Fall

1984

Economic Review

Number

4

Federal Reserve Bank of San Francisco

The Federal Reserve Bank of San Francisco's Economic Review is published quarterly by the Bank's Research and Public Information Department under the supervision of Joseph Bisignano, Senior Vice President and Director of Research. The publication is edited by Gregory J. Tong, with the assistance of Karen Rusk (editorial) and William Rosenthal (graphics).

For free copies of this and other Federal Reserve publications, write or phone the Public Information Department, Federal Reserve Bank of San Francisco, P.O. Box 7702, San Francisco, California 94120. Phone (415) 974-3234.

Money Supply Announcements, Forward Interest Rates and Budget Deficits

John P. Judd*

The positive association between long-term interest rates and M1 "surprises" typically is ascribed to changes in inflation expectations induced by the unanticipated money supply changes. The empirical tests in this paper use a term structure framework for explaining long-term interest rates to isolate more carefully this effect. One of the surprising results is that the expectations effect does not show up in the pre-October 1979 data, the period in which it is generally assumed that the Fed's procedures for controlling money were less well designed to fight inflation. An hypothesis that the presence of large government budget deficits in the post-1979 period may account for the presence of a significant expectations effect then does not appear to be borne out by the data.

In recent years, many financial and monetary economists have offered explanations for the strong responses of interest rates and exchange rates to the Federal Reserve's weekly M1-announcements. For example, when an announced increase in M1 is larger than expected by the market (or a decrease is smaller than expected), short- and long-term interest rates generally increase on the following day, and the dollar appreciates in the foreign exchange market. The opposite movements generally are observed when M1 comes in below market expectations.

This phenomenon probably arises because the market perceives that the Fed attempts to exercise control over M1, but that it does so somewhat cautiously. That is, in the short-run, the Fed is perceived as attempting to offset some, but not all, of the deviations of M1 from target. The responses of short-term interest rates and exchange rates therefore probably reflect a *policy anticipations effect*: when M1 increases more than anticipated, the market expects the Fed to tighten monetary policy temporarily, which will raise real short-term interest rates and exchange rates. Responses of long-term rates have been interpreted primarily as reflecting changes in inflation expectations: the market expects the Fed to react against a money surprise, but not to react strongly enough to prevent some increase in inflation in the future. This phenomenon is called the *expected inflation effect*.

Given these effects, it is nevertheless puzzling that long-term bond rates have responded as sharply as they have in the past five years to money supply announcements, and that they have responded more sharply since October 1979 than before. Since the Fed changed its operating procedures in October 1979 to enhance control over M1 to attain better the objective of gradually bringing inflation down, it would make more sense if bond rates responded more sharply to M1-surprises in the earlier period than in the later one. In this paper, we attempt to solve this puzzle in two separate ways. First, instead of analyzing the behavior of long-term bond rates, as most previous studies have done, we examine short-term interest rates expected to prevail in the distant future. For the reasons discussed below, changes in long-term rates can be difficult to interpret because they reflect changes in short-term real rates as well as expected inflation. However, the expected future short-term rates examined in this study should provide "cleaner" estimates of the responses to expected inflation, and therefore may help solve the puzzle described above.

Second, we examine the possibility that the exis-

* Research Officer. David Murray and David Taylor provided research assistance.

tence of "large" expected future structural budget deficits in recent years might have affected the size of responses to money supply announcements. The argument is that when current and future federal deficits are high, positive M1-surprises may tend to intensify fears that the Fed might monetize part of the government debt associated with the deficits. Conversely, negative M1-surprises could reduce concerns about monetization. Thus, the change in fiscal policy regimes that occurred in 1981, when expected future deficits apparently became large, could have affected the responses of interest rates to M1-surprises.

The tests in this paper support the conclusion that there is both a policy anticipation effect and an inflation expectation effect operating simultaneously. Their existence confirms the idea that the market believes the Fed pursues its monetary control objectives somewhat cautiously. Moreover, the tests provide some evidence that a stronger policy anticipations effect is associated with a weaker inflation expectation effect. Finally, the results suggest that expected inflation effects are significant for only about seven years into the future, and that these effects, together with movements in current and near-term real interest rates, account for the observed large responses of 30-year bond rates.

