Monetary Policy Actions and Long-Term Interest Rates

By V. Vance Roley and Gordon H. Sellon, Jr.

It is generally believed that monetary policy actions are transmitted to the economy through their effect on market interest rates. According to this standard view, a restrictive monetary policy by the Federal Reserve pushes up both short-term and long-term interest rates, leading to less spending by interest-sensitive sectors of the economy such as housing, consumer durable goods, and business fixed investment. Conversely, an easier policy results in lower interest rates that stimulate economic activity.

Unfortunately, this description of the monetary policy process is difficult to reconcile with the actual behavior of interest rates. Although casual observation suggests a close connection between Federal Reserve actions and short-term interest rates, the relationship between policy and long-term interest rates appears much looser and more variable. In addition, empirical studies that attempt to measure the impact of policy actions on long-term rates generally find only a weak relationship. Taken together, the empirical studies and the observed behavior of interest rates appear to challenge the standard view of the monetary transmission mechanism and raise questions about the effectiveness of monetary policy.

This article attempts to reconcile theory and reality by reexamining the connection between monetary policy and long-term interest rates. Using a framework that emphasizes the importance of market expectations of future monetary policy actions, the article argues that the relationship between policy actions and long-term rates is likely to vary over the business cycle as financial market participants alter their views on the persistence of policy actions. Accordingly, the standard view of the monetary transmission mechanism appears to provide an overly simplistic view of the policy process. In addition, by capturing the tendency of market rates to anticipate policy actions, the article finds a larger response of long-term rates to monetary policy than reported in previous research.

The first section of the article describes the standard view of the monetary transmission mechanism and examines its consistency with actual interest rate behavior. The second section uses the expectations theory of the term structure to show how the impact of monetary policy on long-term rates depends on market expectations about the future di-

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rection of policy. The third section presents new empirical estimates of the relationship between policy actions and long-term rates.

MONETARY POLICY AND LONG-TERM RATES: THEORY VS. REALITY

The standard view of the monetary policy transmission mechanism suggests a close relationship between Federal Reserve policy actions and market interest rates. However, while there is considerable evidence that monetary policy has predictable effects on short-term rates, the connection between policy actions and long-term rates appears to be weaker and less reliable.

The monetary transmission mechanism

Changes in the stance of monetary policy take place in the market for reserves held by depository institutions. The Federal Reserve can alter the supply of reserves either by using open market operations to buy or sell government securities or by altering the amount of reserves borrowed through the discount window. Providing fewer reserves than desired by depository institutions puts upward pressure on the price of reserves—the federal funds rate—while supplying more reserves than institutions desire puts downward pressure on the funds rate.

In recent years, the Federal Reserve has implemented monetary policy by using open market operations to maintain a desired level of the federal funds rate (Lindsey). This "short-run operating target" is derived from longer term objectives for price stability and economic activity, and is adjusted when the Federal Reserve believes the stance of policy should be altered to better achieve its long-run objectives (Davis, Meulendyke). For example, in a period of moderate economic growth and low inflation, the Federal Reserve may keep the desired federal funds rate unchanged for a considerable period of time. However, in the event of stronger economic activity and higher inflation the Federal Reserve may tighten policy by reducing reserve growth to push the federal funds rate up to a new and higher desired level.

Although the Federal Reserve can directly influence the reserves market and the federal funds rate, to affect economic activity, monetary policy must also be able to alter the entire spectrum of short-term and long-term interest rates. The standard view of the monetary transmission mechanism relies on a simple version of the expectations theory of the term structure of interest rates. In this theory, long-term rates are an average of current short-term rates and expected future short-term rates. Monetary policy affects long-term rates to the extent that it influences current and expected short-term rates.

In the standard view of the transmission mechanism, the relationship between policy actions and long-term rates is assumed to be straightforward. An increase in the desired level of the federal funds rate causes current short-term rates and expected future short-term rates to rise, which pushes up interest rates across all maturities. Similarly, a decrease in the desired funds rate causes current and expected future short-term rates to fall and leads to lower short-term and long-term rates.

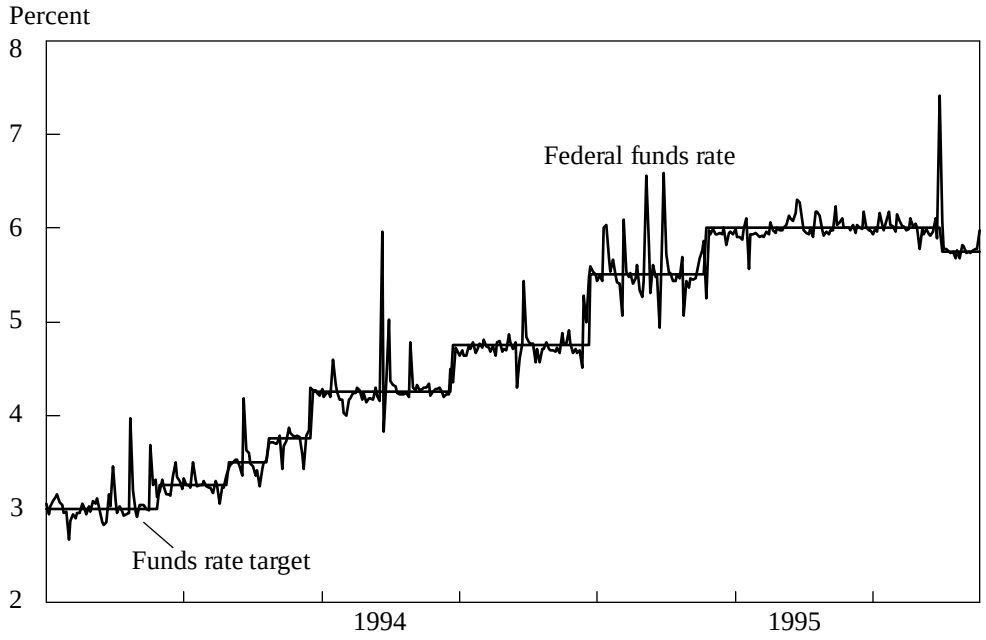
Evidence on the relationship between policy actions and interest rates

In the standard view of the monetary transmission mechanism, monetary policy actions are expected to have a strong, positive effect on long-term rates. In contrast to this theory, the actual relationship between policy actions and long-term rates appears weaker and more variable.

