. Our estimated coefficient for the 10-year rate is closer to -0.5 than to 0.05. Presumably the difference occurs because the narrative approach ends up being more restrictive in classifying an interest rate movement as being exogenous. As noted by Cochrane and Piazzesi (2002), even sophisticated VAR models cannot easily include all relevant information. The 50 basis point target cut on September 17, 2001, following the September 11 terrorist attacks, furnishes a striking example of an event that a standard VAR model would erroneously classify as a huge shock to monetary policy preferences. Having already dropped about 50 points, interest rates hardly moved following the target change on September 17 (the 3-month rate fell by only 5 basis points). Thus, if policy preferences were seen to shift at all, the change must be described as small. (For our test it therefore does not matter how we classify the event.)

We view our approach as complementary to VAR analysis. Narrative analysis admits studying well-defined narrow events, using daily data. The VAR methodology can use more information because it is not restricted to studying the relatively low number of actual policy events, and it is more immune to the problem of subjectivity. However, VAR estimates necessarily use low-frequency data and can sometimes depend quite heavily both on which data series are included and on the econometric specification.

Some authors, notably Rudebusch (1998) and Cochrane and Piazzesi (2002), have suggested that the change in short-run interest rates following a change in the federal funds rate target is a good measure of the movement in monetary policy preferences. Our analysis rejects that view. Even when the Fed takes the bond market by surprise, market participants often interpret the policy move as providing news about the economy. In this respect our analysis complements that of Romer and Romer (2000), who establish that commercial forecasters update their forecasts based on the actions of the Federal Reserve.[2]

Much of the financial literature on the term structure of interest rates uses latent factor models without interpreting what these factors actually are, e.g., Litterman and Scheinkman (1991), Dai and Singleton (2000). Similarly, the literature on the relationship between the term structure and the short rate focuses on the time series properties of the short rate without explaining the driving forces behind the short rate, e.g., Balduzzi et al. (1997, 1998), Farnsworth and Bass (2003). In contrast, we explain the behavior of the short rate and the term structure in terms of the state of the economy and the objectives of the central bank. This is closely related

[2]There is some disagreement as to whether the Fed has access to private information concerning the state of the economy. While Romer and Romer (2000) find evidence that the Fed has private information about the future path of inflation, Faust et al. (2002) find no such evidence. However, Peek et al. (1999, 2003) argue that the Fed's access to confidential bank supervisory information can be used to improve on forecasts of inflation and unemployment.

to recent work by Ang and Piazzesi (2003), who interpret a latent factor model in terms of macroeconomic variables modeled as an atheoretical VAR system. Our use of a simple but explicit macroeconomic model imposes further structure on the relationship between the short rate and the term structure of interest rates.

The paper proceeds as follows. In the next section, we present the theoretical background to our analysis. Section 3 presents our classification scheme. Section 4 utilizes the classification to explain interest rate movements in the United States. Section 5 offers some final remarks.

2 Theoretical background

In Ellingsen and Söderström (2001) we use a simple dynamic macroeconomic model to investigate the response of market interest rates to changes in the monetary policy stance. In the model, due to Svensson (1997), the economic environment is described by two equations. A Phillips curve relationship determines the rate of inflation (π_t) as a function of the output gap (the percentage deviation of real GDP from potential, y_t):

$$\pi_{t+1} = \pi_t + \alpha y_t + \varepsilon_{t+1}, \tag{1}$$

where $\alpha > 0$ and ε_t is an i.i.d. supply shock with mean zero. An aggregate demand equation determines the output gap as a function of the short (one-period) real interest rate ($i_t - \pi_t$):

$$y_{t+1} = \beta y_t - \gamma (i_t - \pi_t) + \eta_{t+1}, \tag{2}$$

where $0 < \beta < 1$; $\gamma > 0$; and η_t is an i.i.d. demand shock with mean zero.[3]

As is common in the monetary policy literature, the nominal interest rate i_t is determined by a central bank that minimizes a loss function that is quadratic in deviations of inflation from target and the output gap:

$$\min \mathrm{E}_t \sum_{s=0}^{\infty} \delta^s \left[(\pi_{t+s} - \pi^*)^2 + \lambda y_{t+s}^2 \right], \tag{3}$$

where $0 < \delta < 1$ is a discount factor, the parameter $\lambda \geq 0$ determines the central bank's preference for output stability relative to inflation stability, and we shall

[3] The assumption that inflation and output are purely backward-looking processes is only for convenience, and is not crucial; as long as there is some inertia in inflation and output, even a large dose of forward-looking behavior does not qualitatively alter the theoretical predictions.

normalize the inflation target π^* to zero. As in Svensson (1997), this leads to a policy rule for the nominal interest rate in terms of inflation and output:

$$i_t = (1 + A)\,\pi_t + By_t, \tag{4}$$

where A and B are convolutions of the parameters $\alpha, \beta, \gamma, \delta$, and λ. Importantly, both A and B are decreasing in the preference parameter λ; a larger preference for inflation stability (a lower λ) leads to larger monetary policy responses to both inflation and output. Finally, long-term interest rates are assumed to be determined through the expectations hypothesis. Thus, the nominal interest rate on a pure discount bond of maturity n is given by

$$i_t^n = \frac{1}{n}\sum_{s=0}^{n-1} \mathrm{E}_t i_{t+s} + \xi_t^n, \tag{5}$$

where E_t is an expectations operator, and ξ_t^n is the term premium at time t for maturity n, assumed to be independent of monetary policy.

Using the policy rule (4) for the short rate, it can be shown that the n-period interest rate will follow

$$i_t^n = \frac{1}{n}\left\{(1 + A)\,\pi_t + By_t + \left[1 + A\,(1 - \gamma B)\right] X_n \left[\pi_t + \alpha y_t\right]\right\} + \xi_t^n, \tag{6}$$

where

$$X_n = \frac{1 - (1 - \alpha\gamma A)^{n-1}}{\alpha\gamma A}. \tag{7}$$

Thus, our theoretical model gives a closed-form expression for the entire yield curve. (See Ellingsen and Söderström, 2001, for details.)

In this model, changes in the stance of monetary policy, as measured by the nominal interest rate i_t, are due either to the development of inflation and output—what we call endogenous policy—or to shifts in the central bank's policy preferences, captured by the parameter λ—exogenous policy.[4] As demonstrated in Ellingsen and Söderström (2001), the model predicts that market interest rates respond differently depending on the information content of the policy action, that is, on whether the policy move is seen as endogenous or exogenous. If a policy move reveals information about economic fundamentals (shocks to inflation or output), all interest rates move in the same direction. If, on the other hand, the policy shift reveals information about the central bank's preferences (the parameter λ), short and long rates move in opposite directions.

[4] We assume that the other parameters, α, β, γ, and δ, are constant and known to all agents.

The mechanisms behind this result are quite straightforward. If the central bank has access to private information about inflation and output shocks, market participants will draw inference about the underlying fundamentals when observing the central bank's policy actions. An unexpected tightening (an increase in i_t) is then interpreted as the central bank's response to an unobservable shock, which, with persistence in the economy, will lead to a period of tight monetary policy. As a consequence, interest rates of all maturities increase as financial markets adjust their expectations of the future path of policy. On the other hand, when economic fundamentals are observable but the central bank's preferences are not, an unexpected tightening by the central bank will be interpreted as a shift to a more inflation-averse policy regime (that is, a lower λ). The central bank will then respond more aggressively to any given shock, wipe out the effects of the shock faster, and return to a neutral policy stance earlier. As a consequence short rates increase with the central bank rate, but sufficiently long rates fall, since the tight policy will be expected to last for a shorter period.

Although we have chosen to model changes in the central bank's preferences in terms of the preference parameter λ, we obtain similar predictions if instead the policy move reveals information about the central bank's inflation target (π^*), while the preference parameter λ is kept constant. An unexpected tightening of monetary policy is then interpreted as a shift towards a lower inflation target, leading to an increase in short rates but a fall in the long end of the yield curve as long-term inflation expectations are adjusted. We will briefly return to this issue below.

