Market Perceptions Of U.S. Monetary Policy Since 1982

By V. Vance Roley

Most market observers agree that Federal Reserve monetary policy operating procedures changed in October 1982, if not before. Views differ, however, about the type of policy implemented since the change. The most common interpretation is that the Federal Reserve adopted an operating procedure designed to stabilize short-term interest rates and abandoned narrowly defined money, M1, as a policy target. Indeed, some analysts apparently believe that the Federal Reserve returned to the procedure in effect before October 1979.

This article examines the behavior of interest rates to infer market perceptions of monetary policy. Three aspects of interest rate behavior are considered. First, the volatility of interest rates since 1982 is compared with the

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volatility of previous periods. The relative volatility across periods provides evidence on the type of operating procedure adopted. Second, the response of interest rates to the Federal Reserve's weekly money announcements is estimated. These estimates provide evidence on both the type of operating procedure and the emphasis on M1 targets. Third, the response of interest rates to new information about inflation and economic activity is empirically examined. These estimates allow further insight about the role of M1 targets in monetary policy.

The results of this article suggest that the behavior of interest rates since 1982 is consistent with an operating procedure different from that of the late 1970s. It is also argued that the behavior of interest rates is consistent with a diminished role for M1 in monetary policy. The evidence also supports the notion that information about economic activity and inflation has assumed increased importance in the recent conduct of monetary policy.

Factors differentiating
monetary policy regimes

Monetary policy regimes are defined in this article in terms of Federal Reserve operating procedures and the emphasis placed on M1 targets. The operating procedures are classified into three stylized types—the federal funds rate, nonborrowed reserves, and borrowed reserves procedures. In conducting monetary policy, the short-run operating target differs depending on the operating procedure. Under the federal funds rate procedure, the Federal Reserve attempts to maintain the federal funds rate at a certain level for a given period, such as a week. Similarly, under the nonborrowed reserves procedure, the path for nonborrowed reserves is maintained over a given short-run period. Finally, under the borrowed reserves procedure, borrowings from the Federal Reserve's discount window are kept relatively stable.

In addition to being classified by operating procedures, monetary policy regimes are characterized by the emphasis on M1 targets. Under any procedure, the behavior of both the federal funds rate and longer term yields will differ over time depending on the degree of monetary control desired. So, both different operating procedures and different emphases on monetary targets imply different interest rate behavior.

To identify monetary policy regimes, three aspects of interest rate behavior are considered in some detail in this section. These aspects are the volatility of interest rates, the response of interest rates to weekly M1 announcements, and the response of interest rates to new information about inflation and economic activity. In brief, the federal funds rate should be most volatile under the nonborrowed reserves procedure, least volatile under the federal funds rate procedure, and somewhere between these

two cases under the borrowed reserves procedure. The volatility of longer term yields should partly reflect the volatility of the federal funds rate and the emphasis on achieving the monetary targets in future weeks. In terms of interest rate responses to new information in weekly M1 announcements, the federal funds rate should not respond under the federal funds rate and borrowed reserves procedures. The federal funds rate should respond, however, under the nonborrowed reserves procedure. The response of longer term yields depends to some extent on the response of the federal funds rate. The response of longer term yields depends primarily, however, on the emphasis the Federal Reserve and market participants place on M1 targets. More specifically, the relative response of longer term interest rates to money announcements and announcements concerning inflation and economic activity indicates the market's perception of the relative importance of these factors in monetary policy.

The remainder of this section describes theoretical considerations regarding the volatility of interest rates, the response of interest rates to weekly M1 announcements, and the response of interest rates to new information about inflation and economic activity. These factors are then used in the next section to characterize four possible monetary policy regimes since the late 1970s.

Volatility of interest rates

The volatility of the federal funds rate—an overnight rate in the bank reserves market—depends on disturbances affecting the market for reserves, Federal Reserve intervention in the reserves market through open market operations, and the market's perception of the type of operating procedures being used. If the market believes that the Federal Reserve will

offset shocks affecting the reserves market through open market operations, the federal funds rate will be relatively stable over a short period, such as a week. If disturbances in either the demand for or supply of reserves are

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not offset, however, the market will act on that information and the federal funds rate will move to clear the reserves market. Different operating procedures imply different behavior for the federal funds rate through these channels.

The volatility of other interest rates, such as the 3-month Treasury bill yield, also depends on the type of operating procedure employed by the Federal Reserve, although to a less extent. The 3-month Treasury bill yield depends on both the current federal funds rate and the rate expected in future weeks.[1] If the current week's federal funds rate fluctuates, then some of this volatility is reflected in the Treasury bill yield.