The major remaining puzzle is why there was not a significant expected inflation effect prior to the Fed's anti-inflation policy that began in October 1979. As noted above, this paper examines the hypothesis that this apparent inconsistency might be related to the change in fiscal policy regimes in 1981. It is possible that greater fears of monetization in the latter period may have caused the inflation expectations effect to be larger. However, tests of this hypothesis met with only mixed success, and this puzzle will have to be solved by future research.

Section I reviews the literature on money supply announcements, and points out the apparently puzzling behavior of long-term interest rates. Section II presents empirical estimates of the responses of short-term spot rates and several forward interest rates to M1-surprises in three monetary control regimes: September 1977–October 1979, October 1979–October 1982, and October 1982–February 1984. Section III tests for effects of the change in fiscal policy regimes in mid-1981. Conclusions are presented in Section IV.

I. The Money Supply Announcement Puzzle

In recent years, economists have produced a plethora of journal articles on the responses of various financial asset prices to the Federal Reserve's weekly announcements of M1.[1] Interest in this subject became intense following the Federal Reserve's change in operating procedures in October 1979. Prior to that date, the Federal Reserve had attempted to control money over periods of several quarters through very gradual changes in the Federal funds rate.[2] Under the new procedures, which used nonborrowed reserves as the instrument of monetary control, the Fed permitted short-term interest rates to vary in the short-run more than they had previously.[3] Greater interest rate volatility was considered necessary to achieve greater control over the monetary aggregates in the short-run. Moreover, for most of the period up to the fall of 1982, M1 was given the most weight in monetary policy decisions.

Coincident with the change in Federal Reserve operating procedures, interest rates and foreign exchange rates began to respond strongly to the Fed's weekly announcement of the most recent weekly M1 figure. Actually, the reactions were systematic only when changes in M1 differed from the change expected by the market. Thus, changes in M1 anticipated by the market seemed to induce *no* systematic response in asset yields, presumably because the responses *previously* had been incorporated into yields.

A large number of studies have estimated the responses of yields to unanticipated changes in M1, both before and after the October 1979 change in the operating procedures of the Fed. These studies used similar econometric techniques in their tests. The explanatory variable in the regressions was the "surprise" in the change in weekly M1—that is, the change in the actual M1 announced by the Fed minus the change in expected M1. The latter variable is measured as the median value of a set of forecasts by money market economists surveyed and recorded by Money Market Services, Inc. This survey has been conducted from September 1977 to

the present. The dependent variables in previous studies include changes in a variety of long- and short-term interest rates and exchange rates, where the change is measured from the end of the day of the M1 announcement to the following day.

Although different studies have used somewhat different sample periods, they have obtained very similar results. Prior to October 1979, the responses of short-term interest rates, long-term interest rates and dollar exchange rates were very small, and generally (though not always) statistically insignificant. For example, using data from January 1978 to October 1979, Cornell (1983) found that, in response to a 1-percent positive M1-surprise, the three-month Treasury bill rate rose by (statistically insignificant) 2 basis points, and the 30-year Treasury bond rate fell by (statistically insignificant) 0.4 basis point. A very small response also was found for the dollar price of the German mark. From October 1979-December 1981, the response became highly significant. A 1-percent positive M1-surprise was associated with a (statistically significant) 30-basis point increase in the three-month Treasury bill rate, a 15-basis-point increase in the 30-year Treasury bond rate, and an appreciation of the exchange rate.

Alternative Theoretical Explanations

A number of theories would predict responses of asset yields to M1-surprises. To understand these channels of influence, it is useful to consider the Fisher equation (1). This equation states that the nominal interest rate (i) of a particular holding period can be decomposed into the real interest rate (r) of the same holding period and the *expected* rate of inflation over that period ($\dot{p}^e$). Both the real and inflation components of the nominal rate depend on expectations about the future. M1 announcements can cause changes in interest rates by altering those expectations.

$$i = r + \dot{p}^e \qquad (1)$$

A second concept that enters the discussion of M1-surprises is the expectations theory of the term structure of interest rates. This theory maintains that securities of different maturities are good substitutes, so that competition in the financial markets will equate the holding period yields of securities of different maturities. Thus, for example, the investor can expect to obtain the same yield by (1) holding a six-month Treasury bill to maturity, or (2) holding a three-month T-bill to maturity and then reinvesting the proceeds in a second three-month bill and holding it to maturity. For this reason, the yield on the six-month bill will be equal to a weighted average of the yield on the three-month bill and the *expected* yield on the three-month bill, three months from now. The latter yield is called a forward rate. Changes in these short-term forward rates cause changes in the same direction in long-term rates. This term structure theory provides a link between expected future short-term rates and long-term rates that plays an important part in the various explanations advanced for the effects of M1-surprises.