Casual observation suggests the Federal Reserve's ability to influence interest rates diminishes as the maturity of the security lengthens. In the overnight market for reserves, for example, the Federal Reserve achieves close control over the

Chart 1

RELATIONSHIP BETWEEN FEDERAL FUNDS RATE AND FUNDS RATE TARGET



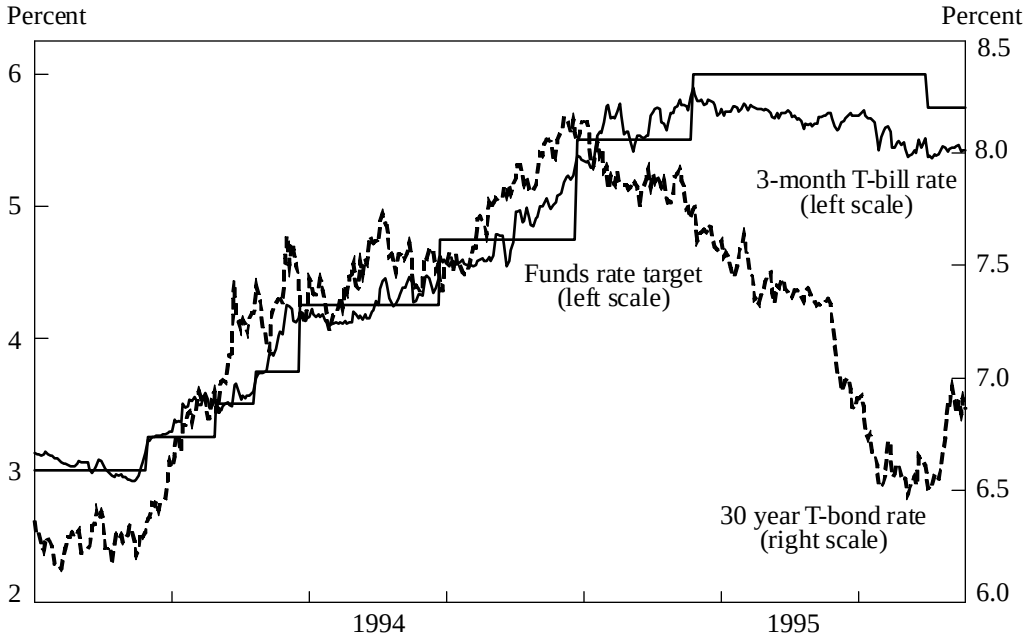
federal funds rate. Chart 1 compares an estimate of the Federal Reserve's desired value for the federal funds rate and the observed daily funds rate over a recent period of monetary policy actions, from the beginning of 1994 through July 1995.[1] The estimated funds rate target is shown as the darker line. Beginning in February 1994, the funds rate target was raised in a series of seven steps from 3 percent to 6 percent and was then lowered to 5.75 percent in July 1995. While the actual federal funds rate shown in the chart is very volatile on a daily basis, it follows the funds rate target closely over time, suggesting the trend in the funds rate is largely determined by policy actions.

Other short-term rates also show a close relationship to the estimated funds rate target. Although the 3-month bill rate deviates occasionally from the estimated funds target over this recent period, it still follows the target quite closely (Chart 2). As shown in the chart, the principal difference between the 3-month rate and the funds rate target over this period is the tendency for the bill rate to move up or down somewhat in advance of policy actions.

In contrast, the connection between long-term rates and the funds rate target appears to be much looser. As shown in Chart 2, in the early stages of the recent policy tightening, the 30-year Treasury bond rate first rose much faster than the funds target. Then, in the latter part of 1994 and early 1995, the 30-year rate actually declined substantially while the funds target continued to rise. While the reaction of long-term rates in the beginning of 1994 was

Chart 2

RELATIONSHIP BETWEEN MARKET RATES AND FUNDS RATE TARGET



considerably greater than expected, the downward trend of long-term rates at the end of 1994 and early 1995 was exactly opposite to that suggested by the standard view of the transmission mechanism.[2]

More sophisticated empirical analysis of the relationship between policy actions and interest rates also casts doubt on the standard view. For example, studies by Cook and Hahn (1989b) and by Radecki and Reinhart examined the response of short-term and long-term rates to changes in a measure of the funds rate target in the days surrounding policy actions.[3] Using a similar approach, Dale measured the short-run response of UK market rates to monetary policy actions by the Bank of England. Although all three studies found that policy actions have a significant positive effect on interest rates of all maturities, these effects decline as maturity lengthens. Indeed, the estimated response of long-term rates to policy actions in these studies is extremely small. For example, long-term rates increase only four to ten basis points in response to a 100-basis-point increase in the interest rate target in the days surrounding the policy change. The small estimated effect of policy actions on long-term rates found in these studies is difficult to reconcile either with the actual behavior of long-term rates shown in Chart 2 or with the standard view of the transmission mechanism. If these estimates are accurate, the influence of monetary policy actions on long-term interest rates would appear to be very limited.

THE ROLE OF EXPECTATIONS IN THE MONETARY TRANSMISSION MECHANISM

Reconciling the actual behavior of long-term interest rates with the standard view of the monetary transmission mechanism requires a framework for understanding how policy actions affect the term structure of interest rates. The expectations theory of the term structure suggests that monetary policy affects long-term rates by directly influencing short-term rates and by altering market expectations of future short-term rates. In this framework, there is no simple relationship between policy actions and long-term rates. Rather, the reaction of long-term rates to policy actions can be highly variable depending on changing views of market participants as to the future direction of monetary policy.