Treasury bill yields also fluctuate if financial market participants change their assessments about the federal funds rate in future weeks. Monetary targets are important in

examining this link.[2] If new information suggests, for example, that the money stock will be higher than previously expected, the Treasury bill yield may rise if the market expects the Federal Reserve to offset this unexpected increase. In this instance, the market expects the Federal Reserve to attempt to achieve a particular monetary target. Alternatively, if the Federal Reserve places little or no weight on a particular monetary target, the market will expect future levels of the federal funds rate to be as previously predicted. So, for a given monetary disturbance, the greater the Federal Reserve's commitment to achieve a particular monetary target, the greater the coinciding fluctuation in longer term yields.[3]

Response of interest rates to money announcements

The response of interest rates to the Federal Reserve's weekly M1 announcement also can be used to determine the market's perception of different monetary policy regimes. The response of the federal funds rate depends directly on the type of operating procedure employed by the Federal Reserve. In particular, the response depends on whether the corresponding shock to the market for reserves is offset. The reserves market is affected by unanticipated announced changes in M1 initially through the market's assessment of the

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[1] Under the pure expectations model of the term structure of interest rates, the 3-month, or 13-week, Treasury bill yield can be approximately related to current and expected future values of the federal funds rate as

$$\Delta RTB_t = (1/13)[RFF_t + E(RFF_{t+1}) + \ldots + E(RFF_{t+12})],$$

where RTB_t is the 13-week yield, RFF_t is the federal funds rate in week t, and $E(RFF_{t+i})$ is the expected federal funds rate in week $t+i$ as of week t.

[2] The Treasury bill yield depends on a number of other factors, most notably the level of expected inflation. This relationship is examined briefly below. For further analyses, see Bradford Cornell, "Money Supply Announcements and Interest Rates: Another View," *Journal of Business*, January 1983, pp. 1-24, and V. Vance Roley and Carl E. Walsh, "Monetary Policy Regimes, Expected Inflation, and the Response of Interest Rates to Money Announcements," *Quarterly Journal of Economics*, Supplement 1985, pp. 1011-1039.

[3] This assumes that the underlying shocks are the same. If the sizes of the shocks differ over periods, the volatility of interest rates also would change.

demand for required reserves. Required reserves depend on the level of bank deposits, the major component of M1. Under the lagged reserve requirements (LRR) system in effect before February 1984, required reserves depended on the level of the money stock two weeks previously, the statement week corresponding to the current week's money announcement data. Under the contemporaneous reserve requirements (CRR) system adopted in February 1984, required reserves depend on the current money stock, with a lag of several days. Also, reserve computation and maintenance periods are two weeks in length, while they lasted one week under LRR. Although the money announcement data under CRR do not coincide with the current reserve periods, unanticipated announced changes in M1 may still affect the demand for reserves if the unanticipated changes or surprises persist. That is, the current week's

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The response of the Treasury bill yield to money announcement surprises can be used to determined whether the Federal Reserve is perceived to be attempting to achieve its M1 target.

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demand for reserves would be affected if a positive money surprise caused market participants to raise their assessment of the current week's money stock.[4]

The response of Treasury bill yields and other longer term yields to money announcement surprises depends partly on the response

of the federal funds rate. Most of the response depends, however, on the extent to which the market expects the Federal Reserve to offset the shock in the future. Under CRR or LRR, the response is greater the more quickly the Federal Reserve acts to offset the money surprise in the future. So, the response of the Treasury bill yield to money announcement surprises can be used to determine whether the Federal Reserve is perceived to be attempting to achieve its M1 target.

Response of interest rates to inflation and economic activity announcements

The response of interest rates to new information about economic activity and inflation may operate through the same channels as money announcements if such information is related to money demand.[5] The demand for nominal money balances is usually thought to depend on the level of real activity and commodity prices. So, if either real economic activity or inflation is higher than expected, the market may raise its assessment of the current and future weeks' demand for money. Interest rates, then, would be expected to rise if the market did not expect the Federal Reserve to accommodate the increased demand.

The primary effect on interest rates is likely to depend on the direct value of information about the economy. In this case, if inflation is announced to be higher than expected, for example, policymakers may adopt more restrictive policies, causing interest rates to rise immediately. The effect could be the same for an unexpectedly large increase in eco-

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[4] This analysis is different from that presented by William T. Gavin and Nicholas V. Karamouzis, "The Reserve Market and the Information Content of M1 Announcements," *Economic Review*, Federal Reserve Bank of Cleveland, Q1:1985, pp. 11-28. They apparently assume that money demand shocks are not autocorrelated. Also, as is discussed in the next section, autocorrelated money supply shocks emanating from the reserves market can affect the response of interest rates under CRR.

[5] For further discussion of the effect of economic information on interest rates, see V. Vance Roley and Rick Troll, "The Impact of New Economic Information on the Volatility of Short-Term Interest Rates," *Economic Review*, Federal Reserve Bank of Kansas City, February 1983, pp. 3-15.

nomic activity. Depending on the Federal Reserve's emphasis on this type of information, the response of interest rates may have varied over the different monetary policy regimes.