Expected Inflation Effect

The *expected inflation theory* holds that an M1-surprise is taken as new information about the current and future growth in the quantity of M1 supplied by the Federal Reserve. As such, a positive M1-surprise causes interest rates to rise because it raises inflation expectations. This theory has an unambiguous implication for long-term rates and for the exchange rate. Higher expected inflation should raise the former and depreciate the latter. The effect on exchange rates follows from the anticipated drop in the purchasing power of the dollar. The effects on short-term rates would depend on how quickly the price level can adjust to a change in money supply —that is, on how "sticky" prices are in the short-run. Presumably, if prices were sufficiently flexible, one would observe an increase in short-term rates following a positive M1-surprise.

The empirical results contradict the expected inflation hypothesis in two ways. First, the exchange rate appreciates with a positive M1-surprise rather than depreciates, as predicted by theory. Second, the positive effects of M1-surprises on long-term rates grew larger with the change in Fed operating procedures in 1979. *If* M1-surprises changed long-term rates by altering inflation expectations, then the implementation of a new anti-inflation policy should have *reduced* the estimated responses. Even if the change in procedures had no credibility, it would not have increased them; it would have left the responses unchanged.

Policy Anticipations Effect

The *policy anticipations theory*[4] proposes that M1-surprises lead to changes in real interest rates. When the Fed attempts to control M1, a positive M1-surprise leads the market to anticipate an increase in short-term (real) interest rates as the Fed attempts to bring M1 under control. In other words, the market believes that the change in M1 was induced by a factor other than an intentional action of the Fed. Since the Fed wants to control M1, it subsequently will take actions to do so and its actions will affect real interest rates. The anticipation of these actions causes rates to change immediately.

The maturities of the rates that are affected depend on what the market perceives is the source of the M1-surprise. If pressures for the change in M1 are not expected to persist for long, then only very short-term interest rates should change. It also is possible, for example, that the market interprets a positive M1-surprise as an indication that GNP is stronger than it originally believed, and that this growth has raised the quantity of money demanded. An upward revision in estimated current GNP could lead to expectations of higher GNP for several years to come, and the market might expect the Fed to offset these pressures through gradual and fairly prolonged increases in short-term rates. As a consequence, expected forward rates would rise, and their rise would push up longer term spot interest rates. However, since the Fed cannot hold real interest rates above the equilibrium level into the very distant future, this theory would predict that little, if any, of the effect of M1-surprises on forward rates would prevail into the distant future.

Finally, the policy anticipation theory predicts that a positive M1-surprise causes the dollar to appreciate. This occurs because money surprises cause *real* interest rates to move, and higher real U.S. interest rates cause the demand for dollar-denominated assets to rise.

This hypothesis is consistent with the responses of short-term interest rates and exchange rates. It also is consistent with the result that both of these variables moved more after October 1979, when the Fed's monetary control efforts were more aggressive, than before that date, when the Fed tended to respond more gradually. However, the strong rise of long-term interest rates after October 1979 has been interpreted as contradicting this hypothesis. The reasoning goes that although the Fed can drive real interest rates up by reducing the money supply in the short-run, the effect on real rates should not be evident in the distant future when prices have had time to adjust. If the period of monetary restraint lasts only a short time, then only the current interest rate and forward rates covering the near future should rise; the effect on long-term interest rates should be small. If the Fed follows a tighter policy far into the future, the policy should eventually reduce inflation expectations and *lower* long-term interest rates.

Combined Effects

The theories discussed above are not mutually exclusive. One can reasonably combine the policy anticipations and expected inflation effects into an explanation of responses of various asset prices to M1-surprises.[5] The argument is that, in the post-October 1979 period, the Fed tried to control M1 but did so somewhat cautiously. As a result, when the market observed a larger-than-expected increase in M1, it assumed that only part of it would be offset by a policy response and that part of it would permanently raise M1. Short-term rates consequently rose because the Fed was expected to tighten policy, and long-term rates rose at the same time because part of the M1 increase was expected to remain in the money stock permanently. Unfortunately, this combined theory cannot be tested with the exchange rate after October 1979 because the predictions are ambiguous, that is, the increase in real rates would cause the dollar to appreciate, while the increase in inflation expectations would cause a depreciation.

