MARKET REACTION TO MONETARY POLICY NONANNOUNCEMENTS

V. Vance Roley

and

Gordon H. Sellon, Jr.

First Version: March 6, 1998

This Version: August 21, 1998

V. Vance Roley is Hughes M. Blake Professor of Business Administration at the University of Washington and a visiting scholar at the Federal Reserve Bank of Kansas City. Gordon H. Sellon, Jr., is vice president and economist at the Federal Reserve Bank of Kansas City. We thank Cathy Bonser-Neal and Craig Hakkio for helpful comments. The views expressed herein are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Kansas City or the Board of Governors of the Federal Reserve System.

MARKET REACTION TO MONETARY POLICY NONANNOUNCEMENTS

ABSTRACT

This paper examines how Treasury security yields, stock prices, and federal funds futures rates respond on Federal Open Market Committee (FOMC) meeting dates when expected policy actions do not occur. The empirical results support the existence of nonannouncement effects on short- and intermediate-term yields. In particular, part of an expected policy action, measured using federal funds futures rates, is unwound when the action does not materialize. This partial unwinding is consistent with markets reacting to the surprise by postponing, but not eliminating, the possibility of a future policy action. We also find that only the response of near-term federal funds futures rates is larger after February 1994, when the Federal Reserve began making virtually all of its nonzero changes in the federal funds rate target at FOMC meetings. As a whole, our results suggest that monetary policy decisions can be informative to financial markets even when these decisions do not involve an overt policy action, and they support the view that market expectations of future policy actions are an important determinant of the behavior of interest rates.

V. Vance Roley
Department of Finance
Box 353200
University of Washington
Seattle, WA 98195-3200

(206) 685-7476
e-mail: vroley@u.washington.edu

Gordon H. Sellon, Jr.
Economic Research Department
Federal Reserve Bank of Kansas City
925 Grand Boulevard
Kansas City, MO 64198-0001

(816) 881-2560
e-mail: gsellon@frbkc.org

I. Introduction

The effects of monetary policy are often thought to be transmitted to the economy through their impact on asset prices. In an efficient markets/rational expectations framework, monetary policy actions influence asset prices only to the extent that they provide new information either about future economic activity or inflation or about future monetary policy actions. In fact, an extensive literature on announcement effects suggests that policy actions, or the release of data thought to influence policy actions, provide new information to financial markets. In particular, changes in central bank interest rates (lending rates or target overnight rates) and the release of money supply and other economic data are associated with asset price responses in fixed income, equity, and foreign exchange markets in a number of recent periods.

While past research indicates that Federal Reserve policy actions are informative for financial market participants, these actions tend to be relatively rare. For example, as we show in Table 1, the Federal Reserve's Federal Open Market Committee (FOMC) made only 41 policy changes over the period from October 1988 through December 1997, where we define a policy action as a change in the Federal Reserve's federal funds rate target.[1] The absence of a policy action does not mean, however, that information is not being conveyed to financial markets. In fact, financial market participants may be as surprised by an expected policy action that does not occur as by an unexpected action that does occur.[2] For example, if a widely anticipated tightening of monetary policy does not materialize, asset prices may respond as financial market participants alter their views about the likelihood of future policy actions.

The effects of no policy actions on financial markets are potentially somewhat more difficult to evaluate empirically, however, since it has not always been clear when an observed zero change in the

[1] Bernanke and Blinder (1992) and Sims (1992) emphasize the appropriateness of using federal funds rate changes to characterize monetary policy actions. Cook and Hahn (1989), Radecki and Reinhart (1994), Thorbecke and Alami (1994), Rudebusch (1995), Roley and Sellon (1995, 1998), Thornton (1996), Balduzzi, Bertola, and Foresi (1997), Thorbecke (1997), Reinhart and Simon (1997), Balduzzi, Bertola, Foresi, and Klapper (1998), and Bonser-Neal, Roley, and Sellon (1998) all use the Federal Reserve's federal funds rate target to examine the effects of monetary policy actions on interest rates, stock prices, and foreign exchange rates.

[2] Rudebusch (1995) and Balduzzi, Bertola, and Foresi (1997) document that federal funds rate target changes tend to be persistent, which could lead to anticipated future changes being reflected in current financial asset prices. Also, Roley and Sellon (1998) estimate that on average most of a federal funds rate target change since October 1987 is already reflected in market interest rates before the policy action is taken. It therefore seems likely that such anticipation effects could sometimes be embedded in market yields when the Federal Reserve decides to leave its federal funds rate target unchanged.

federal funds rate target represents a surprise to market participants. That is, in principal, the Federal Reserve can change its federal funds rate target during any business day of the year. The data summary we present in Table 1 for the October 1988 – December 1998 sample, however, indicates that 16 of the 41 target changes follow FOMC meetings. So, there could be some tendency for market participants to expect target changes after FOMC meetings. Moreover, since February 1994, 10 of the 11 federal funds rate target changes occur immediately following FOMC meetings. Consequently, market participants may now place a much higher probability that future changes will occur at similar times. Even before February 1994, however, 20 percent of the target changes are made immediately after meetings. So, relative to other individual business days between FOMC meetings, the assessed likelihood of a target change was probably greater immediately after FOMC meetings both before and after February 1994.

This paper examines the information content of FOMC decisions not to change monetary policy by estimating the responses of Treasury security yields, stock prices, and federal funds futures rates on FOMC meeting days when a policy action does not occur. We label these as nonannouncement effects because of the way that zero changes in the federal funds rate target have been revealed to market participants since February 1994. For the FOMC meeting ending on Tuesday, May 19, 1998, for example, Reuters reports that " 'The Federal Open Market Committee meeting ended at 1:35 p.m.,' Fed spokesman Joseph Coyne said. 'There is no further announcement.' " Consequently, the nonannouncement informs the market that the federal funds rate target is unchanged. In contrast, when the federal funds rate target is changed, the Federal Reserve has made an explicit announcement about its new level since February 1994. Before February 1994, policy decisions were not formally announced, but markets learned quickly by observing Federal Reserve open-market operations (e.g., Cook and Hahn (1989)).