Monetary policy regimes

The factors related to interest rate behavior discussed in the previous section are used to differentiate four potential monetary policy regimes since the late 1970s. The four regimes correspond to the periods before October 1979, from October 1979 to October 1982, from October 1982 to February 1984, and after February 1984. These regimes are potentially different in terms of the Federal Reserve's operating procedures, its emphasis on M1 targets, and the reserve requirement systems.

Pre-October 1979

Before October 1979, the Federal Reserve used the federal funds rate, or money market conditions, operating procedure.[6] Under this procedure, the Federal Reserve offsets most shocks affecting the reserves market to keep the federal funds rate relatively stable over a given period, such as a week. If the federal funds rate is higher than desired, for example, the Federal Reserve adds nonborrowed reserves to the reserves market by purchasing Treasury securities. The increased supply of reserves causes the federal funds rate to fall.

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[6] For detailed discussions of these different operating procedures, see R. Alton Gilbert, "Operating Procedures for Conducting Monetary Policy," *Review*, Federal Reserve Bank of St. Louis, February 1985, pp. 13-21; and V. Vance Roley, "The Response of Interest Rates to Money Announcements Under Alternative Operating Procedures and Reserve Requirement Systems," *Proceedings of the Fall 1985 Academic Conference*, Federal Reserve Bank of San Francisco, forthcoming.

Even under this procedure, the federal funds rate would be expected to exhibit some volatility over time. In particular, to offset deviations in money growth from its target, the Federal Reserve made discretionary changes in the rate. In turn, the expectation of future discretionary changes influenced the volatility of Treasury bill yields. Nevertheless, the Federal Reserve was often perceived before October 1979 as not quickly offsetting deviations in money growth, so the volatility of both the federal funds rate and Treasury bill yields was likely to be relatively low.

Under the federal funds rate procedure, the federal funds rate also should not respond to money announcement surprises. In this case, a positive money announcement surprise increases the market's assessment of the demand for reserves in the current week. The federal funds rate should not respond, however, because market participants expect the Federal Reserve to accommodate the shock initially in the market for reserves. Nevertheless, if market participants expect the Federal Reserve eventually to offset at least part of the unanticipated increase in money to achieve its monetary targets, Treasury bill yields will rise immediately. Moreover, if the Federal Reserve focused primarily on its monetary targets and not on direct information about the economy, new information about economic activity and inflation should not cause changes in Treasury bill yields.

October 1979-October 1982

In October 1979, the Federal Reserve replaced the federal funds rate operating procedure with the nonborrowed reserves, or reserves aggregate, procedure. Under this procedure, most disturbances affecting the reserves market, and therefore the federal funds rate, are not offset. Instead, the nonbor-

rowed reserves path is maintained over a given period and the federal funds rate fluctuates in response to shocks either to the demand for or supply of reserves. As a result, the federal funds rate would be expected to be more volatile under this procedure.

In addition to the increased volatility due to the procedure itself, the Federal Reserve indicated its desire to improve monetary control in October 1979. So, for a given deviation of money growth from its target, the likelihood of future discretionary changes in policy to offset the deviation may have increased. As a result, the volatility of both the federal funds rate and Treasury bill yields would be expected to be higher than before October 1979.

In terms of the specific monetary information provided by a positive money announce-

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In comparison with the other procedures, the borrowed reserves procedure implies more short-run volatility in the federal funds rate.

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ment surprise, for example, the federal funds rate should increase under the nonborrowed reserves operating procedure. This rise is due to a higher assessment of the demand for reserves that is not expected to be accommodated through Federal Reserve open market operations. In turn, Treasury bill yields partly reflect this increase in the federal funds rate. Moreover, if the Federal Reserve was offsetting monetary shocks more quickly and completely during this period, there would be a further response of Treasury bill yields. So, the responses of both the federal funds rate and Treasury bill yields to money announcement surprises should be greater than before October 1979. Given the focus on monetary targets under the October 1979-October 1982 regime, the effects of new information on eco-

nomic activity and inflation would be expected to be minimal.

October 1982-February 1984

Sometime around October 1982, the Federal Reserve replaced the nonborrowed reserves procedure with a borrowed reserves procedure.[7] Under the borrowed reserves procedure, the Federal Reserve can be characterized as attempting to achieve a certain level of discount window borrowing over a given period. An important determinant of discount window borrowing is usually thought to be the spread between the federal funds rate and the discount rate.[8] If the federal funds rate rises, for example, banks will find borrowing at the discount window more attractive because borrowed reserves can be obtained at less cost.