The expectations theory of the term structure

In the expectations theory, long-term interest rates are related to short-term rates through market expectations of future short-term rates. In the simplest version of the expectations theory, long-term interest rates equal an average of current and expected future short-term interest rates. For example, consider a simple investment opportunity in which an investor with a two-year time horizon has the option of buying a 1-year bond now and a second 1-year bond in one year's time, versus the alternative of buying a 2-year bond now. Suppose further that a 1-year bond is currently trading with an annualized yield of 6 percent and market participants expect a new 1-year bond issued a year from now will yield 7 percent. In this case, under the expectations theory, the current yield on a 2-year bond will be 6.5 percent, a simple average of the current and expected future 1-year yields.

The reasoning behind the expectations theory is that two equivalent investment options should have the same expected return. If not, investors will arbitrage away any differences. Hence, if the current 2-year yield were 6 percent instead of 6.5 percent, investors would be reluctant to buy the 2-year bond. Rather, they would prefer holding the 1-year bond and then purchasing another 1-year bond at the end of the first year to receive a higher expected return. In this situation, investors would sell the 2-year bond, thereby reducing its price and raising its yield until the two investment strategies have the same expected returns.

This basic approach can be easily extended to longer term securities. For example, the current yield on a 3-year bond will equal the average of three rates: the current 1-year rate, the expected 1-year rate one year in the future, and the expected 1-year rate two years in the future. Similarly, the current yield on a 30-year bond will equal the average of the current 1-year rate and a series of 29 expected 1-year rates.[4]

In this simple form of the expectations theory, changes in a long-term interest rate can arise from two sources: factors that change the current short-term rate and factors that change market expectations of future short-term rates. To study the reaction of long-term rates to monetary policy actions, measures of both current short-term rates and expected future short-term rates must be obtained. Unfortunately, while current short-term rates are observable, measures of expected future rates are not readily available.[5]

In the framework of the expectations theory, estimates of expected future short-term rates can be obtained by calculating the "forward rates" that are implied in the existing term structure. The construction of forward rates can be illustrated using the preceding example. Suppose the observed yield on the current 1-year bond is 6 percent, while the 2-year bond currently yields 6.5 percent. Because the 2-year bond yield is an average of the current 1-year yield and the expected 1-year yield one year from now, under the expectations theory the implied value of the expected 1-year yield is 7 percent

(2 x 6.5 - 6 = 7). This implied value is the one-year ahead, 1-year forward rate. In a similar manner, the yield of a bond of any maturity can be decomposed into a current short-term rate and a series of forward rates.[6]

Monetary policy and long-term rates

In the framework of the expectations theory, monetary policy can affect long-term rates by directly affecting short-term rates or by changing forward rates. Depending on how market participants interpret policy changes, the reaction of forward rates to policy changes may differ over time, resulting in a variable response of long-term rates to policy actions.

Policy scenarios. To see the connection between policy actions and long-term rates, consider a simplified example in which an investor has a four-year investment horizon and the option of purchasing a 1-year, 2-year, 3-year, or 4-year security. In this model, the 1-year security is the short-term bond, the 2-year and 3-year securities are medium-term bonds, and the 4-year security is the long-term bond. This model can be used to examine the reaction of the long-term rate in five stylized policy scenarios incorporating different assumptions about how forward rates react to anticipated policy actions. In each scenario, current and future monetary policy actions are assumed to be the only factors influencing interest rates. The analysis abstracts from other factors that might affect interest rates by altering real interest rates or inflationary expectations. The examples also ignore the existence of a term premium or risk premium in interest rates.

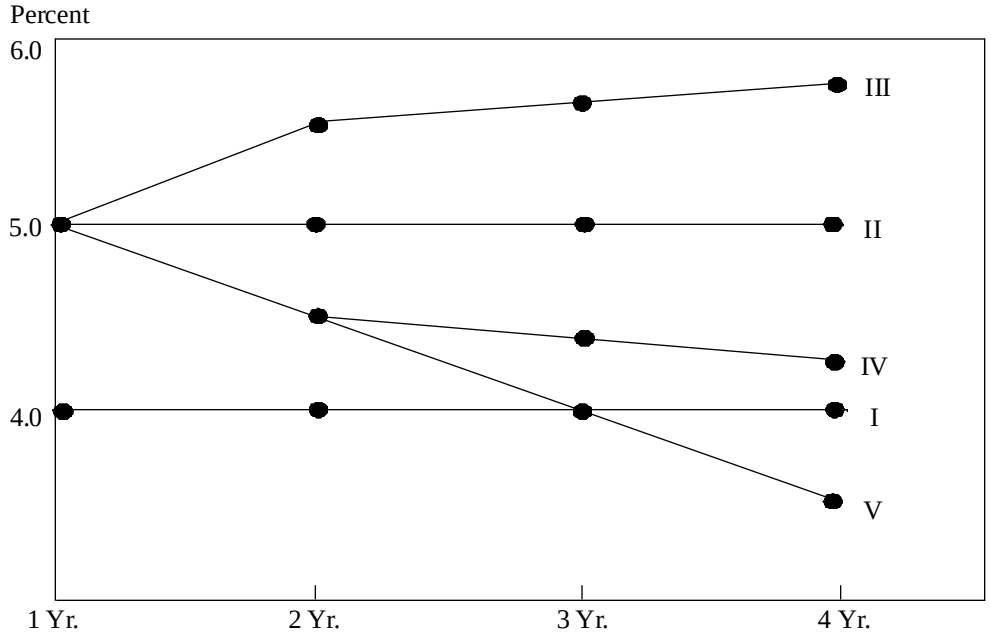
The first scenario (I) is the case of an unchanged monetary policy in which investors foresee no change in the funds rate target over the four-year horizon. Suppose that the current 1-year rate is 4 percent. Because market participants believe that policy will not change, all forward rates will be unchanged and the term structure will be flat with a 4 percent rate at all maturities (Chart 3).