Our empirical results suggest a small, but statistically significant, reversal of rates when an expected federal funds rate target change does not occur. The existence of significant nonannouncement effects suggests that information is conveyed to financial markets even when no policy action takes place. Moreover, the size of the effect is consistent with the view that this information causes financial markets to temporarily postpone, but not eliminate, the likelihood of a policy action. That is, the information provided by the nonannouncement seems limited to the timing of policy actions and not the underlying assessment about the long-run stance of monetary policy. In contrast, for nonzero federal funds rate target changes,

Cook and Hahn (1989) and Roley and Sellon (1998) estimate statistically significant responses of long-term interest rates in both the pre-October 1979 and post-October 1987 periods, and Thorbecke and Alami (1994) and Thorbecke (1997) estimate significant effects on stock prices during these two periods. So, nonzero and zero target changes apparently provide different information for financial markets. We also estimate that only the response of near-term federal funds futures rates is larger after February 1994, suggesting only minor differences in the information content of nonannouncements after the FOMC began announcing target changes after meetings.

The remainder of this paper is divided into three parts. The next section reviews the existing empirical literature on monetary policy announcement effects and examines how nonannouncement effects might arise in a simple model of the term structure. The third section presents empirical estimates of nonannouncement effects on Treasury security yields, federal funds futures rates, and stock prices. The final section provides a summary and concluding observations.

II. The Information Content of Monetary Policy Decisions

In this section, we first review the results from previous studies concerning the announcement effects of monetary policy and of information related to monetary policy on financial markets. We also consider these announcement effects in a simple theoretical framework. Next, we examine why nonannouncement effects may also exist, and we adapt our theoretical framework to examine their determinants.

Announcement effects of monetary policy. Evidence that monetary policy actions provide information to financial markets is contained in an extensive announcement effects literature which examines the response of asset prices to policy actions or to the public release of data that is thought to be important to decisions by policymakers. Generally, this literature uses an event-study methodology in which, to control for the release of other new information, the response of asset prices is examined in a relatively narrow time interval surrounding the policy action or release of other economic news. These studies span a number of financial markets and use a variety of measures of policy actions and other policy-

related events. While the majority of studies estimate the response of interest rates to policy actions and related economic news, a number of studies look at equity markets and foreign exchange markets as well.[3]

Two consistent results emerge from the announcement effects literature. First, across markets, asset prices respond systematically to policy actions or the release of policy-related data. This suggests that new information is being provided to financial markets. In the case of policy actions, this result further implies that these actions are not fully anticipated. Second, measured announcement effects do not appear to be stable over time. One main factor determining the variability in the size of announcement effects appears to be related to changes involving monetary policy procedures. That is, announcement effects vary depending on whether the Federal Reserve is reacting to deviations from monetary targets or to other economic information related to the strength of the economy or inflation. Other institutional changes involving the implementation of monetary policy, such as interest-rate or reserves operating procedures, also cause some announcement effects to vary over time.

The part of the announcement effects literature that is most relevant to this paper examines the response of interest rates and stock prices to changes in the federal funds rate operating target.[4] These studies generally find a significant responses of Treasury security yields to funds rate target changes from maturities of three months to as far as ten years, with the size of the response declining with maturity (e.g., Cook and Hahn (1989) and Roley and Sellon (1998)). Moreoever, Thorbecke and Alami (1994) and Thorbecke (1997) also estimate significant stock-price responses. Dale (1993) and Hardy (1996) find similar results for the response of market interest rates to changes in central bank rates for the UK and Germany, respectively.

Following Balduzzi, Bertola, Foresi, and Kapper (1998) and Roley and Sellon (1998), we can be more precise about how announcement effects might arise and about their quantitative importance by constructing a simple, stylized model of the term structure coupled with assumptions about the monetary policy process that are designed to capture features of US policy. We also use this model below to consider

[3] Pearce and Roley (1983, 1985), Hardouvelis (1987), McQueen and Roley (1993), and Thorbecke (1997), for example, estimate significant effects of announced economic and policy information on stock prices. Engel and Frankel (1984), Hardouvelis (1984), Hakkio and Pearce (1985), Ito and Roley (1987), and Bonser-Neal, Roley, and Sellon (1998), for example, examine similar significant effects on foreign exchange rates.

[4] Again see the references in footnote 1.

the determinants of nonannouncement effects. The model consists of three interest rates: a one-day rate, a one-month rate, and a two-month rate. We assume that the one-day rate, which we take as the federal funds rate target, is controlled by the Federal Reserve, while we determine the one- and two-month rates by a simple expectations model of the term structure.

The model also has some key informational assumptions and institutional features. We assume that the Federal Reserve's open market committee (FOMC) meets once each month to determine the target one-day rate that will be in effect until the next meeting. All policy decisions occur at regular meetings and are immediately announced on the day of the meeting. In contrast to policy decisions, information about the economy can occur on any day of the month and may cause market participants to regularly revise their expectations about future policy actions.

We represent the market's assessment about whether the Federal Reserve will change the federal funds rate target ($\Delta r_{ff,t}$) at the beginning of month t as

$$\begin{aligned} \Delta r_{ff,t} &= \Delta r^{*}_{ff,t} \text{ with probability } (1-q_{0,t}) \\ &= 0 \text{ with probability } q_{0,t} , \end{aligned} \tag{1}$$

where $q_{0,t}$ is the market's assessment of the probability that the federal funds rate target will not change at the current month's FOMC meeting, and $\Delta r^{*}_{ff,t}$ is the expectation of the change in the federal funds rate target conditional on the information about the economy immediately before the FOMC meeting and conditional on the FOMC following its policy reaction function.[5] For example, given the information about

[5] The target-change process (1) is similar to that proposed by Balduzzi, Bertola, Foresi, and Kapper (1998) in that the market assigns probabilities to nonzero and zero changes in the federal funds rate target. We can also derive this process explicitly from the model presented by Roley and Sellon (1998), in which conditional target changes, $\Delta r^{*}_{ff,t}$, depend on either aggregate demand or supply shocks in a sticky-price macro model based on that presented by McCallum (1994). Given these aggregate shocks, the conditional target change is then determined in a policy reaction function following Taylor (1993), Fuhrer and Moore (1995), Clarida, Gali, and Gertler (1997, 1998), and McCallum and Nelson (1998). Finally, also following Roley and Sellon (1998), actual target changes can differ from conditional target changes due to discretionary policy actions. The probability of such discretionary actions, or policy shocks, is represented by $q_{0,t}$.

the economy before the FOMC meeting, Ω_t^b, the FOMC will increase the federal funds rate target by 25 basis points ($\Delta r_{ff,t}^* = 0.25$) if it decides to take a policy action. In turn, the probability that it will take a policy action is $(1-q_{0,t})$. The magnitude of $\Delta r_{ff,t}^*$ depends on whether previous policy actions were postponed or whether new information since the last FOMC meeting now implies a change in the federal funds rate target.[6] If the previous level of the federal funds rate target is consistent with the FOMC's reaction function, and new economic information suggests that the current rate should be maintained, then $\Delta r_{ff,t}^*$ equals zero.