With the borrowed reserves procedure, unanticipated changes in either required or excess reserves are accommodated by changing nonborrowed reserves. If the demand for required reserves is higher than expected, for example, the federal funds rate rises initially and borrowing increases to equate supply and demand in the reserves market. To offset the increase in borrowing, nonborrowed reserves are increased until the federal funds rate falls to its previous level. In contrast, if a shock originating in the demand for borrowed reserves occurs in which borrowing is higher than expected at every level of the federal funds rate, this disturbance is at most partially offset and the federal funds rate falls. The decline in the federal funds rate serves to

[7] For a discussion of this change in operating procedures, see Henry C. Wallich, "Recent Techniques of Monetary Policy," *Economic Review*, Federal Reserve Bank of Kansas City, May 1984, pp. 21-30.

[8] See, for example, Gordon H. Sellon, Jr., "The Role of the Discount Rate in Monetary Policy: A Theoretical Analysis," *Economic Review*, Federal Reserve Bank of Kansas City, June 1980, pp. 3-15.

reduce the demand for borrowed reserves. So, this source of disturbances in the reserves market causes fluctuations in the federal funds rate. In comparison with the other procedures, the borrowed reserves procedure implies more short-run volatility in the federal funds rate than the federal funds rate procedure, in which most reserves market shocks are offset, and less volatility than the nonborrowed reserves procedure, in which most reserves market shocks are not offset.

The behavior of M1 during 1982 also continued to be difficult to interpret. As a result, the Federal Reserve deemphasized its target for M1 about the time it changed operating procedures. This factor would be expected to make both the federal funds rate and Treasury bill yields less volatile than in the October 1979-October 1982 period. The federal funds rate, however, would still be expected to be more volatile than it was before October 1979.

Because the Federal Reserve accommodates shocks to the demand for reserves under the borrowed reserves operating procedure, the federal funds rate should not respond to money announcement surprises. The response of the Treasury bill yield also would be expected to decline in this period. Part of the decline reflects the behavior of the current week's federal funds rate. More importantly, however, the response would have declined if the Federal Reserve placed less emphasis on its M1 targets. If the Federal Reserve placed more weight on direct measures of economic performance, Treasury bill yields may have become more responsive to new information about economic activity and inflation.

Post-February 1984

Another possible change in monetary policy regimes coincides with the Federal Reserve's adoption of contemporaneous reserve require-

ments in February 1984. In contrast to previous episodes, the change in regimes does not involve a change in operating procedures. The previous borrowed reserves procedure probably remained in effect. Instead, the change from lagged reserve requirements strengthened the link between the current week's money stock and the market for reserves. The short-run volatility of interest rates most likely remained about the same as in the previous regime, primarily because operating procedures apparently did not change.

Because of uncertainty about the effects of CRR and the continued problems in interpreting movements in M1, the emphasis placed on M1 may have been further reduced since February 1984. In turn, it is likely that the volatility of interest rates either remained about the same or declined slightly from the previous period. The main characteristic of the period after February 1984, however, does not concern interest rate volatility, but how new information about M1 affects interest rates.

The change in reserve requirement systems in February 1984 may have affected the response of interest rates to the new information provided by money announcements. Money announcement surprises under the previous LRR system predominantly reflected unanticipated shifts in the demand for money since reserves in any given week were tied loosely to the current week's money stock. The relationship is tightened considerably under CRR. As a consequence, money announcement surprises since February 1984 may reflect both money demand shocks and disturbances in the reserves market. These latter disturbances correspond to money supply shocks. In this case, if money demand and supply shocks are equally persistent, the money announcement surprise would not affect the federal funds rate under any operating procedure and the response of Treasury

bill yields would diminish considerably.[9] The response of Treasury bill yields also would decline if the Federal Reserve further deemphasized its M1 target. If that occurred, new economic information may have larger effects on Treasury bill yields.

Empirical evidence on monetary policy regimes

This section presents an empirical evaluation of the implied properties of the four possible monetary policy regimes since the late 1970s. The periods since October 1982 can be characterized more easily by first considering the regimes before October 1982. As in the theoretical discussion, the regimes are evaluated in terms of the volatility of interest rates, the response of interest rates to money announcements, and the response of interest rates to new information about inflation and economic activity.

Volatility of interest rates

The monetary policy regimes discussed in the previous section have distinct implications for the volatility of interest rates. As mentioned, the federal funds rate should exhibit the least variability under the federal funds rate procedure, the most under the nonborrowed reserves procedure, and volatility somewhere between these two cases under the borrowed reserves procedure. The volatility of Treasury bill yields should partly reflect the volatility of the federal funds rate, but a larger portion of the volatility can be attributed to

changes in the market's expectation about future monetary policy. That is, for a given shock affecting the money stock, Treasury bill yields exhibit more volatility the greater the commitment of the Federal Reserve to offset the shock in the near future.