Now consider a second scenario (II) in which a policy action that increases the funds rate target by 1 percent also raises the 1-year rate from 4 to 5 percent. In addition, assume investors expect this new higher rate will persist throughout the four-year investment horizon. In this case, the one-year, two-year, and three-year ahead, 1-year forward rates will all rise to 5 percent, and there will be a parallel shift in the yield curve as short-term, medium-term, and long-term rates all move up to 5 percent (Chart 3). Thus, if investors believe a policy action will be persistent or permanent over the entire investment horizon, there will be a one-for-one movement of the funds target and the long-term rate.[7]

Next consider a third scenario (III) in which the funds rate target and 1-year rate again rise by 1 percent. In this case, however, investors interpret the policy action as only the first stage in tightening and so expect a further increase in the funds target by 1 percent in the second year, followed by no further change in years three and four. In this situation, while the current 1-year rate rises to 5 percent, each of the three 1-year forward rates rises to 6 percent. As a result, medium-term and long-term rates will actually increase more than short-term rates in response to the policy action and the yield curve will steepen (Chart 3).[8]

The fourth scenario (IV) differs from the previous ones because the initial policy action is expected to be only temporary. That is, while the funds rate target and 1-year rate rise by 1 percent, investors see the policy tightening as only temporary and expect the policy action to be offset in the next year. In this situation, although the 1-year rate rises to 5 percent, the three 1-year forward rates remain at 4 percent, giving a response pattern of medium-term and long-term rates that declines as maturity lengthens. Accordingly, medium-term and long-term rates rise less than short-term rates in response to the monetary

Chart 3
INTEREST RATE RESPONSES TO POLICY ACTIONS



I: No change in current or future policy.
II: Permanent change in policy.
III: Additional tightening expected in Year 2.
IV: Temporary tightening.
V: Current tightening followed by future easing.

policy action and the yield curve becomes negatively sloped (Chart 3). Note that, in this scenario, all of the change in longer term rates comes from the increase in the current short-term rate since all forward rates are unchanged.

Finally, in the fifth scenario (V) the funds target and 1-year rate again increase by 1 percent, but investors are assumed to believe that policy tightening now will not only be temporary but will also lead to a significant easing of policy in the future.[9] In this example, forward rates one year ahead are assumed to fall to 4 percent, then 3 percent, then 2 percent. As a result, even though the 1-year rate increases by the full amount of the policy action, the long-term rate actually falls as the funds target is increased and the yield curve becomes sharply inverted (Chart 3).

Policy implications. The analysis of these five policy scenarios highlights the crucial role market expectations of future policy actions play in the response of interest rates to monetary policy. Several important conclusions can be drawn from these examples.

First, the direction in which interest rates move when policy is changed depends on investors' views on the likelihood of future policy actions. Most of the scenarios give a positive response of both short-term and long-term rates to a policy action as suggested in the standard view of the transmission

mechanism. Thus, whether policy actions are seen as highly persistent (Scenarios II and III) or temporary (Scenario IV), long-term rates rise in response to an increase in the funds rate target. According to these examples, however, a negative or inverse relationship between long-term rates and policy actions is also possible and is entirely consistent with the expectations theory. Such a relationship requires that some forward rates fall in response to an increase in the funds rate target. This pattern can occur if investors believe a current policy action will be fully offset and ultimately reversed in the future.

Second, the magnitude of the response of long-term rates to policy actions depends on the expected persistence of policy actions. If policy actions are seen as relatively permanent or as the first in a series of future actions (Scenarios II and III), the change in long-term rates may fully reflect or even exceed the current change in the funds rate target. Conversely, if a policy action is viewed as only temporary (Scenario IV), the response of long-term rates is likely to be muted.

Third, these examples suggest the reaction of long-term rates to monetary policy is likely to be much more variable than the response of short-term rates. While expectations of future policy actions play only a small role in determining short-term rates, the importance of expectations increases as maturity lengthens. In Chart 3, the response of the 2-year rate to a 100-basis-point increase in the current funds rate target ranges from an increase of 50 basis points to a 150-basis-point increase across Scenarios II to V. In contrast, the response of the 4-year rate shows much greater variation, from an increase of 175 basis points to a decrease of 50 basis points.

The variable response of long-term rates to policy actions has important implications for monetary policy. If this variability is systematic and related to the business cycle, the effectiveness of policy as measured by the ability of policy to influence long-term rates may vary over the business cycle.[10] For example, in the early stages of policy tightening, investors may see policy actions as highly persistent or as the first phase of a sequence of policy actions. Such a response might occur because investors foresee a strengthening economy and higher inflation. If so, investors may also believe a significant tightening of policy is necessary to moderate economic activity and lower future inflation. In these circumstances, long-term rates are likely to react to a policy action as much as or more than short-term rates. Such an explanation could account for the sharp response of long-term rates in response to the initial tightening of policy in the spring of 1994, as shown in Chart 2. This explanation suggests policy actions may be particularly effective in influencing long-term rates early in the business cycle because investors believe these actions are likely to be highly persistent.

Later in the business cycle, though, investors may foresee a slowing of economic activity and lower inflation. If so, they may view any additional policy tightening as only temporary and likely to be reversed if the economy weakens. In this situation, while short-term rates may react fully to a policy tightening, long-term rates may show little response or even decline.[11] This explanation could account for the behavior of interest rates in late 1994 and early 1995 when short-term rates rose in response to an increase in the funds rate target while long rates actually declined. If correct, this explanation suggests policy actions may have only limited effectiveness late in the business cycle because financial market participants may not believe the current stance of policy is likely to persist.