We can use equation (1) to represent the anticipation and announcement effects of federal funds rate target changes on market rates. The anticipatory movement in the one-month spot interest rate from immediately after the previous month's FOMC meeting ($r_{1,t-1}^a$) to just before the current month's meeting ($r_{1,t}^b$) is

$$r_{1,t}^b - r_{1,t-1}^a = (1-q_{0,t}) \cdot \Delta r_{ff,t}^* \quad , \tag{2}$$

which is the probability that the FOMC will change the federal funds rate target multiplied by the magnitude of the change given that one is made. Similarly, the announcement effect on the one-month rate from just before to immediately after the current month's FOMC meeting is

$$r_{1,t}^a - r_{1,t}^b = q_{0,t} \cdot \Delta r_{ff,t}^* \quad , \tag{3}$$

[6] From (1), the policy action was postponed if the Federal Reserve took a discretionary action not to change the target when $\Delta r_{ff,t-1}^* \neq 0$. In the absence of new information about the economy, the conditional target change in the current month is that same as that in the previous month (i.e., $\Delta r_{ff,t}^* = \Delta r_{ff,t-1}^*$).

which is equal to the probability that the FOMC will not change the federal funds rate target multiplied by the target change that was actually implemented. The responses (2) and (3) imply that the greater the assessed likelihood that a policy action will be implemented (lower $q_{0,t}$), the larger the movement of the one-month rate in anticipation of the policy change and the smaller the announcement effect.

To consider term-structure effects, we also examine the anticipatory and announcement effects on the expected one-month rate one month from now. In this case, the anticipatory movement of the expected one-month ahead one-month rate from just after the previous FOMC meeting to immediately before the current meeting is

$$E(r_{1,t+1}|\Omega_t^b) - E(r_{1,t}|\Omega_{t-1}^a) = [(1-q_{0,t}) + q_{0,t} \cdot (1-q_{1,t})] \cdot \Delta r_{ff,t}^* , \qquad (4)$$

where the first term in the brackets is the probability that the FOMC will change the federal funds rate target at the current meeting, and the second term is the probability that the FOMC will not change the target at the current meeting $q_{0,t}$ multiplied by the probability that it will change the target at next month's meeting given that the target did not change this month, $(1-q_{1,t})$.[7] In this case the announcement effect from just before to immediately after the current FOMC meeting is

$$E(r_{1,t+1}|\Omega_t^a) - E(r_{1,t+1}|\Omega_t^b) = q_{0,t} \cdot q_{1,t} \cdot \Delta r_{ff,t}^* , \qquad (5)$$

which is equal to the probability that the FOMC will not change rates in the current and the next FOMC meeting multiplied by the target change. Again, the more that the policy action is anticipated (lower $q_{0,t}$ and $q_{1,t}$), the less the announcement effect. Also, the response of the expected one-month ahead one-month rate (5) is less than that of the spot one-month rate (2). This further implies under the linear version

[7] When the federal funds rate target is changed, we assume for simplicity that the change is expected to be permanent. In the model presented by Roley and Sellon (1998), this is equivalent to assuming that shocks to aggregate demand or supply are permanent. In fact, Roley and Sellon (1998) cannot reject the hypothesis that the economic shocks that are offset by the Federal Reserve are permanent.

of the expectations hypothesis that the announcement effect on the spot two-month rate is less than that of the one-month rate. In particular, from (2) and (5), the announcement effect on the spot two-month rate is

$$r_{2,t}^{a} - r_{2,t}^{b} = (1/2)\cdot[q_{0,t} + q_{0,t}\cdot q_{1,t}]\cdot \Delta r_{ff,t}^{*} \quad . \tag{6}$$

Similarly, this model implies that the announcement effect continues to decline as the maturity of the spot interest rate increases. Consequently, the announcement-effect response pattern implied by the model is broadly consistent with the empirical results summarized above (e.g., Cook and Hahn (1989), and Roley and Sellon (1998)). We use this model further below, where we consider the determinants of possible nonannouncement effects. We are also able to compare the relative patterns implied by announcement and nonannouncement effects in the model.

Determinants of Nonannouncement Effects. Nonannouncement effects exist if market rates respond when an expected policy action does not materialize. That is, like policy actions, nonactions may also be informative. As in the case of announcement effects, the size of a nonannouncement effect should depend on the extent to which markets are surprised by the absence of a policy action and on whether markets alter their views as to the path of future policy actions. In general, the market response should be larger the more markets had anticipated a policy change; that is, the greater the nonannouncement surprise. The size of the nonannouncement effect is also likely to depend on how markets interpret the absence of a policy action. For example, if markets interpret the lack of action as signaling that expected future actions may not be forthcoming, the response of rates could be quite large as markets unwind both current and expected future policy actions. Alternatively, if the current lack of action is seen as having little effect on the likelihood of future policy actions, the response of rates is likely to be much smaller.

We can formalize these possible effects in the context of our model. In particular, from (1) and (2), the nonannouncement effect on the one-month spot rate from immediately before to immediately after the current FOMC meeting is

$$r_{1,t}^{a} - r_{1,t}^{b} = -(1-q_{0,t})\cdot \Delta r_{ff,t}^{*} \quad . \tag{7}$$

In this case, the nonannouncement effect is simply the negative of the previous anticipation effect (2). This result is not surprising since we assume that the Federal Reserve only changes the federal funds rate target at FOMC meetings. So, given that a change did not occur, the market knows that the target will not change over the remainder of the month, causing the one-month rate to move to its previous level, $r^{a}_{1,t-1}$. Also note that for a given conditional change in the federal funds rate target, $\Delta r^{*}_{ff,t}$, the size of the nonannouncement effect depends on the market's assessment that the target rate will not change at the current FOMC meeting, $q_{0,t}$. The smaller the probability that the target rate will not change, the greater the nonannouncement effect. At the extremes, the nonannouncement effect equals zero if the market attaches a zero probability to the event that the target will change, and it equals the negative of the entire conditional change in the federal funds rate target if the market assumes that there is a zero probability that the target will <u>not</u> change. Finally, the nonannouncement effect for the one-month rate will be smaller in absolute value than the announcement effect (3) if the probability that the target will <u>not</u> change ($q_{0,t}$) is greater than 0.5.