The volatility of the federal funds rate and the 3-month Treasury bill yield is examined over several periods in Table 1. Volatility is measured as the standard deviation of weekly percentage changes of the respective interest rates.[10] The periods correspond to the different monetary policy regimes. The first period begins in October 1977 and ends in October 1979, and it corresponds to the last two years of the federal funds rate procedure under LRR. The second period starts in October 1979 and ends in October 1982, representing the nonborrowed reserves procedure also under LRR.[11] The October 1982-February 1984 period coincides with the beginning of the borrowed reserves procedure under LRR. The final period is marked by the adoption of CRR in February 1984.

As indicated in the table, the volatility of the federal funds rate increased significantly from the pre-October period to the October 1979-October 1982 period. In particular, the volatility of the percentage change in the federal funds rate was 2.2 percentage points per week in the earlier period, compared with 7.6 percentage points in the October 1979-October 1982 period. This result is consistent with the Federal Reserve adopting a nonborrowed reserves procedure in the later period. The

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[9] This result follows from the formal model presented by V. Vance Roley, "The Response of Interest Rates to Money Announcements Under Alternative Operating Procedures and Reserve Requirement Systems," *Proceedings of the Fall 1985 Academic Conference*, Federal Reserve Bank of San Francisco, forthcoming.

[10] Percentage changes are used to conform with a recent article by Robert H. Rasche, "Interest Rate Volatility and Alternative Monetary Control Procedures," *Economic Review*, Federal Reserve Bank of San Francisco, Summer 1985, pp. 46-63.

[11] Some evidence suggests that the change in operating procedures might have occurred earlier. See, for example, Jan G. Loeys, "Changing Interest Rate Responses to Money Announcements: 1977-1983," *Journal of Monetary Economics*, May 1985, pp. 323-332.

TABLE 1
Volatility of interest rates

	Standard Deviations of Weekly Percentage Changes*			
Interest Rate	Oct. 1977- Oct. 1979	Oct. 1979- Oct. 1982	Oct. 1982- Feb. 1984	Feb. 1984- Sept. 1985
Federal funds rate	0.022	0.076	0.040	0.044
3-month Treasury bill yield	0.026	0.057	0.025	0.021

*Percentage changes, PC, are computed as $PC = (R_t-R_{t-1})/R_{t-1}$, where R_t is the 3:30 p.m. interest rate quote on the day following the money announcement in week t (Source: Board of Governors of the Federal Reserve System, H.15). Standard deviations of percentage changes, SD, are defined as

$$SD = [(1/n-1) \sum_{t=1}^{n} (PC_t-\overline{PC})^2]^{1/2},$$

where n corresponds to the number of weeks in the period and $\overline{PC}$ is the average percentage change over the n-week period.

period beginning in October 1982 exhibited significantly less federal funds rate volatility, as expected if the Federal Reserve actually adopted a borrowed reserves procedure. Also as expected, the volatility of the federal funds rate during this period is significantly greater than before the October 1979 period.[12] The final period, coinciding with the adoption of

CRR, exhibits approximately the same volatility as the immediately preceding period. *As a whole, the results are consistent with Federal Reserve statements about the adoption of different operating procedures.*

The volatility results for the Treasury bill yield are similar to those of the federal funds rate, with one exception. In particular, volatility declined beginning in October 1982 to about the same as in the pre-October 1979 period. The volatility of the Treasury bill yield should not, however, be as dependent on the type of operating procedure as the federal funds rate. The decline in volatility may instead reflect a reduced emphasis on monetary targets by both the Federal Reserve and market participants.

Response of interest rates to money announcements

To consider changes in operating procedures further, along with the possibility that M1 targets have a reduced role in monetary policy, the response of the federal funds rate

[12] These results are different from those reported by Robert H. Rasche, "Interest Rate Volatility and Alternative Monetary Control Procedures," *Economic Review*, pp. 46-63. He finds that the post-October 1982 volatility of the federal funds rate is not significantly different from that of the pre-October 1979 period. By starting the pre-October 1979 period in 1969, his measured volatility is significantly larger. The volatilities reported in the two post-October 1982 periods are very similar to those reported by Rasche. Tests that adjacent periods have the same variances of the federal funds rate yielded F-statistics of 11.76 with (155,104) degrees of freedom, 3.57 (155,68), and 1.19 (86,68). The alternative hypotheses were that the variance in the October 1979-October 1982 period was greater than the variances in the pre-October 1979 and October 1982-February 1984 periods, and the variance in the second post-1982 period was greater than that of the first. Thus, only in the two post-October 1982 periods could the hypothesis of equal variances not be rejected at the 5 percent significance level. The test of the hypothesis that the two post-October 1982 periods have the same volatility as the pre-October 1979 period yielded F-statistics of 3.29 (68,104) and 3.91 (86,104), which are significant at the 5 percent level.

and the 3-month Treasury bill yield to weekly M1 announcements is estimated. An efficient markets model is used to examine the relationship between M1 announcements and changes in interest rates. This model assumes that market participants use all the information available to the public in determining interest rates. As a result, interest rates before an announcement of economic data should reflect the market's expectation concerning the announcement.