3 Classifying monetary policy events

The business press usually watches monetary policy quite carefully, in particular the policy of the U.S. Federal Reserve. To classify events as endogenous or exogenous, we have been interested in finding a source of information that reports the reaction of important economic agents in a way that is consistent over time. For this reason, we have chosen to focus on the reports of U.S. policy in the daily "Credit Markets" column of the *Wall Street Journal*. On any day, the *Journal* interviews a number of bond traders, analysts, and economists for comments about important events concerning the bond markets. A sample of these comments, along with the journalist's own analysis, is then reported in the *Journal*. Since Fed policy moves are crucial for the development of financial markets, especially the bond market, the news of a change in the monetary policy stance typically dominates the commentaries on days following a Fed move.

It has not always been easy for observers to identify changes in monetary policy. During some periods the monetary authorities have been rather secretive of their interventions. The choice of policy instrument also affects transparency; the interest rate instrument is less ambiguous than money stock measures. Thus, we focus on the period after 1988, when Federal Reserve reverted to interest rate targeting.

From October 1988 to December 2001 the Federal Reserve changed its target level for the federal funds rate on 67 occasions, as reported by Rudebusch (1995) for 1988–92 and the Federal Reserve Bank of New York for 1993–2001.[5] We have attempted to classify each of these occasions on the basis of the *WSJ* reports on the days surrounding changes in the federal funds rate target.[6] While the report the day after the event is usually most informative, we also read the column the same day and the day before, as these columns are informative of "the market's frame of mind" at the time of the policy move.

An event is classified as exogenous if it is connected to the policy preferences of the Fed. This may happen, for example, when new members enter the FOMC, or when key members (as the Chairman) are believed to have changed their mind about the desirable trade-off between inflation and output variability. If there is no indication that policy preferences may have changed, the event is classified as endogenous. Often, the *Wall Street Journal's* advance speculations reveal whether there is more uncertainty about policy preferences or about economic developments, and the *Journal's* comments after the events are typically focused on the same set of issues as its comments before the events.

Our procedure implies that endogenous events are defined residually. While this may initially look like a bias in favor of the "endogenous" category, it could easily be the opposite. The reason is that *any* emphasis on policy preferences is sufficient to classify the event as exogenous, even though many of these newspaper reports will devote as much or more attention to the state of the economy.[7] Thus, several of our classifications are rather shaky. It is also sometimes unclear whether policy

[5] Roley and Sellon (1996) argue that some of the target changes reported by Rudebusch do not correspond to actual decisions to change policy. Since some of these cases were apparently noticed by market participants (see the full classification in Appendix 5), we choose to use the Rudebusch series.

[6] The reports for 1988–97 were taken from the printed version of *Wall Street Journal Europe*, while those for 1998–2001 are from the online version of *Wall Street Journal*.

[7] The fact that information about the economy is released also on policy days classified as exogenous will tend to bias the estimated yield curve response on these days. We therefore adjust the response to distill the true exogenous component of policy, see below.

preferences are mentioned or not. (The sensitivity of our empirical results to the classification scheme is discussed in more detail in Section 4.4.)

Perhaps the cleanest case of an exogenous event in our data set is August 16, 1994. The 50 basis point increase in the federal funds rate target is interpreted as a "clear signal that the Fed intends to fight inflation pressures", and the move will lead to an "improvement in inflation psychology." In contrast, there are many events where the *Wall Street Journal* makes no comment about the Fed's resolve, and instead focus the report entirely on economic issues. For example, after the move on September 13, 1991, the *Journal* writes: "The U.S. Federal Reserve's latest move to cut interest rates reflects its uneasiness about the slow growth of the money supply and the disappointingly torpid economic recovery," and after December 19, 1995, the *Journal* reports plainly "inflation has been somewhat more favorable than anticipated." An example of a difficult case is December 20, 1989, when the *Journal* reports that "Coming right after an FOMC meeting, they would not have entered the market unless they wanted to send a clear signal that policy had changed", which could be interpreted as either endogenous or exogenous.

In ten cases, mostly during 1988 and 1989, the *Journal* makes no mention of the policy move, leading us to conclude that market participants never noticed the change in the funds rate target. These cases are omitted from the sample of target changes, and treated as non-policy days.[8] On seven occasions, the monthly employment report from the Bureau of Labor Statistics was released on the same day as the policy move. Likewise, on one occasion (February 2, 2000), the news report was dominated by the Treasury announcing plans to trim debt sales. On these particular dates, we cannot separate the effects on financial markets of the information release from the effects of policy. Consequently, these cases are also treated as non-policy days.[9]

Of the remaining 49 events of policy changes, on two occasions (January 9, 1991,

[8]During this early part of the sample, the Fed did not target the funds rate very closely. From 1990 on, target changes reported by the Federal Reserve Bank of New York are always attributed to one particular day. During 1988 and 1989, however, the New York Fed often reports gradual changes in the target, over several weeks or months. It is thus not surprising that many of these changes were overlooked by market participants on the exact day reported by Rudebusch (1995).

[9]Naturally, there is some information in the data for these days as well. The problem is that when estimating the policy innovation with the 3-month rate (see below), there is always some measurement error, and on days when other significant information is released on the same day as monetary policy is adjusted, this measurement error is expected to be very large. Therefore we choose not to use these observations. That the employment report is important for the conduct of monetary policy is obvious from the newspaper commentaries. For some empirical evidence, see Cook and Korn (1991) or Balduzzi et al. (2001).

and October 31, 1991) the change in the funds rate target was noticed by financial market participants on the day *before* the date reported by Rudebusch (1995). On these occasions we choose to use the interest rate response of the day when the information seems to have reached the markets.

Of these 49 events, 32 were classified as endogenous responses to the state of the economy, and 17 as caused by exogenous changes of the Fed's preferences.[10] Table 1 summarizes the classification. A detailed description of all events, with the relevant quotes from the *Wall Street Journal*, is found in the Appendix.

We end this section by stressing again that the classification presented here should be seen as tentative. Alternative classifications as well as robustness checks are discussed in Section 4.4.

4 The effect on market interest rates

We now want to demonstrate that the classification scheme is useful for explaining the behavior of the bond market.

4.1 Empirical interpretation

In the theoretical model, the central bank adjusts its interest rate in every period, as new information about the economy is revealed. In reality, central banks adjust their monetary policy stance at discrete intervals, after accumulating a sufficient amount of information. Consequently, when translating our results to empirically testable hypotheses, we need to separate days on which the central bank does not intervene from days on which it does.

On days when the central bank rate is left unchanged, the information revealed predominantly concerns the state of the economy, and since no information is revealed from the central bank's policy moves, this information is symmetrically observed. Consequently, on these days, interest rates should move in the same direction.

On days when the central bank does act to change its interest rate instrument, however, its private information may be revealed. Then our theory predicts that if the central bank action reveals information about the economy, all interest rates should move in the same direction, with long rates reacting less than short rates,

[10] The fact that we identify 17 exogenous events does not necessarily imply that the Fed actually changed its preferences on 17 occasions, only that market participants changed their perception of the Fed's policy preferences 17 times.

Table 1: Summary of classification

Endogenous	Exogenous	Excluded	Unnoticed
Dec 15, 1988	Jan 5, 1989	Dec 7, 1990	Oct 20, 1988
Feb 23, 1989	Feb 14, 1989	Feb 1, 1991	Nov 17, 1988
Jun 6, 1989	Feb 24, 1989	Mar 8, 1991	Nov 22, 1988
Jul 7, 1989	Dec 20, 1989	Dec 6, 1991	Dec 29, 1988
Jul 27, 1989	Jul 13, 1990	Jul 2, 1992	Feb 9, 1989
Oct 29, 1990	Dec 19, 1990	Sep 4, 1992	May 4, 1989
Jan 8, 1991	Apr 30, 1991	Feb 4, 1994	Aug 10, 1989
Aug 6, 1991	May 17, 1994	Feb 2, 2000	Oct 18, 1989
Sep 13, 1991	Aug 16, 1994		Nov 6, 1989
Oct 30, 1991	Nov 15, 1994		Nov 14, 1990
Nov 6, 1991	Jan 31, 1996		
Dec 20, 1991	Aug 24, 1999		
Apr 9, 1992	Nov 16, 1999		
Mar 22, 1994	Mar 21, 2000		
Apr 18, 1994	May 16, 2000		
Feb 1, 1995	May 15, 2001		
Jul 6, 1995	Sep 17, 2001		
Dec 19, 1995			
Mar 25, 1997			
Sep 28, 1998			
Oct 15, 1998			
Nov 17, 1998			
Jun 30, 1999			
Jan 3, 2001			
Jan 31, 2001			
Mar 20, 2001			
Apr 18, 2001			
Jun 27, 2001			
Aug 21, 2001			
Oct 2, 2001			
Nov 6, 2001			
Dec 11, 2001			

This table reports the dates of each change in the Federal Reserve's target for the federal funds rate from October 1988 until December 2001. The events are classified by the authors according to the interpretation of bond market participants of the reasons underlying the target change, as reported in the *Wall Street Journal*. "Endogenous" events were interpreted as responses to the state of the economy, "exogenous" events were interpreted as reflecting changes in the Federal Reserve's policy preferences. Unnoticed events were not reported in the *Wall Street Journal*, excluded events coincided with the publication of the employment report from the Bureau of Labor Statistics or other significant news.

but if the central bank move reveals information about the bank's preferences, short and long rates should move in opposite directions.