This explanation fits the post-October 1979 data quite well, with both long- and short-term interest rates rising when M1 came in over expectations. For the pre-October 1979 period, the prediction clearly would be for (at most) the observed small response of the short-term rate because the Fed reacted very gradually to the M1 numbers. However, the long-term rate should have responded positively, because the former funds rate operating procedure of the Fed implied that a larger part of an M1-surprise would be permanent. By the same token, the exchange rate should have depreciated when M1 came in over expectations. These last two predictions of the combination theory do not fit the data for the pre-October 1979 period—neither the long-term rate nor the exchange rate responded significantly in that period.

II. Forward Interest Rates

One key aspect of the puzzling reaction of financial asset prices to M1-surprises is that short- and long-term rates seem to respond in the same way. Thus, prior to October 1979, neither rate responded significantly, whereas afterward, they both responded positively. As discussed above, the two theories used to explain these responses, as well as the combination theory, do *not* necessarily predict that long- and short-rates will move in the same direction. The reason is that short-term rates are taken as a measure of changes in real interest rates, whereas changes in long-term rates are seen primarily to reflect changes in inflation expectations. The real and expected inflation components of nominal interest rates should respond in different ways to an M1-surprise depending upon the public's perception of how policy is being conducted. Prior to October 1979, the Fed may have been perceived as permitting a significant part of a positive M1-surprise to remain in the money supply permanently. In reaction, there should have been only a small response by real rates (reflected in the short-term rate) and a fairly large increase in inflation expectations (reflected in the long-term rates). After October 1979, short-term rates should have responded strongly, whereas long-rates might have been expected to respond only slightly because of the Fed's anti-inflation stance.

The assumption that the responses of short-term rates to M1-surprises reflect the real component of interest rates is strongly supported by evidence that prices adjust to changes in the money supply with a lag. Given this evidence, it is difficult to believe that today's money "blip" causes any perceptible change in the inflation expected, say, over the next three months.

However, the assumption that movements in long-term rates primarily reflect changes in inflation expectations does not rest on such firm footing. According to the expectations theory of the term structure of interest rates, long-term spot rates are weighted averages of the current short-term spot rate and the expected short-term *forward* rates. Thus, it is possible that long- and short-term rates move in the same direction because long-term rates, in part, are made up of short-term rates. In other words, changes in inflation expectations may not always dominate observed changes in long-term interest rates. At times, observed changes may simply reflect movements in short-term spot rates and fairly near-term forward rates. This observation suggests that the hypotheses concerning responses to M1-surprises should be tested with short-term spot rates and short-term forward rates expected to prevail far into the future. Changes in, say, the expected one-year rate, thirty years forward should give an indication of movements in inflation expectations.

Unfortunately, it is mathematically difficult to calculate expected forward rates from the term structure when one must use bonds that are coupon instruments. Forward rates have been used in another study of M1-surprises, but the calculations were simplified by assuming, in effect, that coupon bonds were discount bonds.[6] This method provides only very rough estimates of forward rate changes, and the result that forward rates far into the future moved in the same direction as long-term spot rates should be viewed with caution.

The study in this paper uses a method of calculating forward rates from a term structure of spot rates on coupon bonds developed by Shiller, Campbell and Schoenholtz (1983).[7] The authors have demonstrated that their approximation of the true formula for calculating the desired forward rates yields close estimates, except in cases of extreme interest rate volatility.

Empirical Results

In this section, we analyze the impact of M1-announcements on the financial markets by regression methods similar to those that have been commonly applied in the literature described above, *except* that we look at the responses of short-term forward rates rather than long-term spot rates. More specifically, we use weekly M1-surprises as the variable to explain changes on the day after the M1-announcement in three financial variables—the three-month Treasury bill rate; the two-year T-bill rate, expected 5-years forward; and the ten-year T-note rate, expected 20-years forward. Changes in the three-month rate are taken to reflect changes in the real component. Changes in the two forward rates are taken as reflecting changes in expected inflation.