The efficient markets model yields two primary implications in this application. First, daily changes in interest rates should depend predominantly on the information market participants obtain between the closing quotations at the end of successive business days.[13] As a consequence, the closing yield of the current business day often represents the optimal forecast of the next day's closing yield. Second, any relevant information obtained between successive daily quotes should influence interest rates, but information already known by market participants should not. Moreover, any relevant information obtained from an economic release should affect interest rates immediately. Together, these considerations imply that on days of economic data announcements, including M1 announcements, daily movements in interest rates depend on the unanticipated components of the announcements plus a random error term.[14]

The first section suggested that under the federal funds rate and borrowed reserves pro-

cedures, the federal funds rate should not respond significantly to money announcement surprises. In contrast, under the nonborrowed reserves procedure, the response should be significant. For the Treasury bill yield, the response depends not only on the response of the federal funds rate, but also on the market's assessment of the Federal Reserve's desire to offset the surprise in future weeks.

A number of previous studies estimate responses of interest rates to money announcement surprises for the period before 1980. The results from these studies indicate that the federal funds rate did not respond to money announcement surprises before October 1979, but the Treasury bill yield did.[15] Moreover, responses after October 1979 during the nonborrowed reserves operating procedure were significantly greater for both interest rates.

The responses of the federal funds rate and the 3-month Treasury bill yield are estimated for the nonborrowed reserves period in the first two rows of Table 2. The specifications include a constant term and the expected value of the money announcement to examine the efficient markets model. According to this model, the constant term and the coefficient on expected money should not differ significantly from zero. The results correspond to those reported in other studies in that both the federal funds rate and the 3-month Treasury bill yield respond significantly to the unantici-

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[13] If the pure expectations model of the term structure is true, movements in interest rates approximately follow a random walk if the change is measured over a short interval in comparison with the time to maturity. Because daily changes in the federal funds rate coincide with the maturity of these instruments, the random walk model may be less appropriate for this interest rate.

[14] A formal specification of this model is presented in Table 2. Survey data provided by Money Market Services, Inc., were used to form the market's expectation of M1 and other announcements. These survey data were revised using regression tech-

niques to correct biases and incorporate movements in the Treasury bill yield from the time of the previous announcement. See V. Vance Roley, "The Response of Interest Rates to Money Announcements Under Alternative Operating Procedures and Reserve Requirement Systems," *Proceedings of the Fall 1985 Academic Conference*, Federal Reserve Bank of San Francisco, forthcoming. Raul Nicho and John Lilley supplied the survey data used in this article.

[15] See, for example, V. Vance Roley and Carl E. Walsh, "Monetary Policy Regimes, Expected Inflation, and the Response of Interest Rates to Money Announcements," *Quarterly Journal of Economics*, Supplement 1985, pp. 1011-1039.

TABLE 2
Market's response to M1 announcements

Estimation Period	Interest Rate	Constant	UM1	EM1	Summary Statistics $\bar{R}^2$	SE	DW
Jan. 1980-Oct. 1982	ΔRFF	0.0504 (0.0548)	0.1003* (0.0244)	−0.0181 (0.0315)	0.10	0.64	2.56
Jan. 1980-Oct. 1982	ΔRTB	0.0814* (0.0297)	0.0846* (0.0133)	−0.0372* (0.0171)	0.23	0.35	1.91
Oct. 1982-Feb. 1984	ΔRFF	0.0484† (0.0269)	0.0148 (0.0128)	0.0007 (0.0123)	−0.01	0.20	1.70
Oct. 1982-Feb. 1984	ΔRTB	0.0118 (0.0130)	0.0342* (0.0062)	−0.0043 (0.0059)	0.30	0.10	1.81
Feb. 1984-Sept. 1985	ΔRFF	−0.0772* (0.0284)	0.0161 (0.0170)	−0.0302* (0.0113)	0.07	0.25	1.37
Feb. 1984-Sept. 1985	ΔRTB	0.0138 (0.0111)	0.0080 (0.0066)	−0.0047 (0.0044)	0.01	0.10	2.17

*Significant at the 5 percent level.
†Significant at the 10 percent level.

Note: The precise estimation period dates are: January 1, 1980-October 5, 1982; October 6, 1982-February 1, 1984; February 2, 1984-September 26, 1985. Numbers in parentheses are standard errors of estimated coefficients. Equations are estimated in the form:

$$\Delta RFF_t \text{ or } \Delta RTB_t = b_0 + b_1 UM1_t + b_2 EM1_t + e_t$$

where b_0, b_1, and b_2 are estimated coefficients and e_t is a random error term.