Observe that fully anticipated changes in monetary policy will, by definition, not lead to any change in market interest rates. Thus, it is the unexpected component of the policy move that concerns us. We choose to measure this component as the one-day change in the 3-month treasury bill rate. The 3-month rate is sufficiently short to be mainly determined by current and expected future policy actions, but of sufficiently long maturity to avoid noise from expectation errors due to the exact timing of Fed actions.[11] On trading days when the Fed leaves its target level for the federal funds rate unchanged, the change in the 3-month rate is interpreted as a measure of expected future changes in the Fed's policy stance in response to new information on that day. On days when the funds rate target level is adjusted, any movement in the 3-month rate is, as a first approximation, interpreted as the surprise element of the policy action, that is, the policy innovation. Thus we can compare the response of market interest rates to policy innovations on exogenous and endogenous policy days, and also compare with days when the Fed has left its funds rate target unchanged, but new information has led bond markets to update their expectations of Fed policy.

4.2 Basic empirical results

Daily data on interest rates from October 3, 1988, to December 31, 2001, were taken from the FRED database of the Federal Reserve Bank of St. Louis. Short-term interest rates (3-month and 6-month rates) are treasury bill rates from the secondary market, and longer-term interest rates (of 1, 2, 3, 5, 7, 10, and 30 years' maturity) are treasury bond rates of constant maturity.[12]

Using these data, we want to estimate how market interest rates move both in

[11] We acknowledge that the 3-month rate is a noisy indicator of policy expectations, since it is bound to be affected also by other factors than policy considerations. However, we believe that there are no better alternative measures of daily policy innovations. Using a shorter rate as a measure of policy (e.g., the innovation in the funds rate target) is problematic if bond markets anticipate the size of a policy move correctly, but not the actual timing of policy. The measured policy innovation then overestimates the true innovation. Harvey and Huang (2002) present evidence that markets are better at predicting the direction of Fed actions than their timing. Also, as shown by Söderström (2001), market expectations of Fed policy extracted from the federal funds futures market vary systematically across months and trading days, and thus are less reliable as measures of the expected component of policy moves on a daily basis.

[12] Note that the longer-term interest rates used in this empirical analysis are not interest rates on pure discount bonds, in contrast to the theoretical analysis. A cleaner test would use estimated zero-coupon yields of the type computed by McCulloch (1990). Unfortunately, these estimates are not currently available on a daily basis.

response to actual Fed policy moves and in anticipation of Fed reactions to new information. We thus estimate the regression

$$\Delta i_t^n = \alpha_n + \left(\beta_n^{\mathrm{NP}} d_t^{\mathrm{NP}} + \beta_n^{\mathrm{End}} d_t^{\mathrm{End}} + \beta_n^{\mathrm{Ex}} d_t^{\mathrm{Ex}}\right) \Delta i_t^{3\mathrm{m}} + \upsilon_t^n, \tag{8}$$

where Δi_t^n is the change in the n-maturity interest rate on day t; $\Delta i_t^{3\mathrm{m}}$ is the corresponding change in the 3-month rate, that is, our measure of policy innovations; and d_t^j is a dummy variable taking the value one if day t belongs to group j and zero otherwise.

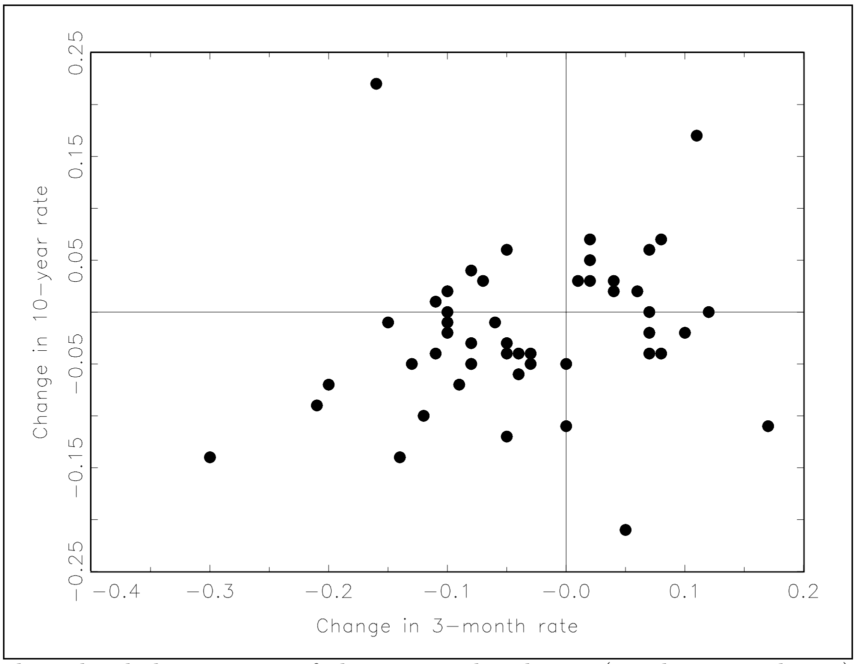
To the group *NP* (non-policy) belong all days when the Fed has left its funds rate target unchanged. On these days, the 3-month rate moves in anticipation of future Fed policy reactions to information released on day t, and longer interest rates may respond to this "policy innovation." The group *End* corresponds to policy days classified as endogenous, and *Ex* are exogenous policy days. The obtained estimates of β_n^j are thus the estimated responses of the n-maturity interest rate to a policy innovation of type j.[13]

Before resorting to statistical methods, let us eyeball some of the data. Figures 1–3 show scatter plots of the change in the 10-year rate against the change in the 3-month rate on the classified policy days. Figure 1 shows the relationship for all 49 policy events, and Figures 2 and 3 break up the relationship into endogenous and exogenous events. In Figure 1 there is a clear positive relationship between the long rate response and the policy innovation, although there are some odd observations. For the endogenous events in Figure 2, the positive correlation is obvious, whereas the exogenous events in Figure 3 show a more ambiguous picture.