These (ordinary least squares) regressions were run over three sample periods, each corresponding to a different monetary policy regime. Regime I stretches from September 21, 1977 to October 3, 1979, and falls in the period when the Fed used the Federal funds rate as an operating instrument. As discussed earlier, this is a period when the Fed attempted monetary control only over periods of several quarters through gradual movements in the funds rate. In doing so, it tended to smooth short-run changes in the funds rate. Regime II covers October 6, 1979 to October 3, 1982, the period of the nonborrowed reserves operating procedure in which the Fed attempted monetary control over shorter time periods, and in doing so permitted much more short-run variation in short-term interest rates. In Regime III, which covers October 10, 1982 to February 8, 1984, nonborrowed reserves no longer were linked to M1 as they had been before. This period can be considered a kind of "half-way house" between I and II. The Fed used borrowed reserves as its operating instrument, and

Table 1

Regression Results

$DA_t = \alpha_0 + \alpha_1 UM_t$

	α_0	α_1	$\bar{R}^2$
Regime I: 9/21/77 to 10/3/79 (98 degrees of freedom)			
Three-Month Treasury Bill Rate	0.03 **	5.79**	0.05
	(2.76)	(2.59)	
Two- Year Treasury Rate, Five Years Forward	0.01	0.25	0.01
	(0.86)	(0.16)	
Ten-Year Treasury Rate, Twenty Years Forward	0.001	1.34	0.01
	(0.012)	(0.50)	
Regime II: 10/10/79 to 10/3/82 (135 degrees of freedom)			
Three-Month Treasury Bill Rate	0.04	36.45**	0.23
	(1.18)	(6.38)	
Two- Year Treasury Rate, Five Years Forward	0.03	7.48*	0.02
	(1.50)	(2.08)	
Ten-Year Treasury Rate, Twenty Years Forward	0.02	2.21	0.01
	(0.36)	(0.21)	
Regime III: 10/10/82 to 2/8/84 (52 degrees of freedom)			
Three-Month Treasury Bill Rate	0.004	16.31**	0.34
	(0.35)	(5.45)	
Two-Year Treasury Rate, Five Years Forward	0.02	12.57*	0.06
	(0.73)	(2.17)	
Ten-Year Treasury Rate, Twenty Years Forward	0.01	7.17	0.001
	(0.21)	(0.99)	

UM = weekly percentage change in M1 minus the expected weekly percentage change (latter variable defined as the median forecast of the survey of money market economists conducted by Money Market Services, Inc.).

DA = change in specified variable
where, the changes are calculated for Friday over Thursday in weeks prior to 1/30/80, and for Monday over Friday in weeks ending 1/30/80 and after. When the day of or the day following an M1 announcement fell on a holiday, data for that week were excluded from the sample.

Note: * significant at the 5-percent level
** significant at the 1-percent level
t = statistics in parentheses.

permitted more short-run variability in interest rates than in Regime I, but less than in II.[8]

Thus, purely on the basis of considering monetary policy regimes, we would expect to find the largest increases in short-term rates in response to positive M1-surprises to occur in Regime II, the next largest in Regime III and the smallest in Regime I. The size of these hypothesized responses reflects the hypothesized market perception of the Fed's commitment to controlling money in the short-run, that is, the greatest perceived commitment is demonstrated by the greatest willingness to permit short-term interest rates to move in response to a money "blip." Moreover, we might expect that forward rates would respond most strongly in the funds rate Regime I, less strongly in Regime III and the least strongly in Regime II.

The empirical results are presented in Table 1. These results seem to resolve some, but not all, of the money supply announcement puzzle. The results for Regimes II and III seem to make sense in terms of the theoretical expectations discussed earlier. In the nonborrowed reserves Regime II, a one percent positive M1-surprise caused a substantial 36-basis-point increase in M1 on the following day. Moreover, this response is highly statistically significant (the t-statistic is 6.38).

This large response in the real rate contrasts with the far smaller increase in expected inflation, as measured by the 7½ basis point increase in the two-year rate, five years forward. Although this response is fairly small, it is statistically significant (the t-statistic is 2.08). Forward rates extending beyond seven years are not statistically significant, indicating that a money surprise today has no systematic effect on inflation expectations beyond seven years. The point is illustrated by the result presented in Table 1, that the 10-year rate, twenty years forward, has a coefficient of only 2 basis points with a t-statistic of only 0.21. (Other results not presented show that the three-year rate, seven years forward, also was not significantly influenced by M1-surprises).

As expected, the results for Regime III show a smaller response for the real component (as reflected in the 3-month T-bill rate) and a larger response in inflation expectations (as reflected in the forward rates).