The nonannouncement effect for the expected one-month ahead one-month rate can be derived using (1) and (4). In this case, the nonannouncement effect is

$$E(r_{1,t+1}|\Omega^{a}_{t}) - E(r_{1,t+1}|\Omega^{b}_{t}) = -(1-q_{0,t}) \cdot q_{1,t} \cdot \Delta r^{*}_{ff,t} \quad , \qquad (8)$$

The nonannouncement effect is equal to the negative of the anticipation effect due to an expected target change at the current meeting (2), multiplied by the probability that the target also will not change at next month's FOMC meeting. That is, the anticipation effect from a possible target change is being unwound from the expected future spot rate, but only to the extent that the target is not expected to change at next month's meeting. Different values for the probabilities that the target rate will not change in the current month or in the next month imply a range of possible nonannouncement effects. If market participants feel that if the target does not change this month, then there is no chance that it will change next month

($q_{1,t} = 1$), then the entire anticipation effect will be unwound from the expected future spot rate. Alternatively, if participants feel that if the target does not change this month, then it will change with a probability of 1 next month ($q_{1,t} = 0$), the nonannouncement effect equals zero.

Term structure effects can again be considered by combining the nonannouncement effects of the spot and expected future interest rate. In particular, using equations (7) and (8), the response of the spot two-month rate is

$$r^a_{2,t} - r^b_{2,t} = -(1/2)\cdot[(1-q_{0,t}) + (1-q_{0,t})\cdot q_{1,t}]\cdot \Delta r^*_{ff,t} \ . \qquad (9)$$

The nonannouncement effect (9) is larger than the announcement effect (6) in absolute value if the probability that the target will not change at the current month's FOMC meeting is less than a half ($q_{0,t} < 0.5$). Possible values for the nonannouncement effect (9) follow from the discussions of the nonannouncement effects on the spot and expected future interest rate. In particular, the greater the probability that the target will change at this month's meeting (lower $q_{0,t}$) and the greater the probability that the target will not change at next month's meeting given that it did not change this month's meeting (higher $q_{1,t}$), the larger the absolute value of the nonannouncement effect.

Despite its simplicity, this model provides a framework for understanding how market interest rates may respond when an anticipated monetary policy action does not occur. The size of a nonannouncement effect clearly depends on the extent to which the market is surprised by the policy decision as reflected in an expected change that is built into market rates prior to the decision. If no change is expected, there is no surprise and no nonannouncement effect. In addition, the response to a nonannouncement depends on market participants' views on expected future policy actions given that an action did not occur at the current FOMC meeting. The model shows that, for a security of given maturity, the nonannouncement effect will be larger the greater the probability that the expected policy action will be postponed. In the limit, an anticipated policy action will be fully unwound from market rates if the absence of action at the current meeting is seen as eliminating the likelihood of future actions during the maturity of

the security. Alternatively, for a given length of time that a policy action is expected to be postponed, the size of the nonannouncement effect will decline with the maturity of the security.

A closer look at the model, however, shows a possible limitation. Indeed, an important assumption generating nonannouncement effects in the model is the requirement that the dates of policy decisions occur at discrete intervals and are known with certainty. While this assumption is reasonable in recent years where, since 1994, 10 out of 11 FOMC decisions have occurred at regularly scheduled meetings, it has not been accurate in the past. Indeed, as we show in Table 1, during the period from October 1988 to February 1994 most policy actions happened on nonmeeting dates. If the timing of policy decisions is uncertain, nonannouncement effects will tend to be smaller. In our model, for example, a decision not to change policy results in a complete unwinding of anticipated effects in the one-month rate only because it is known that no policy action will be forthcoming until the next scheduled meeting. If actions can occur at any time in the next month, the lack of action at the current FOMC meeting may not be particularly informative. If so, markets may continue to incorporate an expected policy action, reducing the size of a nonannouncement effect or even eliminating the effect. Furthermore, if the timing of policy decisions is uncertain and FOMC meeting dates are not especially informative, it becomes conceptually difficult even to measure nonannouncement effects.

III. Estimating Nonannouncement Effects

The model we present above suggests that market interest rates may respond when a central bank decides not to take a policy action that is widely expected in financial markets. These nonannouncement effects depend both on the extent to which markets are surprised by the lack of action and on how the absence of action leads financial market participants to revise their estimates of the likelihood and timing of future policy actions. Whether nonannouncement effects exist, however, is an empirical question. In this section, we attempt to estimate nonannouncement effects and also examine the extent to which financial markets react to the absence of an expected policy action by altering their expectations of future policy actions. We also test whether nonannouncement effects changed after February 1994.

Specification and data. The first issue that we address is whether market interest rates react systematically on FOMC meeting dates when a policy action is expected but does not occur. To examine

this question, we need a measure of the market's expectation of a policy action. We employ federal funds futures rates to construct a proxy for this expectation. Specifically, we use the deviation of the one-month ahead federal funds futures rate from the existing federal funds rate operating target on the day prior to the nonannouncement day as our measure of market expectations of policy actions. When the one-month ahead futures contract spans two FOMC meetings, however, we use the current month's contract. In this case, we adjust the futures rate to take into account the daily observations in the federal funds rate that have already occurred during the current month.[8]

While federal funds futures rates would seem to be natural candidates to serve as a proxies for the market's expectation of future federal funds rate target changes, recent studies suggest several possible shortcomings. First, Krueger and Kuttner (1996) and Robertson and Thornton (1997) estimate that the one-month ahead futures rate is a biased forecast of the average of actual daily funds rates over a month. The additive biases estimated by these researchers, however, do not affect our estimates. In particular, any additive bias would be reflected in the constant terms in our nonannouncement effects regressions. Second, Robertson and Thornton (1997) also suggest that the monthly averages of actual daily funds rates can exhibit persistent biases relative to the average federal funds rate target over a month. To the extent that these biases are time varying, this property could introduce noise into our expectations measure and hence reduce our nonannouncement effects estimates. Finally, Robertson and Thornton (1997) also suggest that it is difficult to infer the timing and magnitude of future target changes using federal funds futures rates. We are not, however, using federal funds futures rates for this purpose. Instead, we use futures rates to represent market expectations at a particular point in time (i.e., the day before FOMC meetings). Moreover, as we discuss above, we use futures contracts that only span the FOMC meeting on the next day. So, if the market expects a change in the target rate at the FOMC meeting, this expectation should be reflected in our measure. However, if for some reason the market instead expects a target change between the current and next FOMC meetings and not at the current meeting, then our measure will again contain