One observation in the upper left quadrant of Figure 2 clearly stands out. Although classified as endogenous, the 10-year rate increased by 22 basis points after a fall in the 3-month rate by 16 basis points (and a 50 basis point decrease in the funds rate target). This observation is from January 3, 2001, which was the first in a series of rate cuts by the Federal Reserve to revive the weak economy. The newspaper reports tell us that although the rate cut was seen as increasingly likely, most analysts had focused on the employment report that was to be released later that week. Before the cut, bond markets had gained significantly as bad news about the economy had prompted investors to move from stocks to bonds. When the

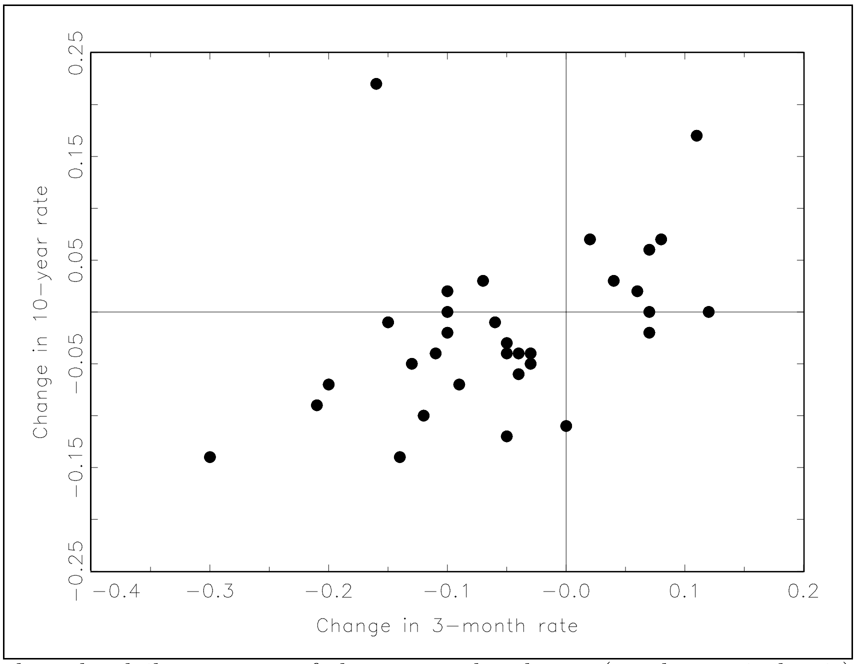
[13] Estimating all parameters in a single regression, we assume that the residual variance is constant across the three groups of policy events. Estimating separate regressions for the different groups gives the same parameter estimates (apart from small changes due to the new constant terms), but with slightly different standard errors. Our results are not very sensitive to such an exercise.

Figure 1: Response of the 10-year interest rate to a change in the 3-month rate: classified policy events



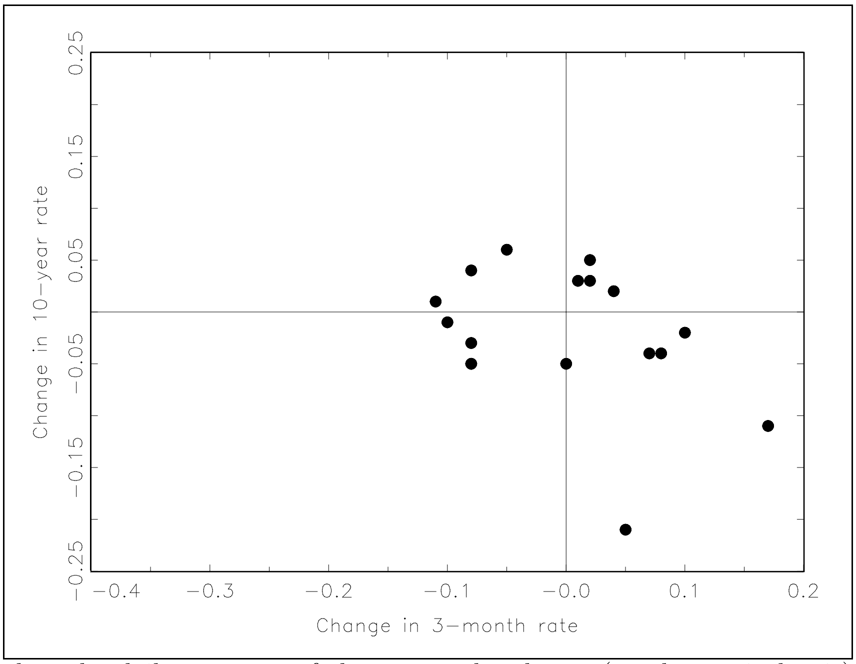
This figure plots the daily response of the 10-year bond rate (on the vertical axis) against the daily change in the 3-month T-bill rate (on the horizontal axis) on the 49 policy events in Table 1 classified as either endogenous or exogenous.

Figure 2: Response of the 10-year interest rate to a change in the 3-month rate: endogenous policy events



This figure plots the daily response of the 10-year bond rate (on the vertical axis) against the daily change in the 3-month T-bill rate (on the horizontal axis) on the 32 policy events in Table 1 classified as endogenous.

Figure 3: Response of the 10-year interest rate to a change in the 3-month rate: exogenous policy events



This figure plots the daily response of the 10-year bond rate (on the vertical axis) against the daily change in the 3-month T-bill rate (on the horizontal axis) on the 17 policy events in Table 1 classified as exogenous.

Fed surprised the markets with an early easing of policy, these movements were reversed, and long-term rates increased. Thus, market participants clearly interpreted the move as due to the weak economy, justifying the endogenous classification. Although this observation is an extreme outlier, in the end it does not matter much for our results.

When estimating equation (8), the main hypothesis to be examined is that long-term interest rates respond positively to endogenous policy moves but negatively to exogenous moves:

Hypothesis 1 *For large n, $\beta_n^{Ex} < 0 < \beta_n^{End}$.*

The discussion in Section 4.1 also leads us to test the hypothesis that all rates respond similarly (positively) to endogenous policy innovations as to the information released on non-policy days:

Hypothesis 2 $\beta_n^{NP} = \beta_n^{End} > 0$ *for all n.*

And finally, our theoretical model predicts that for all maturities, the response to endogenous or non-policy events falls with maturity:

Hypothesis 3 β_n^j *is decreasing in n for $j = NP$, End.*

Table 2: Interest rate response to a policy innovation

	6 mth	1 yr	2 yr	3 yr	5 yr	7 yr	10 yr	30 yr
α_n	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_n^{NP}	0.73**	0.73**	0.70**	0.66**	0.60**	0.52**	0.47**	0.33**
	(0.02)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
β_n^{End}	0.94**	0.91**	0.78**	0.71**	0.59**	0.42**	0.34**	0.24*
	(0.04)	(0.07)	(0.11)	(0.12)	(0.14)	(0.13)	(0.13)	(0.09)
β_n^{Ex}	0.63**	0.48*	0.25	0.05	−0.10	−0.26	−0.29°	−0.39**
	(0.19)	(0.23)	(0.21)	(0.18)	(0.20)	(0.20)	(0.17)	(0.15)
$\bar{R}^2$	0.60	0.43	0.31	0.26	0.22	0.17	0.15	0.10
D-W	1.96	1.98	1.89	1.87	1.89	1.86	1.87	1.92
$\beta_n^{\text{NP}} = \beta_n^{\text{End}}$	21.29**	5.14*	0.46	0.17	0.01	0.50	0.89	0.95
$\beta_n^{\text{End}} = \beta_n^{\text{Ex}}$	2.44	3.12°	5.02*	9.24**	7.94**	7.95**	8.56**	12.62**

This table reports ordinary-least-squares estimates of equation (8) for interest rates of maturities from 6 months to 30 years. The coefficient β_n^{NP} measures the response of the n-maturity interest rate to the 3-month T-bill rate on days when the federal funds rate target has not been changed; β_n^{End} measures the response on policy events classified as endogenous; β_n^{Ex} measures the response on policy events classified as exogenous; α_n are constant terms. The last two rows report test statistics from tests of equality between the estimated coefficients. The sample contains 3,312 daily observations from October 3, 1988, to December 31, 2001; numbers in parentheses are White (1980) standard errors; **/*/° denote significance at the 1%-, 5%-, and 10%-level, respectively.

Table 2 reports OLS estimates of equation (8).[14] The estimated intercept terms are always zero, as expected, and all three hypotheses find strong support in the data.

First, the slope coefficients for the non-policy and endogenous policy events are large and strongly significant for all maturities, and the two responses cannot be statistically separated for maturities of two years and above. Second, after the non-policy and endogenous events, the response falls with maturity.

Third, and most importantly, for the exogenous events the estimated slope coefficients are positive for short maturities and negative for maturities of 5 years and longer. The coefficients for the 10-year and 30-year rates are significantly different from zero at the 10%- and 1%-levels, respectively. There are also significant differences between the responses to endogenous and exogenous policy for maturities of one year and above. Thus, the predictions from our theoretical model find strong support in U.S. data.

[14] The Durbin-Watson statistics reported in Table 2 do not suggest any problems with serially correlated error terms. To test the econometric specification, we also estimated regressions including squared independent variables. The squared change in the 3-month rate is occasionally significant, but adds nothing to the explanatory power of the model, in terms of adjusted R^2.