Taken as a whole, these examples suggest that the standard view of the monetary transmission mechanism is not incorrect but is greatly oversimplified. According to the expectations theory, both the direction and magnitude of the response of long-term rates to monetary policy depend on market percep-

tions of future policy actions. In this framework, a strong, positive connection between long-term rates and policy actions is certainly possible. However, other patterns may also occur depending on investors' views as to the persistence of policy actions. At the same time, because the relationship between policy actions and long-term rates is likely to be highly variable, the effectiveness of policy actions may vary over time.[12]

MEASURING THE IMPACT OF POLICY ON LONG-TERM RATES

The expectations theory also has implications for measuring the effect of policy actions on market interest rates. Using a model that captures the tendency of market rates to anticipate policy actions, this article finds evidence of a stronger and more persistent response of long-term rates to policy actions than found in previous research.

The choice of measurement interval

As discussed above, a key part of the response of long-term rates to policy actions in the expectations theory arises from the impact of anticipated future policy actions on expected future short-term rates. At any point in time, the term structure of interest rates implicitly incorporates investors' best forecast as to the likelihood and magnitude of future policy actions. That is, forward rates already contain information about anticipated future policy actions based on investors' reaction to previous policy actions and their outlook for economic activity.[13] As a result, when the Federal Reserve changes policy, the observed response of long-term rates will depend partly on how accurately investors have anticipated the policy action and partly on revisions to their expectations of future policy actions. On the one hand, if investors are surprised at the timing or magnitude of the policy change, there may be a large response of long-term rates because the policy action causes market participants to alter their expectations of future policy actions. On the other hand, if market participants have anticipated the policy action correctly and see no need to revise their expectations of future policy actions, there may be little response of interest rates to the policy change.

The key role that anticipations play is illustrated in the following two examples. First, suppose investors do not foresee a change in monetary policy over an extended time horizon, but the funds rate target is unexpectedly increased by 25 basis points. In this situation, the full 25-basis-point "policy surprise" is likely to be immediately incorporated into market rates. Moreover, medium-term and long-term rates may rise by more than 25 basis points if market participants see the policy action as the first in an extended series of policy changes. In contrast, consider a second example in which market rates have already incorporated a 25-basis-point tightening of policy. In this case, there may be little immediate response to a 25-basis-point increase in the funds rate target because the change has been anticipated by investors and does not cause them to revise their expectations of future policy actions.

If policy actions are anticipated, there are important implications for the choice of a time interval over which the interest rate response is measured. As shown in the preceding examples, the immediate response of interest rates to a policy action may underestimate the total response to the extent that the policy action is anticipated. Hence, the choice of a measurement interval that is too narrow may fail to capture these anticipation effects, resulting in a measured interest rate response that is too small.

The correct choice of a measurement interval is a difficult issue. Previous studies of the reaction of market rates to policy actions have tended to use a rather narrow time interval for measuring the response of interest rates (Cook and Hahn 1989a; Radecki and Reinhart; and Dale). These studies have generally examined only the immediate interest rate response on the day of a policy change and in an interval of a few days surrounding the policy

action. However, the actual behavior of interest rates suggests a wider measurement interval may be appropriate. For example, during 1994 and early 1995, both short-term and long-term rates appear to have anticipated Federal Reserve policy actions well in advance of the day of the policy change (Chart 2).

To better capture these anticipation effects, this article measures the response of market rates over a time interval extending from the day after the previous policy action to the day after the current policy action.[14] The rationale for this particular measurement interval is that investors are likely to have revised their expectations of future policy actions after the previous policy change. In addition, incoming information about the economy is likely to have caused participants to further revise their expectations about the likelihood of future policy actions. For example, if the economic outlook strengthened unexpectedly after the previous policy action, market participants may have anticipated a further tightening of monetary policy well in advance of the current policy action. As a result, both short-term and long-term rates could have moved up weeks ahead rather than days ahead of the current policy move.

The significance of the choice of a measurement interval is highlighted in Chart 4. This chart compares the change in the 30-year Treasury bond rate over two different measurement intervals for each of the seven increases in the estimated federal funds rate target during 1994 and 1995.[15] The immediate response is the change in the 30-year rate occurring on the day of and the day after the policy action, an interval similar to that used in previous studies. The total response is the change in the 30-year rate measured from the day after the last policy change to the day after the current policy action. As shown in this chart, the immediate change in the days surrounding the policy action is generally very small. In contrast, use of the wider interval shows the total change is generally much larger than the immediate response. This suggests much of the movement in the 30-year rate during this period occurred in anticipation of monetary policy actions.

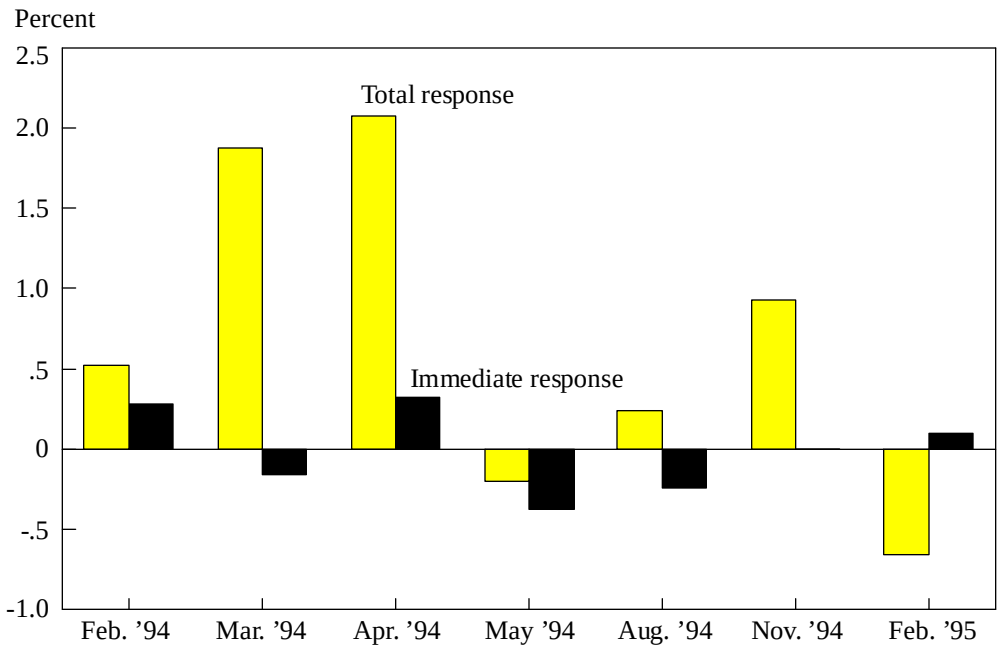
Estimates of the relationship between long-term rates and policy actions