[8] A federal funds rate futures contract represents the average of daily observations in the federal funds rate in a given month. For the current month's contract, the futures rate reflects an average of the daily funds rates that have already been observed and the expected future daily rates for the remainder of the month. We adjust the current month's contract so that it only reflects a daily average of the expected funds rates from the day of the FOMC meeting through the end of the month.

noise and our response estimates will be lower. Nevertheless, Krueger and Kuttner (1996) and Robertson and Thornton (1997) find that federal funds futures rates contain information about target changes, and Krueger and Kuttner find that forecasts using one-month ahead futures rates dominate those using alternative empirical models.[9]

We estimate nonannouncement effects using our expectations proxy in the following specification:

$$\Delta r_{i,t} = a_i + b_i \cdot urff_t + e_{i,t} \qquad , \tag{10}$$

where $urff_t$ is the nonannouncement surprise, which we calculate as the actual federal funds rate target change ($=0$) minus the expected change using the federal funds rate futures data, $e_{i,t}$ is a random error term, a_i and b_i are coefficient estimates, and $\Delta r_{i,t}$ is the one-day change in interest rate or stock price i from the day before to the day of a policy nonannouncement. Starting in February 1994, the nonannouncement day is the day of the Federal Reserve statement at the conclusion of the FOMC meeting. Before February 1994, the nonannouncement day is the day after the FOMC meeting, since federal funds rate target changes were typically first revealed in open-market operations on this day. As we indicate in Table 1, the entire sample begins on October 20, 1988 and ends on November 12, 1997, with 35 and 21 nonannouncements in the pre- and post-February 1994 periods, respectively. The starting date corresponds to the availability of federal funds rate futures data, which we discuss below.

Using specification (10), we estimate the responses of interest rates and stock prices to nonannouncement surprises. The interest rates consist of 3- and 6-month Treasury bill yields and 1-, 3-, 5-, 7-, and 10-year zero-coupon yields. The original source of these data is the Federal Reserve's data files. We convert the available constant-maturity Treasury security yields from this source into zero-coupon

[9] Similar to Robertson and Thornton (1997), we also considered a dummy variable based on movements in the 3-month Treasury bill yield from the day after the previous target change to the day before the current FOMC meeting as a proxy for market expectations of a policy change. In particular, we constructed a dummy variable that was equal to 1 or -1 if the value of the cumulative change in the bill rate exceeded 12.5 basis points or was below -12.5 basis points, which is one-half of the typical target change of plus or minus 25 basis points, and zero otherwise. Thus, we interpret changes in the bill rate of less than 12.5 basis points in absolute value as not reflecting an expectation of a policy action at the current meeting. The estimation and test results using this measure are qualitatively the same as those we report for the expectations proxy based on federal funds futures rates.

yields.[10] From this same data source, we also collect data for the level of the Standard & Poor's 500 Index, and we calculate the one-day change in logs. We consider the response of stock prices in addition to long-term interest rates to help determine whether nonannouncement effects relate to short- or long-run monetary-policy information.

We also estimate the responses of the 1-, 2-, and 3-month ahead federal funds futures rates in specification (10), where the underlying contracts began trading in October 1988. We collect these data from DRI/McGraw-Hill and from the Chicago Board of Trade (CBOT). When the day before and the day of a nonannouncement are in different months, we realign the futures contracts so that the response is measured for the same contract. We estimate these futures-rate responses to help us determine whether our estimates of the spot interest-rate and stock-price responses represent changes in expected future policy.[11] As before, when the one-month ahead futures contract spans two FOMC meetings, we use the current month's contract. In this case, we again adjust the futures rate to take into account the daily observations in the federal funds rate that have already occurred during the current month.

We can relate our empirical nonannouncement surprise measure to our theoretical nonannouncements effects model. In particular, the empirical surprise measure, $urff_t$, corresponds to the theoretical one-month spot-rate response (7). That is, the nonannouncement surprise represents the actual target change ($=0$) minus the expected target change. In turn, the expected target change equals the probability that the Federal Reserve will change the target, $(1-q_{0,t})$, multiplied by the conditional change in the target, $\Delta r^{*}_{ff,t}$. We assume that the spread in the one-month ahead federal funds futures rate relative to the target rate before an FOMC meeting is equal to the theoretical expected change. Moreover, as we indicate in the theoretical specification (7), we also recognize that the probability of a target change at the current FOMC meeting, $(1-q_{0,t})$, may vary over time. Our empirical expectations measure captures this

[10] To convert the Treasury yield data into zero-coupon yields, we first calculate the durations of the available maturities. We then estimate a cubic spline to calculate yields on zero-coupon Treasury securities with exactly 1, 3, 5, 7, and 10 years to maturity. For a description of a related procedure, see McCulloch (1975). For a good description of the cubic spline, see Judd (1995).

[11] For discussions of the relation between federal funds futures rates and future Federal Reserve policy actions, see Carlson, McIntire, and Thomson (1995), Krueger and Kuttner (1996) and Robertson and Thornton (1997).

potential time variation since the federal funds futures rate presumably embodies the market's assessed probability of a target change at any given time.

We can also relate the empirical response coefficients, b_i, to the theoretical nonannouncement effects model. In this case, the interest-rate responses to nonannouncement surprises are functions of future conditional probabilities of target changes. These conditional probabilities, $q_{n,t}$, represent the probability that the target rate will not change in period $t+n$ given that it has not changed in the $n-1$ previous periods. For example, given the hypothetical assumption of our theoretical model that target changes are only made at the beginning of the month, the implied empirical response coefficient of the 2-month interest rate to a nonannouncement surprise is, from equation (9), equal to $(1/2)\cdot(1+q_{1,t})$.[12] Similarly, the 3-month interest-rate response coefficient is $(1/3)\cdot(1+q_{1,t}+q_{1,t}\cdot q_{2,t})$. The responses of longer-term interest rates take similar form, with the addition of multiplicative terms as maturity lengthens. Again, however, we derive these theoretical response coefficients under the assumption that target changes are only made at the beginning of the month.