Our classification is thus helpful in explaining the response of market interest rates to policy moves. In regressions (not reported here) only including the policy days, the explained variation (R^2) in the 10-year rate's response to the 3-month rate increases from 5% with non-classified data to 17% with classified data. This is also clear from Figures 1–3.

4.3 Adjusted estimates

As mentioned above, there is likely to be some new information about the economy released also on exogenous policy days, leading to an upward bias in the estimated slope coefficients. We therefore suggest a new method to distill the true exogenous component of the policy innovation on these dates.[15]

This method controls for the typical non-policy component by calculating the implied slope coefficient of the exogenous component from the hypothetical regression

$$\Delta i_t^n = \alpha_n + \beta_n^{\text{Ex}*} \Delta i_t^{\text{Ex}*} + \beta_n^{\text{NP}*} \Delta i_t^{\text{NP}*} + \varepsilon_t^n \tag{9}$$

on the 17 exogenous observations. Here, $\Delta i_t^{\text{Ex}*}$ is the part of the policy innovation which is truly exogenous, due to a perceived change in the Fed's preferences, and $\Delta i_t^{\text{NP}*}$ is the "non-policy event," due to new information released on the policy day. These two components are not directly observable, as we only observe the total policy innovation

$$\Delta i_t^{\text{3m}} = \Delta i_t^{\text{Ex}*} + \Delta i_t^{\text{NP}*}. \tag{10}$$

However, assuming that the non-policy events on exogenous policy days behave as on any non-policy day, $\beta_n^{\text{NP}*}$ is equal to β_n^{NP} estimated over the large sample of non-policy days and reported in Table 2. We can also calculate the variance of the 3-month rate and its covariance with longer rates—$\text{Var}(\Delta i_t^{\text{3m}})$ and $\text{Cov}(\Delta i_t^{\text{3m}}, \Delta i_t^n)$—over the 17 exogenous events, and the variance of the 3-month rate on non-policy days and its covariance with longer rates—$\text{Var}(\Delta i_t^{\text{NP}*})$ and $\text{Cov}(\Delta i_t^{\text{NP}*}, \Delta i_t^n)$—from the sample of non-policy days.

Furthermore, assuming that $\Delta i_t^{\text{Ex}*}$ and $\Delta i_t^{\text{NP}*}$ are independent, we obtain

$$\text{Var}(\Delta i_t^{\text{Ex}*}) = \text{Var}(\Delta i_t^{\text{3m}}) - \text{Var}(\Delta i_t^{\text{NP}*}) \tag{11}$$

[15] Rigobon and Sack (2002) independently develop a similar estimator to analyze the impact of monetary policy on asset prices.

and

$$\mathrm{Cov}(\Delta i_t^{\mathrm{Ex}*}, \Delta i_t^n) = \mathrm{Cov}(\Delta i_t^{3\mathrm{m}}, \Delta i_t^n) - \mathrm{Cov}(\Delta i_t^{\mathrm{NP}*}, \Delta i_t^n). \tag{12}$$

Thus, we can calculate the hypothetical least-squares estimate of the response of the n-maturity interest rate to the truly exogenous component ($\beta_n^{\mathrm{Ex}*}$) as

$$\hat{\beta}_n^{\mathrm{Ex}*} = \frac{\mathrm{Cov}(\Delta i_t^{\mathrm{Ex}*}, \Delta i_t^n)}{\mathrm{Var}(\Delta i_t^{\mathrm{Ex}*})}. \tag{13}$$

To calculate the estimated variance of this coefficient, we first calculate the residual sum of squares as[16]

$$\begin{aligned}\sum_h (e_h^n)^2 &= (N-1) \\ &\times \left[\mathrm{Var}(\Delta i_t^n) - \hat{\beta}_n^{\mathrm{Ex}*}\mathrm{Cov}(\Delta i_t^{\mathrm{Ex}*}, \Delta i_t^n) - \hat{\beta}_n^{\mathrm{NP}}\mathrm{Cov}(\Delta i_t^{\mathrm{NP}}, \Delta i_t^n)\right].\end{aligned} \tag{14}$$

The variance of $\hat{\beta}_n^{\mathrm{Ex}*}$ is then given by

$$\mathrm{Var}(\hat{\beta}_n^{\mathrm{Ex}*}) = \frac{\sum_h (e_h^n)^2 / (N-k)}{(N-1)\mathrm{Var}(\Delta i_t^{\mathrm{Ex}*})}, \tag{15}$$

where N is the number of observations and k is the number of explanatory variables in regression (9) (so in our case, $N = 17$ and $k = 3$). The resulting variances, covariances, and regression results for all maturities are reported in Table 3. (By assumption, the estimates of $\beta_n^{\mathrm{NP}*}$ are identical to those of β_n^{NP} in Table 2.) After distilling the truly exogenous component, all interest rates of 5 years' maturity and longer have responses to exogenous policy innovations that are significantly negative at least at the 5%-level.

4.4 Sensitivity analysis

The above test of our main hypothesis is subject to a number of caveats. We discuss the two most important ones here.

[16] In a general regression of y on x_1, x_2, the residual sum of squares can be calculated as

$$\begin{aligned}\sum_h e_h^2 &= \sum_h e_h \left[y_h - a - b_1 x_{1h} - b_2 x_{2h}\right] \\ &= \sum_h (y_h - \bar{y}) \left[(y_h - \bar{y}) - b_1(x_{1h} - \bar{x}_1) - b_2(x_{2h} - \bar{x}_2)\right] \\ &= \sum_h (y_h - \bar{y})^2 - \sum_h b_1 (y_h - \bar{y})(x_{1h} - \bar{x}_1) - \sum_h b_2 (y_h - \bar{y})(x_{2h} - \bar{x}_2),\end{aligned}$$

leading to equation (14). See, for example, Gujarati (1988, Section 7A.3).

Table 3: Variances, covariances and hypothetical regression results

	6 mth	1 yr	2 yr	3 yr	5 yr	7 yr	10 yr	30 yr
(*a*) Variances of policy components ($\times 1,000$)								
$\text{Var}(\Delta i_t^{3\text{m}})$	6.586							
$\text{Var}(\Delta i_t^{\text{NP}*})$	2.371							
$\text{Var}(\Delta i_t^{\text{Ex}*})$	4.215							
(*b*) Variances and covariances of interest rate response ($\times 1,000$)								
$\text{Var}(\Delta i_t^n)$	5.831	4.894	4.924	4.706	4.560	5.338	4.390	3.890
$\text{Cov}(\Delta i_t^{3\text{m}}, \Delta i_t^n)$	4.151	3.141	1.623	0.343	−0.659	−1.770	−1.927	−2.623
$\text{Cov}(\Delta i_t^{\text{NP}*}, \Delta i_t^n)$	1.722	1.733	1.660	1.565	1.416	1.222	1.106	0.786
$\text{Cov}(\Delta i_t^{\text{Ex}*}, \Delta i_t^n)$	2.429	1.407	−0.037	−1.222	−2.075	−2.992	−3.033	−3.408
(*c*) Hypothetical regression results								
$\beta_n^{\text{NP}*}$	0.726**	0.731**	0.700**	0.660**	0.597**	0.515**	0.466**	0.331**
	(0.020)	(0.033)	(0.038)	(0.039)	(0.036)	(0.033)	(0.031)	(0.027)
$\beta_n^{\text{Ex}*}$	0.576*	0.334	−0.009	−0.290	−0.492*	−0.710**	−0.720**	−0.809**
	(0.232)	(0.231)	(0.252)	(0.237)	(0.214)	(0.209)	(0.169)	(0.122)
$1,000 \times \sum_h (e_h^n)^2$	50.894	50.512	60.194	53.103	43.081	41.366	27.084	13.987
$\beta_n^{\text{Ex}*} = \beta_n^{\text{NP}}$	0.413	2.891	7.703*	15.628**	25.297**	33.401**	47.465**	83.460**

This table reports hypothetical ordinary-least-squares estimates of equation (9) on the 17 classified policy events. Panels (*a*) and (*b*) report some preliminary calculations of variances and covariances: $\text{Var}(\Delta i_t^{3\text{m}})$, $\text{Var}(\Delta i_t^n)$, and $\text{Cov}(\Delta i_t^{3\text{m}}, \Delta i_t^n)$ are calculated over the 17 exogenous policy events; $\text{Var}(\Delta i_t^{\text{NP}*})$ and $\text{Cov}(\Delta i_t^{\text{NP}*}, \Delta i_t^n)$ are calculated over the 3,264 non-policy days; $\text{Var}(\Delta i_t^{\text{Ex}*})$ and $\text{Cov}(\Delta i_t^{\text{Ex}*}, \Delta i_t^n)$ are computed according to equations (11) and (12). Panel (*c*) reports the calculated coefficients in the hypothetical regression: the coefficient $\beta_n^{\text{NP}*}$ measures the response of the n-maturity interest rate to the component of the 3-month T-bill rate change that is not related to policy but due to new information released on the policy day, and is by assumption equal to the coefficient β_n^{NP} in Table 2; $\beta_n^{\text{Ex}*}$ measures the response to the truly exogenous part of the policy innovation, calculated using equation (13). The last row reports test statistics from tests of equality between $\beta_n^{\text{Ex}*}$ and β_n^{NP}. Numbers in parentheses are standard errors; **/*/° denote significance at the 1%-, 5%-, and 10%-level, respectively.