New estimates of the relationship between monetary policy actions and long-term interest rates were obtained by examining the response of the 30-year Treasury bond yield to changes in an estimate of the federal funds rate target over the period from October 28, 1987, through July 6, 1995.[16] During this period there were 47 policy actions as measured by changes in the estimated funds rate target. The interest rate response is estimated over both the narrow time interval used in previous studies and over the wider time interval discussed above.

The estimated response of the 30-year Treasury bond yield to effective federal funds rate target changes is presented in Table 1.[17] The total response of the 30-year rate over the entire interval, from the day after the previous policy action to the day after the current change, is shown in the bottom row of the table. This total effect is broken down into three sub-intervals. The first row, labeled "before the change," shows the part of the total response that occurred from the day after the previous policy change to the day before the current policy action. This effect measures the extent to which policy actions are anticipated. The second row shows the response on the day of the current policy action. The third row reports the response on the day after the current policy action.

Although the estimates reported in Table 1 share some similarities with previous work, they also show important differences. The immediate reaction of long-term rates to policy actions is very similar to the previous work. The response of the 30-year bond on the day of and day after the policy change, the sum of rows two and three, is only 0.10. According to this estimate, a 100-basis-point in-

Chart 4
RESPONSE OF LONG-TERM RATES TO POLICY ACTIONS



crease in the funds target is associated with a small, ten-basis-point increase in the 30-year rate in the days surrounding the policy action.[18]

In addition to the small immediate response, there is evidence that market rates anticipate policy moves well in advance of the current policy action. Moreover, the magnitude of this anticipation effect (0.28) is much greater than the immediate response. When these two responses are combined, the total response of the 30-year rate (0.38) is considerably larger than previous estimates, reflecting the fact that almost three-quarters of the movement in the 30-year rate appears to occur well in advance of the policy action.[19]

According to the expectations theory, this response of long-term rates to monetary policy can be separated into changes in current short-term rates and market expectations of future short-term rates as measured by forward rates. Such a decomposition provides an indication of whether market participants view policy actions as temporary or more persistent.

The impact of policy actions on current short-term rates and forward rates is shown in Table 2.[20] In this table, the current short-term rate is taken to be the 1-year constant maturity Treasury security yield. Because the Treasury does not issue bonds for all maturities, it is difficult to derive all 29 forward rates imbedded in the 30-year bond. However, using constant maturity data for available maturities, it is possible to calculate a set of combinations of forward rates that span the 30-year bond. Table 2 shows 2-year forward rates for periods one, three, and five years ahead, the seven-year ahead, 3-year forward rate, and the ten-year ahead, 20-year forward rate.[21]

Table 1

RESPONSE OF THE 30-YEAR TREASURY BOND YIELD TO EFFECTIVE FEDERAL FUNDS RATE TARGET CHANGES: 1987-95

		Summary statistics		
Response	Response estimates	R^2	SE	DW
Before change	.2793**	.048	.341	1.50
	(.1533)			
Day of change	.0437	.016	.073	2.10
	(.0330)			
Day after change	.0570*	.129	.045	2.15
	(.0204)			
Total	.3799*	.090	.357	1.50
	(.1609)			

* Significant at the 5 percent level.

** Significant at the 10 percent level.

Note: Estimated standard errors in parentheses.

R^2 = multiple correlation coefficient corrected for degrees of freedom.

SE = standard error.

DW = Durbin-Watson statistic.

According to the results in Table 2, the estimated effect of monetary policy actions on the 30-year bond comes both from an increase in current short-term rates and from an increase in forward rates. The estimated total effects of policy on both the current 1-year rate and the one-year ahead, 2-year forward rate, shown in the bottom row of Table 2, are approximately 1.0. That is, a change in the funds rate target is fully reflected in market rates over a one-to-three-year horizon.[22] In the framework of the policy scenarios discussed earlier, these results suggest market participants view monetary policy actions as very persistent over a three-year horizon. The effects on other forward rates shown in Table 2 diminish with maturity, and the total effect is not statistically significant beyond a five-year horizon. This implies that, while policy actions are seen as persistent, they are not viewed as permanent. At the same time, there is no evidence in Table 2 that forward rates systematically decline in response to an increase in the funds rate target. Again, this suggests market participants do not expect policy actions to be more than offset even over a long horizon. Finally, when the response of current and forward rates is divided into the reaction before, during, and after the policy action, as shown in the first three rows of Table 2, it is clear most of the movement in these rates occurs in anticipation of the policy action.

Two principal conclusions emerge from these empirical results. First, the average effect of monetary policy actions on long-term rates is positive and larger than found in previous studies. The larger

Table 2

CURRENT AND FORWARD RATE RESPONSES

Response	1-year rate	2-year forward rate in 1 year	2-year forward rate in 3 years	2-year forward rate in 5 years	3-year forward rate in 7 years	20-year forward rate in 10 years
Before change	.7710*	.6285*	.3626*	.1447	.2413	.0829
	(.1407)	(.2022)	(.2079)	(.1917)	(.1968)	(.1626)
Day of change	.2239*	.1017*	.0861**	-.0378	.0261	.0042
	(.0419)	(.0431)	(.0459)	(.0551)	(.0388)	(.0377)
Day after change	.0301	.0880*	.0460	.1423*	.0102	.0506**
	(.0219)	(.0279)	(.0312)	(.0479)	(.0391)	(.0260)
Total	1.0249*	.8182*	.4947*	.2492	.2776	.1377
	(.1452)	(.2153)	(.2178)	(.1892)	(.2076)	(.1765)

* Significant at the 5 percent level.