If the market instead feels that target changes may be made both at and between FOMC meetings, then the response coefficients are altered. For example, the response coefficient of the one-month rate is equal to 1 if target changes are only made at the beginning of the month. That is, the entire expected target change is unwound from the one-month rate, following equation (7). If, however, the market feels that target changes may be made at any of three possible dates within a month, then the response of the one-month rate is equal to $(1/3)\cdot(1+q_{1,t}+q_{1,t}\cdot q_{2,t})\leq 1$, where $q_{1,t}$ and $q_{2,t}$ now represent the probabilities that the target will not change after one-third and two-thirds of the current month has passed, respectively. Consequently, our estimated responses to nonannouncements (b_i) reflect both the average assessed probabilities and frequencies of target changes. Again, we might expect larger responses in the post-February 1994 period because 10 of the 11 the target changes occurred immediately following FOMC

[12] Recall that the nonannouncement surprise is equal to $-(1-q_{0,t})\cdot\Delta r^{*}_{ff,t}$. So, the 2-month interest-rate response coefficient multiplied by this surprise is equal to the theoretical 2-month interest-rate response (9).

meetings.[13] That is, consistent with the nonannouncement responses in our theoretical model, market participants may expect that most target changes will occur immediately following FOMC meetings after February 1994. This further implies that any expected target change is more likely to be unwound from market rates on securities maturing before the next FOMC meeting. In the pre-February 1994 period, this effect may be smaller since 80 percent of the target changes were made between FOMC meetings.

Estimation and test results. To test for nonannouncement effects, we estimate specification (10) presented above. This specification relates one-day responses of Treasury security yields, stock prices, and federal funds futures rates to nonannouncement surprises.[14] The results, shown in Table 2, suggest that there are statistically significant nonannouncement effects at the short- to intermediate-end of the yield curve. In particular, there are significant nonannouncement effects in the Treasury market from three months out to three years. Indeed, approximately 18 percent of the expected target change is reversed in the three-month bill yield and about 13 percent of the expected change is taken out of the three-year yield. The 6-month and 1-year yields also exhibit statistically significant nonannouncement effects. Beyond three years, there does not appear to be any effect. Consistent with the lack of response of long-term yields, we also estimate that stock prices do not respond significantly. The responses of federal funds futures rates provide evidence that a portion of expected future target changes is unwound at short horizons, similar to the responses of short- to intermediate-term Treasury yields. In particular, we estimate significant responses for each of the futures rates, as indicated in the last three rows in the table. Estimates for the one-month ahead futures rate suggest that about 27 percent of the expected target change is unwound from this rate.

[13] Moreover, both announcements and nonannouncements were made following meetings. The predictability of the timing of target changes, however, should be much more important than whether announcements or nonannouncements are made. In particular, Thornton (1996) notes that when federal funds rate target changes were accompanied by discount rate changes before February 1994, this reveals similar information as a target change announcement. Also, even when the Federal Reserve used the federal funds rate to implement policy before October 1979, Cook and Hahn (1989) document that the market knew virtually all of the target changes.

[14] We also estimated two-day responses to nonannouncement surprises. The point estimates of the two-day responses are very similar to those of the one-day responses in Table 2, but the standard errors of the two-day responses are larger in every instance. Consequently, expanding the response window to two days appears to just add noise to the estimates.

As a whole, the results in Table 2 suggest four conclusions. First, the statistically significant responses to nonannouncements indicate that these events provide information to financial markets. Second, because all of our interest-rate response estimates are significantly less than one, our results suggest that nonannouncements are perceived to represent postponements rather than cancellations of expected future policy actions. Third, with the exception of the one-year yield's response, the term structure's response declines monotonically as maturity lengthens, consistent with our theoretical model. Finally, the information content of zero and nonzero changes in the federal funds rate target appears to be different. In particular, the lack of significant responses of long-term interest rates and stock prices to nonannouncements is in sharp contrast to previous studies estimating their responses to nonzero target changes (e.g., Cook and Hahn (1989), Roley and Sellon (1998), Thorbecke and Alami (1994), and Thorbecke (1997)). Consequently, the market response suggests that policy actions are expected to be much more persistent than policy nonactions.

We next test whether the responses to nonannouncements change after February 1994. We conduct these tests using a modified version of specification (10). As we report in Table 3, we find no evidence of larger nonannouncement effects for Treasury security yields after February 1994. In particular, the test results indicate that the hypothesis that the responses are the same across pre- and post-February 1994 periods cannot be rejected at the 10 percent significance level for any Treasury security yield.[15] We obtain similar results for the two- and three-month ahead federal funds futures rates, where we again cannot reject the hypothesis that the responses in the pre- and post-February 1994 periods are the same at the 10 percent level. In contrast, the hypothesis that the response of the one-month ahead futures rate is the same across subsamples can be rejected at the 5 percent level. In this case, the estimation results suggest that about 20 percent of the expected target change is unwound from the one-month ahead futures rate before February 1994, and this rises to about 40 percent after February 1994.

The larger response of the one-month ahead federal funds futures rate after February 1994 is consistent with the market expecting fewer target changes between meetings. The response of this futures rate is not equal to one, however, suggesting that the market still thinks it is possible that the Federal

[15] Thornton (1996) reports a similar result for nonzero target changes. In particular, he finds that the total response of the 3-month Treasury bill yield to target changes is not significantly different across pre- and post-February 1994 periods.

Reserve will change the target rate between meetings. That is, not all of the expected change in the federal funds rate is unwound from this futures rate. The results for Treasury security yields in Table 3 further imply that the practice of announcing most target changes after FOMC meetings starting in February 1994 has not significantly affected the response of the term structure to nonannouncements. Moreover, the results suggest that the market views nonannouncements as postponements rather than changes in the long-run stance of monetary policy both before and after February 1994.

IV. Summary and Conclusions

While there is an extensive literature on how asset prices respond to monetary policy actions and economic data that are thought to influence policy actions, a lack of attention has been given to how asset prices react when expected policy actions do not materialize. Such a response could occur if the absence of an expected policy action provides information to financial markets. In an expectations view of the term structure, for example, a nonannouncement surprise could cause interest rates to respond to the extent that it cause markets to alter the expected path of future short-term rates.

This paper examines how Treasury security yields, stock prices, and federal funds futures rates respond on FOMC meeting dates when expected policy actions do not occur. The empirical results support the existence of nonannouncement effects on short- to intermediate-term yields. In particular, part of an expected policy action, measured using federal funds futures rates, is unwound when the action does not materialize. In an expectations framework, this partial unwinding is consistent with markets reacting to the surprise by postponing, but not eliminating, the possibility of a future policy action. Our empirical results also lend support to this interpretation. On FOMC days where we find evidence of nonannouncement effects in the Treasury market, we also find a response in federal funds futures rates consistent with a revision to expectations of future policy actions. We also test whether the market reaction to policy nonannouncements is larger after February 1994, when the Federal Reserve made all but one of its nonzero changes in the federal funds rate target at FOMC meetings. We find that the response to nonannouncements is only larger for a near-term federal funds future rate, and not for the Treasury security yields we consider. Taken together, these results suggest that monetary policy decisions can be informative to financial markets even when these decisions do not involve an overt policy action.