First, we have assumed that the term premium is orthogonal to policy innovations. This assumption might not be completely innocent: in particular after exogenous changes in the perceived policy preferences, one could expect that the uncertainty about the Fed's preferences would diminish, leading to a downward shift in the term premium. If so, long-term market rates should respond asymmetrically to such events, since a policy tightening would lead to a large fall in interest rates, whereas an easing would lead to a smaller increase in these rates. Although this is a plausible hypothesis, and there are some indications of such an effect in Figure 3, the small number of exogenous events makes formal testing of this hypothesis all but impossible. What we have done is to look in our case material for statements concerning changes in policy uncertainty. As it happens, two events stand out: May 17 and August 16, 1994 (the observations in the lower right corner of Figure 3). On these occasions, the reports from the *Wall Street Journal* make clear that the Fed's actions considerably reduced the uncertainty concerning the future path of policy. In other words, these moves seem to have been followed by reductions in the term premium.[17] (Campbell, 1995, suggests that variations in the term premium may account for the large swings in long-term interest rates during the spring of 1994.) If we introduce dummies for both dates, our conclusions are weakened. The responses of the 10- and 30-year rates to exogenous policy then are negative and significantly different from the response to endogenous policy, but not significantly different from zero. When controlling for the non-policy component, however, the 7-, 10- and 30-year responses are all significantly negative.

Second, given the small number of observations, there is a serious concern that the results are affected by the classification of a few events. Among the events we have classified as exogenous, the two key observations in Figure 3 are precisely May 17, 1994, and August 16, 1994; the very same events that might be associated with reductions in the term premium. (Apart from these, the most important event appears to be November 15, 1994, but in this case it appears that ex ante uncertainty is not a major issue, and hence variation in the term premium is likely to have been small.) In addition, our result could also be overturned if some of the events were re-classified. To provide further robustness checks, we have therefore looked at a variety of subsamples. Generally, our results are strengthened if we confine attention to the period from 1994 onwards, even if May 17, 1994, is excluded. Likewise, the results are strengthened if we classify as exogenous only those events where policy preferences really dominate the newspaper reports. (The strictest criteria leave only November 15, 1994, August 16, 1994, and possibly February 24, 1989.) On the other hand, if we exclude 1994 altogether, the results are weaker. Then the coefficient for exogenous events is negative only for the 30-year rate, and not significantly different from zero (although significantly different from the endogenous response). Again, however, when controlling for the non-policy event, the 7-, 10- and 30-year rates all

[17]It does not follow that the entire movement in interest rates at these two dates was driven by reductions in the uncertainty concerning the Fed's preferences rather than perceived changes in the preferences. During this period there was considerable uncertainty as to how the Fed would respond to new inflationary pressures, and the market was worried that too small steps would not be sufficient to keep inflation under control (Beckner, 1996). These worries were enhanced by strong political pressures from the White House and changes in the composition of the FOMC which could lead to a less fierce policy on inflation. Thus the observed response of market rates could plausibly be ascribed to changes in the perceived preferences as the Fed responded more strongly than expected.

obtain significantly negative coefficients.

5 Final remarks

To summarize, we have shown that market participants are keenly aware of the dichotomy between changes in the policy preferences of monetary authorities on the one hand and economic developments on the other. We have also shown that the classification of events by market participants is correlated with the change in yield spreads following policy interventions.

We note that although our theory manages to get the sign of long-term rates' response to monetary policy right, these rates seem to overreact. In the basic regression in Table 2, the 30-year rate increases by 24 basis points after an endogenous 1% policy innovation, and falls by 39 basis points after a 1% exogenous innovation. The theory in Ellingsen and Söderström (2001) predicts that the response of long-term rates to both endogenous and exogenous policy approaches zero as the maturity increases indefinitely. However, in an alternative formulation of our theory, where exogenous policy moves reveal information about the central bank's inflation target while the preference parameter λ is kept constant, very long-term interest rate would indeed respond negatively to such moves as long-term inflation expectations adjust. This theory could also explain the excess sensitivity to endogenous policy, if the Fed's inflation target were believed to vary with observed inflation.

It would of course be desirable to investigate whether our empirical results hold true for other time periods and other countries. A related question is whether the classification scheme can also explain the impact of monetary policy on price movements in other markets.

In a separate set of regressions (not reported), we have found that the scheme does help to explain stock price movements: endogenous increases in the interest rate lead to a relatively strong reduction in stock prices during 1988–1997, whereas exogenous changes have a much more ambiguous effect. These findings are consistent with, and shed light on, the average negative relationship between policy changes and stock prices reported by Thorbecke (1997). Since an endogenous policy tightening drives down bond prices, it should also affect stock prices negatively, as stocks and long-term bonds are close substitutes. An exogenous policy tightening, on the other hand, has a smaller effect on the bond market, and thus also on stock prices.

Appendix: Classification of Federal Reserve actions

This table reports each change in the Federal Reserve's target rate for the federal funds rate from October 1988 until December 2001. For each event, the table shows the change in the funds rate target, the change in the 3-month T-bill rate (our measure of the policy innovation), our classification of the policy event, and a quote from the *Wall Street Journal* to support the classification. The classification is: End—Endogenous, based on new economic information; Ex—Exogenous, based on preference shifts; R—Employment report or other significant news released on same day; U—Action unnoticed. Notes: [1]No actual policy decision, according to Roley and Sellon (1996); [2]Also discount rate change; [3]Target change noticed one day before the official target change.

Event	Date	Change in funds rate target (%)	Change in 3-month rate (%)	Description of event	Classi-fication
1	Oct 20, 1988	+0.125	+0.02	"...the Federal Reserve provided a hint that it isn't tightening credit."	U
2	Nov 17, 1988[1]	+0.0625	−0.02	"Investment managers worry that the dollar's weakness soon will lead to even higher interest rates."	U
3	Nov 22, 1988	+0.0625	+0.01	No mention of monetary policy.	U
4	Dec 15, 1988	+0.3125	+0.07	"Several recent economic reports have indicated robust economic growth that aroused inflation jitters."	End
5	Dec 29, 1988[1]	+0.0625	−0.13	"...the federal funds rate rose again, largely reflecting what traders refer to as 'year-end window dressing'."	U
6	Jan 5, 1989	+0.25	+0.02	"...the Fed's aggressive moves might encourage bond investors by convincing them of the central bank's determination to keep inflation under control."	Ex
7	Feb 9, 1989[1]	+0.0625	−0.05	"Some analysts predict the Fed... will raise rates Friday or early next week."	U
8	Feb 14, 1989	+0.25	+0.01	"Fed officials are tightening their credit clamp further in an effort to rein in on inflation." *Before:* " 'If, as we expect, the Fed gradually nudges the federal funds rate towards 9 1/2%, market participants may regain faith that containing inflation remains a top priority for the monetary authorities.' "	Ex
9	Feb 23, 1989[1]	+0.25	+0.08	"The Federal Reserve, trying to calm inflation worries, drove up short-term interest rates."	End
10	Feb 24, 1989[2]	+0.1875	+0.04	"The Fed's long-awaited discount-rate increase is too small and too late to help calm inflation fears..." "Fed officials' anti-inflation rhetoric 'is wearing thin' ..."	Ex
11	May 4, 1989[1]	+0.0625	0.00	No mention of monetary policy.	U
12	Jun 6, 1989	−0.25	−0.10	"The U.S. Federal Reserve apparently has eased its grip on credit, reflecting the belief of many Fed officials that the economy has slowed..."	End
13	Jul 7, 1989	−0.25	−0.04	"...for several weeks now, strong signs of economic weakness have convinced Fed officials to ease instead."	End
14	Jul 27, 1989	−0.25	−0.12	"...it became clear that the Federal Reserve is easing credit and that the economy is growing weaker."	End
15	Aug 10, 1989[1]	−0.0625	−0.05	No mention of monetary policy.	U