** Significant at the 10 percent level.

Note: Estimated standard errors in parentheses.

response is due to the fact that anticipated policy actions seem to be built into market rates well in advance of the policy action, an effect captured by the wider measurement interval used in this article. Second, much of the impact of policy actions on market rates appears to come from the reaction of forward rates. As a result, market participants seem to view monetary policy actions as highly persistent over a one-to-three-year horizon.

SUMMARY AND CONCLUSIONS

Standard views of the monetary transmission mechanism rest on a reliable relationship between monetary policy actions and market interest rates. While there is considerable evidence that monetary policy has a large impact on short-term interest rates, the connection between policy actions and long-term rates often appears weaker and less reliable.

The analysis presented in this article suggests a stronger but more variable connection between monetary policy actions and long-term rates. To a considerable degree, long-term rates appear to anticipate policy changes, moving well in advance of policy actions. Previous studies, which focus on the behavior of long-term rates only around the day of the policy action, do not fully capture these anticipation effects and so understate the relationship between policy actions and long-term rates.

Because market expectations play such an important role in the response of long-term rates to monetary policy, however, the connection between policy

actions and long-term rates is likely to be more variable than suggested by the standard view of the monetary transmission mechanism. Monetary policy actions are likely to be most effective in changing long-term rates when these actions are seen as persistent. Consequently, to the extent that investors' views about the persistence of monetary policy actions change over the business cycle, the ability of monetary policy to influence long-term rates may vary over time.

ENDNOTES

[1] The Federal Reserve does not publish an official series for its short-run operating targets. Thus, any data for an operating target must be constructed from declassified historical data or from financial market estimates of the operating target. The federal funds target series used in this article was constructed by one of the authors from historical data provided by the Federal Reserve Bank of New York through 1992 and updated using the published record of FOMC policy actions. Construction of this series required some judgment as to the timing of policy actions so that this series should be viewed as an estimate rather than an official record of policy actions.

[2] Additional anecdotal evidence supporting a weak linkage between policy actions and long-term rates can be found in the immediate reaction of long-term rates in the days surrounding announcements of policy actions. In the past year, market analysts have made note of instances in which long-term rates fell rather than increased in response to an announced increase in the funds target. This behavior of long-term rates has also led some analysts to question the ability of the Federal Reserve to influence long-term rates.

[3] Cook and Hahn (1989a) studied the reaction of market rates to changes in the Federal Reserve's estimated federal funds rate target over the period from September 1974 to September 1979. They derived their measure of the funds rate target from *Wall Street Journal* discussions of policy actions. In a related study, they found that the *Wall Street Journal* estimates tracked the official record of policy actions quite closely (Cook and Hahn 1989b). Radecki and Reinhart examined the response of market rates to a series of funds target changes over the period from June 1989 to September 1992. Their measure of the funds rate target was obtained from declassified information released by the Federal Reserve.

[4] This discussion of the simple form of the expectations theory ignores a term premium or risk premium. Because expected future rates are uncertain, it is commonly believed that investors demand a risk premium to hold longer term securities. Thus, in the example in the text, the 2-year bond yield is likely to be above 6.5 percent to compensate investors for the risk of a possible capital loss. Early versions of the expectations theory assume that the risk premium is constant or even zero (Hicks). More recent versions allow the risk premium to vary over time and to depend on more elaborate sources of risk than that discussed above (Cox, Ingersoll; and Ross; Engle, Lilien, and Rubins; Longstaff; Campbell and Shiller).

[5] For some maturities, the futures market is one possible source to determine the market's expectations about future interest rates. However, the entire range of expected future short-term rates comprising very long-term rates cannot be observed directly in futures markets.

[6] For example, the current yield on a 3-year bond can be decomposed into a current 1-year rate and two 1-year forward rates. Similarly, the yield on a 30-year bond can be broken down into the yield on a current 1-year rate and 29 1-year forward rates.

[7] This scenario finds some support in the empirical literature on the term structure. Mankiw and Miron suggest that after the Federal Reserve was formed in 1914, short-term interest rates followed a random walk. Consequently, each change in short-term rates is expected to be permanent for the entire maturity of a security.

[8] In this example, the new 2-year rate is computed as the average of the new 1-year rate and the new one-year ahead, 1-year forward rate (.5 x (5+6)). Similarly, the new yield on the 3-year bond is calculated as (.333 x (5+6+6)) and the new yield on the 4-year bond is calculated as (.25 x (5+6+6+6)). This scenario is similar to the "excess sensitivity" of long-term rates to policy changes examined by Mankiw and Summers. While commentary by financial market participants suggests that long-term rates may overreact to monetary policy actions, Mankiw and Summers find no systematic tendency of rates to overreact to policy changes.

[9] This scenario is consistent with stories sometimes appearing in the financial press that long-term interest rates may fall if the Federal Reserve tightens policy. Goodfriend also

discusses how credible policy tightening may result in lower long-term rates by decreasing inflationary expectations.

10 The variable response of long-term rates to policy actions has another implication for policy. If this variability is not systematic, that is, market participants simply change their outlook on future policy actions very frequently, estimates of the response of long-term rates to policy actions may be very imprecise. If so, policymakers may have difficulty in accurately predicting the response of long-term rates to a change in policy.

11 Long-term rates may already be on a downward trend if the weaker economic outlook leads market participants to lower inflationary expectations. In this situation, an increase in the funds rate target will have little effect on long-term rates because market participants believe that the funds target will eventually be lowered as future inflation declines.