References

Balduzzi, Pierluigi, Guiseppe Bertola, and Silverio Foresi, "A Model of Target Changes and the Term Structure of Interest Rates," Journal of Monetary Economics, 39 (July, 1997) 223-49.

Balduzzi, Pierluigi, Guiseppe Bertola, Silverio Foresi, and Leora Klapper, "Interest Rate Targeting and the Dynamics of Short-term Rates," Journal of Money, Credit, and Banking, 30 (February, 1998), 26-50.

Bernanke, Ben S., and Alan S. Blinder, "The Federal Funds Rate and the Channels of Monetary Transmission," American Economic Review, 82 (September, 1992), 901-21.

Bonser-Neal, Catherine, V. Vance Roley, and Gordon H. Sellon, Jr., "Monetary Policy Actions, Intervention, and Exchange Rates: A Re-examination of the Empirical Relationships Using Federal Funds Rate Target Data," Journal of Business, 71 (April, 1998), 147-77.

Carlson, John B., Jean McIntire, and James B. Thomson, "Federal Funds Futures as an Indicator of Future Monetary Policy: A Primer," Federal Reserve Bank of Cleveland, Economic Review, (First Quarter, 1995), 20-30.

Clarida, Richard, Jordi Gali, and Mark Gertler, "Monetary Policy Rules in Practice: Some International Evidence," National Bureau of Economic Research, Working Paper No. 6254, 1997.

Clarida, Richard, Jordi Gali, and Mark Gertler, "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," New York University, Working Paper RR# 98-01, 1998.

Cook, Timothy, and Thomas Hahn, "The Effect of Changes in the Federal Funds Target on Market Interest Rates in the 1970s," Journal of Monetary Economics, 24 (November, 1989), 331-51.

Engel, Charles, and Jeffrey Frankel, "Why Interest Rates React to Money Announcements: An Explanation from the Foreign Exchange Market," Journal of Monetary Economics, 13 (January, 1984), 31-9.

Fuhrer, Jeffrey C., and George R. Moore, "Monetary Policy Trade-offs and the Correlation between Nominal Interest Rates and Real Output," American Economic Review, 85 (March, 1995), 219-39

Hakkio, Craig S. and Douglas K. Pearce, "The Reaction of Exchange Rates to Economic News," Economic Inquiry, 23 (October, 1985), 621-36.

Hardouvelis, Gikas A., "Market Perceptions of Federal Reserve Policy and the Weekly Money Announcements," Journal of Monetary Economics, 14 (September, 1984), 225-40.

Hardouvelis, Gikas A., "Macroeconomic Information and Stock Prices," Journal of Economics and Business, 39 (May, 1987), 131-40.

Ito, Takatoshi, and V. Vance Roley, "News from the U.S. and Japan: Which moves the Yen/Dollar Exchange Rates?" Journal of Monetary Economics, 19 (March, 1987), 255-77.

Judd, Kenneth L., Numerical Methods in Economics, unpublished manuscript, April 1995.

Krueger, Joel T., and Kenneth N. Kuttner, "The Fed Funds Futures Rate as a Predictor of Federal Reserve Policy," Journal of Futures Markets, 16 (December, 1996), 865-79.

McCallum, Bennett T., "A Semi-classical Model of Price-level Adjustment," Carnegie-Rochester Conference Series on Public Policy, 41 (December, 1994), 251-84.

McCallum, Bennett T., and Edward Nelson, "Performance of Operational Policy Rules in an Estimated Semi-Classical Structural Model," Working Paper, Carnegie Mellon University, 1998.

McCulloch, J. Huston, "The Tax-Adjusted Yield Curve," Journal of Finance, 30 (June, 1975), 811-30.

McQueen, Grant R., and V. Vance Roley, "Stock Prices, Economic News, and Business Conditions," Review of Financial Studies, 6 (No. 3, 1993), 683-707.

Pearce, Douglas K., and V. Vance Roley, "The Reaction of Stock Prices to Unanticipated Changes in Money: A Note," Journal of Finance, 38 (September, 1983), 1323-33.

Pearce, Douglas K., and V. Vance Roley, "Stock Prices and Economic News," Journal of Business, 58 (January, 1985), 49-67.

Radecki, Lawrence J., and Vincent Reinhart, "The Financial Linkages in the Transmission of Monetary Policy in the United States," in National Differences in Interest Rate Transmission. Basle: Bank for International Settlements, 1994.

Reinhart, Vincent, and Timothy Simin, "The Market Reaction to Federal Reserve Policy Action from 1989 to 1992," Journal of Economics and Business, 49 (March/April, 1997), 149-68.

Robertson, John C., and Daniel L. Thornton, "Using Federal Funds Futures Rates to Predict Federal Reserve Actions," Federal Reserve Bank of St. Louis, Review, 79 (November/December, 1997), 45-53.

Roley, V. Vance, and Gordon H. Sellon, Jr., "Monetary Policy Actions and Long-Term Interest Rates," Federal Reserve Bank of Kansas City, Economic Review, 80 (Fourth Quarter, 1995), 73-89.

Roley, V. Vance, and Gordon H. Sellon, Jr., "The Response of Interest Rates to Anticipated and Unanticipated Monetary Policy Actions," working paper, University of Washington, June 1998.

Rudebusch, Glenn D., "Federal Reserve Interest Rate Targeting, Rational Expectations, and the Term Structure," Journal of Monetary Economics, 35 (April, 1995a), 245-74.

Sims, Christopher A., "Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy," European Economic Review, 36 (June, 1992), 975-1000.

Taylor, John B., "Discretion Versus Policy Rules in Practice," Carnegie-Rochester Conference Series on Public Policy, 39 (1993), 195-214.

Thorbecke, Willem, "On Stock Market Returns and Monetary Policy," Journal of Finance, 52 (June, 1997), 635-54.

Thorbecke, Willem, and Tarik Alami, "The Effect of Changes in the Federal Funds Rate on Stock Prices in the 1970s," Journal of Economics and Business, 46 (February, 1994), 13-20.

Thornton, Daniel L., "Does the Fed's New Policy of Immediate Disclosure Affect the Market?" Federal Reserve Bank of St. Louis, Review, 78 (November/December, 1996), 77-88.