ΔRFF, ΔRTB = change in the federal funds rate and the 3-month Treasury bill yield, respectively, from 3:30 p.m. on the day of the money announcement to 3:30 p.m. on the following business day (Source: Board of Governors of the Federal Reserve System, H.15)

UM1 = money announcement surprise, defined as M1 - EM1, where M1 is the announced change in the narrowly defined money stock, in billions of dollars (Source: Board of Governors of the Federal Reserve System, H.6)

EM1 = expected announced change in the narrowly defined money stock, based on the survey measure provided by Money Market Services, Inc.

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

SE = standard error

DW = Durbin-Watson statistic

pated component of the announcement. The estimated response of the Treasury bill yield indicates, for example, an average change of 0.08 percentage points, or eight basis points, in response to a $1 billion money announcement surprise. Similarly, the federal funds rate changed, on average, by ten basis points in response to the same $1 billion surprise. These results are consistent with both the implications of the nonborrowed reserves procedure and the importance of M1 targets.

The third and fourth rows of the table report estimated responses during the October 1982-February 1984 period, coinciding with the borrowed reserves procedure under LRR. The results indicate that the federal funds rate does not exhibit a response to money announcement surprises significantly different from zero, consistent with the borrowed reserves procedure. The Treasury bill yield's response is still significantly positive, but its magnitude is less than half the size of the response in the previous period.[16] Given the significance of this response, however, the market still perceived some role for M1 targets during this period.

The final two rows in the table report estimated responses for the period starting in February 1984, coinciding with the adoption of CRR. Consistent with the borrowed reserves procedure, the federal funds rate again does not exhibit a significant response to money announcement surprises. In contrast to the previous period, however, the Treasury bill yield's response also is insignificantly different from zero.[17] This result is consistent with a reduced role for M1 targets in that money announcement surprises are apparently not expected to be offset in the future. The impact

of CRR on the response, however, complicates the interpretation. In particular, money announcement surprises under CRR may reflect both money demand and supply errors that partially offset each other.[18] Nevertheless, the responses of the federal funds rate and the 3-month Treasury bill yield are consistent with Federal Reserve statements about the implementation of different operating procedures and the diminished role of M1 targets.

Response of interest rates to inflation and economic activity announcements

To examine the possibility that the Federal Reserve focused more directly on inflation and economic activity since 1982 and placed less emphasis on M1, the response of the Treasury bill yield to this type of new information is examined. Only the response of the Treasury bill yield is considered because its response should be affected more than the response of the federal funds rate in the presence of a change in policy targets. The response of the federal funds rate predominantly reflects the impact of new information on the supply of and demand for reserves.

The estimates reported in Table 3 show the response of the 3-month Treasury bill yield to the unanticipated components of economic data announcements. As before, the efficient markets model is used, and the response is measured over a one-day period around the

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[16] The hypothesis that the responses are the same can be rejected at the 5 percent significance level. The corresponding F-statistic is 11.84 (1,207). In this test, as well as all subsequent tests across periods, the estimated equations are weighted by their standard errors to reduce the possibility of heteroscedasticity.

[17] The hypothesis that the responses are the same can again be rejected at the 5 percent significance level. The F-statistic is 8.35 (1,150).

[18] To examine the responses over all four periods further, money surprises were separated into four groups depending on size. Large positive surprises took values of $2 billion or more, small positive surprises had values from $0 to $2 billion, and similarly for negative surprises. In the October 1982-February 1984 period, both small and large positive surprises were statistically significant at the 5 percent level. In the post-February 1984 period, however, none of the surprises were significant at even the 10 percent level.

TABLE 3
Market's response to the unanticipated component of economic data announcements*

Estimation Period	Constant	Unanticipated Change in:					Summary Statistics	
		PPI	CPI	IP	UNEM	M1	$\bar{R}^2$	SE
Jan. 1980-	0.0395†	0.0270	−0.1859	0.0850	−0.1876	0.0833†	0.16	0.31
Oct. 1982	(0.0198)	(0.0175)	(0.2069)	(0.1188)	(0.2594)	(0.0118)		
Oct. 1982-	0.0044	−0.0838	−0.2127	0.0562	−0.1734	0.0387†	0.22	0.10
Feb. 1984	(0.0091)	(0.0905)	(0.1944)	(0.0866)	(0.1567)	(0.0064)		
Feb. 1984-	−0.0018	0.0251	−0.0497	0.1497‡	0.0948	0.0087	0.00	0.10
Sept. 1985	(0.0083)	(0.0918)	(0.1964)	(0.0874)	(0.1261)	(0.0067)		

†Significant at the 5 percent level
‡Significant at the 10 percent level
*See the notes in Table 2. Equations are estimated in the form:

$$\Delta RTB_t = b_0 + b_1 UPPI_t + b_2 UCPI_t + b_3 UIP_t + b_4 UUNEM_t + b_5 UM1_t + e_t.$$

where the u's indicate that only the unanticipated components of the data announcements are included. Unanticipated values are calculated using survey data provided by Money Market Services, Inc.