12 Explaining why expectations vary over the business cycle is a more difficult issue that is beyond the scope of this article. Clearly, policy actions are not the only factor determining market expectations of future interest rates. Indeed, market expectations of future interest rates are likely to depend on a variety of factors influencing both real interest rates and inflationary expectations. This article has highlighted the importance of policy persistence. According to the expectations theory, policy actions are likely to have a large effect on long-term rates only to the extent that they are viewed as persistent. However, policy actions are more likely to be viewed as persistent when they are also seen as compatible with other fundamental factors determining the outlook for real interest rates and inflationary expectations. Thus, the effectiveness of monetary policy in influencing long-term rates may vary over time, depending on financial market perceptions as to the consistency of policy actions and other factors determining the economic outlook.

13 Other studies that examine the relationship between Federal Reserve behavior and the term structure include Mankiw and Milan, Cook and Hahn (1990), Rudebusch, and Dotsey and Otrok, and McCallum.

14 Extending the interval to the day after the policy action is consistent with previous studies which generally find a significant response of interest rates a day or two after the policy action. One explanation for this result is that until 1994, policy actions by the Federal Reserve were not officially announced and so it may have taken time for market participants to discern the timing and magnitude of a policy change.

15 Since the size of the change in the funds rate target is not constant across time, each change in the 30-year rate is normalized by dividing by the change in the funds rate target. Thus, if the reaction of the 30-year rate is equal to 1.0 in the chart, this indicates that the 30-year rate rose by the same amount as the funds rate target. Also, since the last policy change prior to the February 1994 change occurred in 1992, the beginning of the measurement interval for this change was arbitrarily set at the last business day of 1993.

16 While data for the most recent period are available starting in 1985, the sample used here starts in October 1987 for two reasons. One is that the Federal Reserve appeared to focus more directly on the federal funds rate in implementing monetary policy after the October 1987 stock market crash (Lindsey). Another, and perhaps related, factor is that the empirical results reported below are significantly different for the period before October 1987. Consequently, the model is estimated from October 1987 to reflect the most recent experience.

17 The equations are estimated in the following form:

$$\Delta R^{i}_{30y,t} = b_o + b_1 * \Delta r_{ff,t} + e_t \quad i = 1,2,3,4$$

$\Delta R^{1}_{30y,t}$ = change in the 30-year Treasury bond from the day after the change in the effective federal funds rate target at time t-1 to the day before the change at time t.

$\Delta R^{2}_{30y,t}$ = change in the 30-year yield from the close on the day before the change in the funds rate target at time t to the close on the day of the change.

$\Delta R^{3}_{30y,t}$ = change in the 30-year yield from the close on the day of the change in the funds rate target at time t to the close on the day after the change.

$$\Delta R^{4}_{30y,t} = \Delta R^{1}_{30y,t} + \Delta R^{2}_{30y,t} + \Delta R^{3}_{30y,t}$$

= change in the 30-year rate from the day after the change in the funds rate target at time t-1 to the close on the day after the change in the funds rate target at time t.

18 Estimates of the immediate response of long-term rates to a 100-basis-point increase in the interest rate target range from four to ten basis points (Cook and Hahn (1989a), Radecki and Reinhart, Dale). Some studies use the 20-year rate instead of the 30-year rate as the long-term bond. The Federal Reserve began announcing policy actions in 1994. None of the estimated results in this article differ in the pre-1994 and post-1994 period.

19 The simple model used to obtain these estimates abstracts from econometric issues that could affect the estimates. One

issue raised in the previous section is that the response of long-term rates may vary systematically over the business cycle while the model estimated does not attempt to incorporate this variability. The relatively short length of the sample precludes a detailed examination of business-cycle effects. If variability is important, the estimates reported in Tables 1 and 2 are best viewed as measures of an average response over the sample period. Thus, an estimated positive response is consistent with either an average of large responses at the beginning of an expansion and small responses toward the end or a relatively stable moderate response throughout an expansion. Without indicating any particular pattern, however, the results do suggest that responses are quite variable as indicated by the relative imprecision of the response estimates. This variability is consistent with the response pattern for the brief period illustrated in Chart 4. A second issue is that there is no attempt to model a term premium. Forward rates incorporate both expectations of future short-term rates and term premia. If these term premia depend upon the level of interest rates, the estimates could be biased.

[20] The equations in Table 3 are estimated in the following form:

Change in current or forward rate $\overset{i}{}_t$ =

$$b_0 + b_1 * \Delta r_{ff,t} + e_t \quad i = 1,2,3,4$$

Change in current or forward rate $\overset{1}{}_t$ = change in the rate from the day after the change in the effective funds rate target at time t-1 to the day before the change at time t.

Change in current or forward rate $\overset{2}{}_t$ = change in the rate from the close on the day before the change in the funds target at time t to the close on the day of the change.

Change in current or forward rate $\overset{3}{}_t$ = change in the rate from the close on the day of the change in the funds target at time t to the close on the day after the change at time t.

Change in current or forward rate $\overset{4}{}_t$ = change in the rate from the day after the change in the funds rate target at time t-1 to the close on the day after the change at time t.

$\Delta r_{ff,t}$ = change in the effective funds rate target from time t-1 to time t.

[21] Forward rates are calculated with the adjustments suggested by Shiller, Campbell, and Schoenholtz. These forward rates are adjusted for the durations of the different securities that depend on the level of interest rates. The responses of unadjusted forward rates (not reported), along with the one-year spot rate, would sum to the response of the 30-year yield (0.38) as reported in Table 1. Because of the duration adjustments, however, the sum of the adjusted forward rates used in Table 3 implies a somewhat different (0.25) response of the 30-year rate.

[22] Of the three previous studies cited, only Radecki and Reinhart look at the reaction of forward rates to policy actions. These authors find a much smaller response of the one-year rate than this study and find no significant response of forward rates beyond a one-year horizon.

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