Event	Date	Change in funds rate target (%)	Change in 3-month rate (%)	Description of event	Classi-fication
16	Oct 18, 1989	−0.25	+0.07	No mention of monetary policy.	U
17	Nov 6, 1989	−0.25	+0.03	No mention of monetary policy.	U
18	Dec 20, 1989	−0.25	−0.10	"'Coming right after an FOMC meeting, they would not have entered the market unless they wanted to send a clear signal that policy had changed.'"	Ex
19	Jul 13, 1990	−0.25	−0.08	"Several investment managers fear that the Fed pulled the trigger too soon..." "'If you're looking to the Fed as a bulwark against inflation, then this doesn't support that case.'"	Ex
20	Oct 29, 1990	−0.25	+0.02	"...widely anticipated move..." *Before:* "...further signs of U.S. economic weakness..."	End
21	Nov 14, 1990	−0.25	+0.03	"...few investors are willing to participate in the market until they see clear signs that the Federal Reserve has eased monetary policy."	U
22	Dec 7, 1990	−0.25	−0.11	"...[the Fed's] move came shortly after the U.S. Labor Department reported a surge in the November U.S. employment and sharp declines in jobs."	R
23	Dec 19, 1990[2]	−0.25	−0.11	"...some disappointment that the Federal Reserve didn't signal a larger cut in the rate."	Ex
24	Jan 8, 1991[3]	−0.25	−0.07	"After yesterday's easing move, the new level for the rate is believed to be 6 3/4%."	End
25	Feb 1, 1991[2]	−0.50	−0.19	"Prices of U.S. government bonds soared Friday in response to a surprisingly weak U.S. employment report and a cut in the discount rate by the Federal Reserve."	R
26	Mar 8, 1991	−0.25	−0.10	"...they ignored the Department of Labor's report that the unemployment rate rose to 6.5% from 6.2%..."	R
27	Apr 30, 1991[2]	−0.25	−0.08	"...the central bank surprised the market by pushing rates another notch lower." "...[the move] didn't follow any major economic report..." "...'smacks of some political pressure on the Fed.'"	Ex
28	Aug 6, 1991	−0.25	−0.09	"'On any kind of economic basis, the Fed move was entirely justified'..."	End
29	Sep 13, 1991[2]	−0.25	−0.06	"The U.S. Federal Reserve's latest move to cut interest rates reflects its uneasiness about the slow growth of the money supply and the disappointingly torpid economic recovery."	End
30	Oct 30, 1991[3]	−0.25	−0.05	"...by late afternoon, the Fed had eased at least 25 basis points..." *Before:* "Evidence the recovery is wilting and inflation is waning..."	End
31	Nov 6, 1991[2]	−0.25	−0.13	"...the Federal Reserve Bank's surprise announcement of a discount rate cut."	End
32	Dec 6, 1991	−0.25	−0.07	"...news from the U.S. Labor Department that non-farm payrolls shrank 241.000 in November."	R
33	Dec 20, 1991[2]	−0.50	−0.30	"A still-faltering economy and slower inflation is likely to cause U.S. interest rates to fall even further..." "...following the Federal Reserve's surprisingly aggressive move on Friday..."	End
34	Apr 9, 1992	−0.25	−0.21	"...the Fed's decision to cut rates...came primarily for concerns about recent contractions in the U.S. money supply."	End

Event	Date	Change in funds rate target (%)	Change in 3-month rate (%)	Description of event	Classi-fication
35	Jul 2, 1992[2]	−0.50	−0.31	"... a stunningly weak employment report, which unlocked the door for lower interest rates."	R
36	Sep 4, 1992	−0.25	−0.22	"... in the wake of Friday's extraordinarily weak employment report."	R
37	Feb 4, 1994	+0.25	0.10	"The tightening came about three hours after a weaker-than-expected January employment report."	R
38	Mar 22, 1994	+0.25	0.00	*Before:* "Some studies show that inflationary pressures are building..." "... traders and investors had been expecting such a move for some time..."	End
39	Apr 18, 1994	+0.25	+0.11	*Before:* "... fear that we are going to see an acceleration of inflation." "... disappointment that the Fed didn't raise interest rates by a larger margin."	End
40	May 17, 1994[2]	+0.50	+0.05	"... analysts said the Fed has indicated it will sit tight for a little while..." "... the action cleared the air of uncertainty that had been restraining investors for months."	Ex
41	Aug 16, 1994[2]	+0.50	+0.17	"'... a clear signal that the Fed intends to fight inflation pressures,'" "... improvement in inflation psychology..."	Ex
42	Nov 15, 1994[2]	+0.75	+0.10	"... bigger-than-expected boost in interest rates by the U.S. Federal Reserve." "... market participants view the Fed as doing well in its effort to contain inflation."	Ex
43	Feb 1, 1995[2]	+0.50	+0.07	"... the US Federal Reserve raised short-term rates and indicated that there are only tentative signs the economy is slowing."	End
44	Jul 6, 1995	−0.25	−0.14	"... the Fed's willingness to ease ahead of Friday's data suggests that the central bank is looking for a weak employment report."	End
45	Dec 19, 1995	−0.25	−0.11	"'... inflation has been somewhat more favorable than anticipated...'"	End
46	Jan 31, 1996[2]	−0.25	−0.08	"'This rate cut says the Fed is likely to be more aggressive cutting rates than people thought'..."	Ex
47	Mar 25, 1997	+0.25	+0.04	"... 'the risk of inflation is increasing'..."	End
48	Sep 29, 1998	−0.25	+0.07	"... the FOMC [statement] said 'The recent changes in the global economy and adjustments in U.S. financial markets mean that a slightly lower federal-funds rate should now be consistent with keeping inflation low...' " "'... the Fed's action was right in line with the Street consensus'."	End
49	Oct 15, 1998[2]	−0.25	+0.12	"Most analysts say that the Fed's decision to ease was probably based on the increasing unwillingness of creditors to finance borrowers."	End
50	Nov 17, 1998[2]	−0.25	−0.10	"Many bond traders and investors had predicted that the Fed would cut rates ... to ensure that recent improvements in the liquidity and tone of various credit markets wouldn't dissipate. "	End
51	Jun 30, 1999	+0.25	−0.05	"Two of the most widely watched economic releases are scheduled before the end of this week."	End
52	Aug 24, 1999[2]	+0.25	+0.07	"... some investors were disappointed the Fed didn't sound a stronger warning on the need to cool an overheating economy." "'They may be behind the curve on inflation'..."	Ex