ΔRTB_t = change in the 3-month Treasury bill yield from 3:30 p.m. to 3:30 p.m. on the subsequent business day

PPI = percentage change in the producer price index (Source: Bureau of Labor Statistics)

CPI = percentage change in the consumer price index (Source: Bureau of Labor Statistics)

IP = percentage change in the industrial production index (Source: Board of Governors of the Federal Reserve System)

UNEM = percentage of labor force unemployed (Source: Bureau of Labor Statistics)

particular announcement. Monthly inflation announcement surprises are measured by using the producer price index, PPI, and the consumer price index, CPI. Monthly information related to economic activity is represented by industrial production, IP, and unemployment rate, UNEM, announcements. Weekly M1 announcements also are included in the estimated models.[19]

A previous article indicated that among these sources of new information, only money announcement surprises significantly affected the Treasury bill yield in both the pre-October

1979 and the October 1979-October 1982 periods.[20] In the pre-October 1979 period, how-

[19] The estimated responses to money surprises differ slightly from those in Table 2 for two reasons. First, other announcements sometimes occurred on days of money announcements. Second, constant terms associated with the announcement surprises were assumed to be the same. The survey data used to form expectations of the announcements again were adjusted to remove biases and incorporate information about Treasury bill yield movements over the previous five business days.

[20] See V. Vance Roley and Rick Troll, "The Impact of New Economic Information on the Volatility of Short-Term Interest Rates," *Economic Review*, Federal Reserve Bank of Kansas City, February 1983, pp. 3-15.

ever, industrial production announcement sur-
prises had some weak effects. The first row of
the table reexamines the second of these peri-
ods. As before, the results indicate that only
money announcement surprises significantly
affect the Treasury bill yield.[21]

Estimated responses for the two periods fol-
lowing October 1982 are reported in the sec-
ond and third rows in the table. For the Octo-
ber 1982-February 1984 period, the results
indicate again that the Treasury bill yield does
not significantly respond to any single piece of
economic information other than M1
announcements. In contrast to the previous
period, however, the set of economic informa-
tion other than M1 announcements signifi-
cantly affects the Treasury bill yield.[22] After
February 1984, the effects of money
announcement surprises are no longer signifi-
cant, and the evidence suggests that the mar-
ket may react to industrial production sur-
prises. In particular, a one percentage point
positive surprise in the growth of industrial
production increases the Treasury bill yield by
an average of about 15 basis points. In this
case, stronger than expected real economic
activity causes the market to expect future
tightening of policy. The set of economic
information other than M1 announcements
also significantly affects the Treasury bill
yield in this period.[23]

As a whole, the results in Table 3 are
consistent with a reduced role for M1 after
February 1984. The evidence also suggests a
shift in emphasis by the Federal Reserve and
market participants to direct measures of eco-
nomic activity.

Conclusions

The behavior of interest rates since 1982 is
consistent with at least two changes involving
monetary policy. One relates to the adoption of a
borrowed reserves operating procedure in Octo-
ber 1982, replacing the previous nonborrowed
reserves procedure implemented in October
1979. The other change involves a deemphasis of
M1 as a monetary target. The adoption of con-
temporaneous reserve requirements in February
1984 may have had further effects on interest rate
behavior.

Three sources of empirical evidence support
the notion that the market has perceived
changes in policy-related factors. First, the
federal funds rate became less volatile after
October 1982, but the volatility remained sig-
nificantly greater than before October 1979.
As a result, the evidence indicates that the
Federal Reserve has not reverted to the federal
funds rate, or money market conditions, oper-
ating procedure of the late 1970s. Second,
also consistent with the adoption of a bor-
rowed reserves procedure, the response of the
federal funds rate to new information about
M1 has not been significant since October
1982. Finally, the empirical results indicate
that since February 1984 the market has
placed no weight on M1 announcements, as
reflected by the lack of response of the 3-
month Treasury bill yield. Moreover, the mar-
ket's response to new information about eco-
nomic activity has been somewhat enhanced
since October 1982. These results are consis-
tent with a reduced role for M1 in conducting
monetary policy and also consistent with Fed-
eral Reserve statements about its operating
procedures.

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[21] The hypothesis that all responses other than that correspond-
ing to M1 announcements equal zero cannot be rejected at the 5
percent significance level. The F-statistic is 1.90 (4,231).

[22] The hypothesis that all responses other than that correspond-
ing to M1 announcements equal zero can be rejected at the 5 per-
cent level. The F-statistic is 3.85 (4,117).

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[23] The hypothesis that all responses other than that correspond-
ing to M1 announcements equal zero can again be rejected at the
5 percent level. The F-statistic is 3.77 (4,128).