Table 1

Summary of Federal Reserve Policy Actions at and between FOMC Meetings in terms of Federal Funds Rate Target Changes: October 20, 1988 – November 12, 1997

FOMC Meeting				Non FOMC Meeting	
Target Change		No Target Change		Target Change	
16		56		25	
Pre 1994	Post 1994	Pre 1994	Post 1994	Pre 1994	Post 1994
6	10	35	21	24	1

Notes. The post-1994 period begins with the announced change in the federal funds rate target following the FOMC meeting on February 4, 1994.

Table 2

1-Day Responses to No Change in the Federal Funds Rate Target following FOMC Meetings: Federal Funds Rate Target Surprises using Federal Funds Futures Rates on the Day before Zero Target Changes

$$\Delta r_{i,t} = a_i + b_i \cdot urff_t + e_{i,t}$$

Sample: October 20, 1988 - November 12, 1997 (N=56)

$\Delta r_{i,t}$	a_i	b_i	$\bar{R}^2$	*SE*	*DW*
Treasury Security Yields					
3-month	0.0065	0.1839**	0.17	0.05	2.04
	(0.0066)	(0.0527)			
6-month	0.0029	0.1499**	0.12	0.05	2.14
	(0.0065)	(0.0516)			
1-year	0.0057	0.2010**	0.23	0.04	2.09
	(0.0060)	(0.0478)			
3-year	0.0049	0.1331**	0.06	0.06	2.14
	(0.0081)	(0.0646)			
5-year	0.0036	0.0600	-0.00	0.06	2.27
	(0.0084)	(0.0669)			
7-year	0.0040	0.0256	-0.02	0.05	2.26
	(0.0076)	(0.0603)			
10-year	-0.0000	0.0013	-0.02	0.06	2.20
	(0.0080)	(0.0636)			
Stock Return					
S&P 500	0.1256	0.3129	-0.02	0.86	1.39
	(0.1222)	(0.9763)			
Fed Funds Futures Rates					
1-month ahead	0.0038	0.2697**	0.41	0.04	1.70
	(0.0054)	(0.0431)			
2-months ahead	0.0046	0.1900**	0.41	0.03	2.19
	(0.0038)	(0.0304)			
3-months ahead	0.0019	0.1637**	0.28	0.03	2.01
	(0.0043)	(0.0345)			

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Notes. Estimated standard errors in parentheses.

Table 3

1-Day Responses to No Change in the Federal Funds Rate Target following FOMC Meetings Allowing Different Responses Starting in February 1994: Federal Funds Rate Target Surprises using Federal Funds Futures Rates on the Day before Zero Target Changes

$$\Delta r_{i,t} = a_i + b_i \cdot urff_{88,t} + c_i \cdot urff_{94,t} + e_{i,t}$$

Sample: October 20, 1988 - November 12, 1997 (N=56)

							$H_0: b_i = c_i$	
$\Delta r_{i,t}$	a_i	b_i	c_i	$\bar{R}^2$	*SE*	*DW*	$F(1,53)$	*p-value*
Treasury Security Yields								
3-month	0.0059 (0.0068)	0.1997** (0.0653)	0.1563* (0.0847)	0.16	0.05	2.03	0.1746	0.6777
6-month	0.0027 (0.0067)	0.1569** (0.0640)	0.1377 (0.0829)	0.10	0.05	2.14	0.0354	0.8514
1-year	0.0063 (0.0062)	0.1842** (0.0591)	0.2301** (0.0766)	0.22	0.04	2.08	0.2380	0.6276
3-year	0.0040 (0.0083)	0.1581* (0.0799)	0.0896 (0.1035)	0.04	0.06	2.14	0.2908	0.5920
5-year	0.0031 (0.0086)	0.0731 (0.0829)	0.0372 (0.1075)	-0.02	0.06	2.26	0.0739	0.7868
7-year	0.0036 (0.0078)	0.0390 (0.0748)	0.0023 (0.0969)	-0.03	0.05	2.26	0.0948	0.7593
10-year	-0.0010 (0.0082)	0.0273 (0.0787)	-0.0438 (0.1020)	-0.03	0.06	2.21	0.3225	0.5725
Stock Return								
S&P 500	0.1340 (0.1258)	0.0825 (1.2100)	0.7126 (1.5682)	-0.03	0.87	1.40	0.1072	0.7446
Fed Funds Futures Rates								
1-month ahead	0.0065 (0.0053)	0.1967** (0.0506)	0.3964** (0.0655)	0.46	0.04	1.85	6.1713**	0.0162
2-months ahead	0.0047 (0.0039)	0.1883** (0.0378)	0.1929** (0.0489)	0.40	0.03	2.19	0.0060	0.9387
3-months ahead	0.0015 (0.0044)	0.1751** (0.0428)	0.1439** (0.0554)	0.27	0.03	2.03	0.2102	0.6485

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Notes. Estimated standard errors in parentheses.

$urff_{87,t} = urff_t$ before February 4, 1994, zero otherwise.

$urff_{94,t} = urff_t$ after February 4, 1994, zero otherwise.

$urff_t$ = current zero federal funds rate target change minus the expected target change, where the expected target change is the one-month ahead federal funds futures rate minus the current target as of the day before the zero target change resulting from the FOMC meeting.

$\Delta r_{i,t}$ = either changes in Treasury security yields in percentage points, the percentage change in the level of the Standard and Poor's 500 Index (measured as the change in logarithms), or changes in Federal funds futures rates in percentage points, where all changes are measured from the day before to the day of zero changes in the federal funds rate target resulting from FOMC meetings.

a_i, b_i, c_i = estimated coefficients for security i.

e_i = random error term for equation i.

$\bar{R}^2$ = multiple correlation coefficient corrected for degrees of freedom.

DW = Durbin-Watson statistic.

F(1, 53) = F-statistic with 1 and 53 degrees of freedom.

$urff_t$ = current zero federal funds rate target change minus the expected target change, where the expected target change is the one-month ahead federal funds futures rate minus the current target as of the day before the zero target change resulting from the FOMC meeting.

$\Delta r_{i,t}$ = either changes in Treasury security yields in percentage points, the percentage change in the level of the Standard and Poor's 500 Index (measured as the change in logarithms), or changes in Federal funds futures rates in percentage points, where all changes are measured from the day before to the day of zero changes in the federal funds rate target resulting from FOMC meetings.

a_i , b_i = estimated coefficients for security i.

e_i = random error term for equation i.

$\bar{R}^2$ = multiple correlation coefficient corrected for degrees of freedom.

DW = Durbin-Watson statistic.