Event	Date	Change in funds rate target (%)	Change in 3-month rate (%)	Description of event	Classification
53	Nov 16, 1999[2]	+0.25	+0.02	"'The Fed is showing the fact that they are preemptive...'"	Ex
54	Feb 2, 2000[2]	+0.25	−0.05	"The Treasury's auction announcement largely overshadowed news of the Fed monetary-policy tightening."	R
55	Mar 21, 2000[2]	+0.25	0.00	"...the central bank will remain a vigilant inflation fighter." "...'there seems to be a growing confidence among investors that the Fed is in fact ahead of the inflationary curve,'..."	Ex
56	May 16, 2000	+0.50	+0.08	"...the bond market is starting to believe that the Fed will succeed in fighting inflation..."	Ex
57	Jan 3, 2001[2]	−0.50	−0.16	"...many people in the bond market had been focusing on the Labor Department's monthly employment report tomorrow, expecting that further signs of economic weakness might prompt a move by the Fed ..."	End
58	Jan 31, 2001[2]	−0.50	−0.03	"The forward-looking bond market focused on the wording of the announcement, in which the Fed said the economy's weakening and tame inflation 'called for a rapid and forceful response of monetary policy.'"	End
59	Mar 20, 2001[2]	−0.50	−0.04	"'...excess productive capacity has emerged recently. In these circumstances, when the economic situation could be evolving rapidly, the Federal Reserve will need to monitor developments closely.'" (FOMC statement)	End
60	Apr 18, 2001[2]	−0.50	−0.20	"'benign inflation gives the Fed the green light to do whatever they want ... The Fed won't stop cutting rates until they feel the economy has bottomed out, and we're on the road to recovery.'"	End
61	May 15, 2001[2]	−0.50	−0.08	"But yesterday's Fed move sparked some concern that if the Fed succeeds in boosting the economy, a resurgence of inflation could follow." "'They're erring on the side of [trying to boost] growth, and the market is fearful the Fed may over do it' by cutting rates too much, sparking inflation..."	Ex
62	Jun 27, 2001[2]	−0.25	+0.06	"Some predicted a quarter percentage point, while others—citing signs of weakness in the economy—expected half a percentage point."	End
63	Aug 21, 2001[2]	−0.25	−0.03	"'They specifically cited falling business profits, that capital spending is expected to continue to weaken and that [slowing] global growth may impact the U.S. as well.'"	End
64	Sep 17, 2001[2]	−0.50	−0.05	"'In this environment where everything is highly emotional, symbols do matter'..."	Ex
65	Oct 2, 2001[2]	−0.50	−0.10	"...many await two Labor Department reports: tomorrow's weekly update on claim filings for unemployment-insurance benefits and Friday's monthly report on employment trends."	End
66	Nov 6, 2001[2]	−0.50	−0.15	"The Fed is 'concerned about the world economy's sharp slowdown,'..."	End
67	Dec 11, 2001[2]	−0.25	−0.05	"...the Fed's suggestion that recent strength in some economic data is 'preliminary and tentative' was seen by many as a sign that the central bank stands ready to cut rates again."	End

References

Ang, Andrew and Monika Piazzesi, "A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables," *Journal of Monetary Economics* 50 (4), 745–787, May 2003.

Balduzzi, Pierluigi, Giuseppe Bertola, Silverio Foresi, and Leora Klapper, "Interest rate targeting and the dynamics of short-term rates," *Journal of Money, Credit, and Banking* 30 (1), 26–50, February 1998.

Balduzzi, Pierluigi, Giuseppe Bertola, and Silverio Foresi, "A model of target changes and the term structure of interest rates," *Journal of Monetary Economics* 39 (2), 223–249, July 1997.

Balduzzi, Pierluigi, Edwin J. Elton, and T. Clifton Green, "Economic news and the yield curve: Evidence from the U.S. treasury market," *Journal of Financial and Quantitative Analysis* 36 (4), 523–543, December 2001.

Battellino, Ric, John Broadbent, and Philip Lowe, "The implementation of monetary policy in Australia," in *Implementation and Tactics of Monetary Policy*, Bank for International Settlements, Basel, March 1997.

Beckner, Steven K., *Back from the Brink: The Greenspan Years*, John Wiley and Sons, New York, 1996.

Buttiglione, Luigi, Paolo Del Giovane, and Eugenio Gaiotti, "Implementation of monetary policy in Italy: The role of repo operations and official rates," in *Implementation and Tactics of Monetary Policy*, Bank for International Settlements, Basel, March 1997.

Campbell, John Y., "Some lessons from the yield curve," *Journal of Economic Perspectives* 9 (3), 129–152, Summer 1995.

Cochrane, John H. and Monika Piazzesi, "The Fed and interest rates—A high-frequency identification," *American Economic Review Papers and Proceedings* 92 (2), 90–95, May 2002.

Cook, Timothy and Thomas Hahn, "The effect of changes in the federal funds rate target on market interest rates in the 1970s," *Journal of Monetary Economics* 24 (3), 331–351, November 1989.

Cook, Timothy and Steven Korn, "The reaction of interest rates to the employment report: The role of policy anticipation," *Federal Reserve Bank of Richmond Economic Review* 77 (5), 3–12, September–October 1991.

Dai, Qiang and Kenneth J. Singleton, "Specification analysis of affine term structure models," *Journal of Finance* 55 (5), 1943–1978, October 2000.

Ellingsen, Tore and Ulf Söderström, "Monetary policy and market interest rates," *American Economic Review* 91 (5), 1594–1607, December 2001.

Evans, Charles L. and David A. Marshall, "Monetary policy and the term structure of nominal interest rates: Evidence and theory," *Carnegie-Rochester Conference Series on Public Policy* 49 (1), 53–111, November 1998.

Farnsworth, Heber and Richard Bass, "The term structure with semi-credible targeting," *Journal of Finance* 58 (2), 839–865, April 2003.

Faust, Jon, Eric Swanson, and Jonathan Wright, "Does the Fed possess inside information about the economy?" Manuscript, Board of Governors of the Federal Reserve System, June 2002.

Gujarati, Damodar N., *Basic Econometrics*, McGraw-Hill, New York, 1988.

Harvey, Campbell R. and Roger D. Huang, "The impact of the Federal Reserve Bank's open market operations," *Journal of Financial Markets* 5 (2), 223–257, April 2002.

Lindberg, Hans, Kerstin Mitlid, and Peter Sellin, "Monetary tactics with an inflation target: The Swedish case," in *Implementation and Tactics of Monetary Policy*, Bank for International Settlements, Basel, March 1997.

Litterman, Robert and José Scheinkman, "Common factors affecting bond returns," *Journal of Fixed Income* 1, 54–61, June 1991.

McCulloch, J. Huston, "U.S. term structure data, 1946–87," in Friedman, Benjamin M. and Frank H. Hahn (eds.), *Handbook of Monetary Economics*, Elsevier Science North-Holland, Amsterdam, 1990. Appendix B in Shiller (1990).

Peek, Joe, Eric S. Rosengren, and Geoffrey M. B. Tootell, "Is bank supervision central to central banking?" *Quarterly Journal of Economics* 114 (2), 629–655, May 1999.

———, "Does the Federal Reserve possess an exploitable informational advantage?" *Journal of Monetary Economics* 50 (4), 817–839, May 2003.

Peersman, Gert, "Monetary policy and long term interest rates in Germany," *Economics Letters* 77 (2), 271–277, October 2002.

Rigobon, Roberto and Brian Sack, "The impact of monetary policy on asset prices," Working Paper No. 8794, National Bureau of Economic Research, February 2002.

Roley, V. Vance and Gordon H. Sellon, "The response of the term structure of interest rates to federal funds rate target changes," Research Working Paper No. 96-08, Federal Reserve Bank of Kansas City, November 1996.

Romer, Christina D. and David H. Romer, "Federal Reserve information and the behavior of interest rates," *American Economic Review* 90 (3), 429–457, June 2000.

Rudebusch, Glenn D., "Federal Reserve interest rate targeting, rational expectations, and the term structure," *Journal of Monetary Economics* 35 (2), 245–274, April 1995.

———, "Do measures of monetary policy in a VAR make sense?" *International Economic Review* 39 (4), 907–931, November 1998.

Shiller, Robert J., "The term structure of interest rates," in Friedman, Benjamin M. and Frank H. Hahn (eds.), *Handbook of Monetary Economics*, Elsevier Science North-Holland, Amsterdam, 1990.

Skinner, Tom and Jerónimo Zettelmeyer, "Long rates and monetary policy: Is Europe different?" in Zettelmeyer, Jerónimo (ed.), *Essays on monetary policy*, Ph.D. dissertation, Massachusetts Institute of Technology, February 1995.

Söderström, Ulf, "Predicting monetary policy with federal funds futures prices," *Journal of Futures Markets* 21 (4), 377–391, April 2001.

Svensson, Lars E. O., "Inflation forecast targeting: Implementing and monitoring inflation targets," *European Economic Review* 41 (6), 1111–1146, June 1997.

Thorbecke, Willem, "On stock market returns and monetary policy," *Journal of Finance* 52 (2), 635–654, June 1997.

White, Halbert, "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity," *Econometrica* 48 (4), 817–838, May 1980.