Specifically, a one-percent positive M1-surprise causes the three-month T-bill rate to rise by 16 basis points (less than in Regime II) and the two-year rate, five years forward, to rise by 12½ percent (more than in Regime II). As with Regime II, there is no significant response of the ten-year rate, twenty years forward.

However, the real puzzle occurs in Regime I, the federal funds rate period. The apparent perception by the market that the Fed reacted cautiously to M1-surprises did not translate into changes in inflation expectations when M1 came in over or under expectations. In that period, a one-percent M1-surprise caused a small, but statistically significant, 6-basis-point increase in the Treasury bill rate, and no statistically significant change in the two forward rates reported.

III. Large Structural Deficits and the Effects of Money Supply Announcements

The preceding analysis of the impact of M1-announcements on asset prices separated the sample period at October 1979 and October 1982 on the theory that the Federal Reserve has a significant influence on those prices. With different operating procedures, the market presumably anticipates different Fed behavior and asset prices respond differently. This is quite a reasonable presumption. However, the Fed's change in operating procedures was not the only major policy change affecting the data in the 1980s. There also was a major change in fiscal policy, as reflected in the emergence of large sustained federal deficits. Expectations of future large structural deficits were well-formed at least as early as President Reagan's tax cuts in July 1981.

How could the presence of large structural deficits affect the response of asset prices to money supply announcements? They could affect the response of asset prices if the public believes the Federal Reserve may monetize part of the federal debt that is generated by budget deficits. Some evidence of past monetization is in the economics literature, although it is by no means conclusive, and expectations concerning monetization are frequently voiced in the financial press.[9] For example, Hoey and Hotchkiss (1983) report results of a sur-

vey of financial decision-makers in December 1983, which found that out of over 600 respondents, about two-thirds agreed with the following statement: "One can have no confidence in the staying power of disinflationary monetary policy as long as federal deficits remain in triple digits."

Monetization of the debt obviously would result in higher inflation rates in the long-run, and thus higher long-term interest rates. Once it becomes clear that deficits are and will remain large, bond rates should rise if the public believes the monetization hypothesis. What role do M1-announcements play? Although the public might believe the monetization hypothesis as a general principle, it presumably would be uncertain about how much of the federal debt might be monetized. Such uncertainty would be consistent with the apparently changing relationship between deficits and M1 growth in the past. Moreover, changes in the make-up of the Federal Open Market Committee, and in the general political "climate" may be expected to influence the degree of monetization.

As the weekly stock of M1 is announced, the public may refine its views about the degree of monetization, and therefore about future money growth and inflation. Thus, if M1 comes in higher (lower) than expected, the market may revise up (down) its estimate of the degree of monetization, and as a consequence, long-term rates will rise (fall). The effects on long-term rates would not be observed in a period of low budget deficits because there would not be much pressure for monetization in such a period. With respect to short-term rates, a positive M1-surprise might elicit smaller responses when deficits are large because the market expects a less aggressive offsetting action by the Fed.

As pointed out by Hardonvelis, 1982, large structural deficits may help to make more sense out of the combined inflation expectations/policy anticipation explanation of asset price movements. In the 1980-1982 period, a positive M1-surprise may have caused short-term rates to rise because of anticipations of a *partially* offsetting action by the Fed under the reserve control procedures. The same positive M1-surprise may have caused forward rates to rise because the public revised up its estimate of how much of the government debt would be monetized, and thus its view of inflation in the long-run. In the pre-1980 period, short rates may have responded only slightly because no immediate Fed policy reaction was anticipated, and forward rates may have responded only slightly because deficits were small and there was little pressure for monetization.

A Test of the Monetization Hypothesis

Simply stated, the monetization hypothesis is that a positive (negative) M1-surprise will elicit a smaller increase (decrease) in short-term rates and a larger increase (decrease) in forward rates when deficits are "large" than when they are small. This hypothesis can be tested using data from monetary policy Regime II. If we assume that the dividing line between "small" and "large" expected future deficits was designed by the Reagan tax cuts of July 1981, then we can test the monetization hypothesis by using data from monetary policy Regime II—October 1979 to October 1982. Specifically, we can see whether the estimated responses of spot and forward interest rate and exchange rates changed as predicted in mid-1981. To do so, we estimate the same model as in Table 1 over the period October 10, 1979 to October 3, 1982, with two additional arguments: (1) a dummy variable (D), that is zero prior to July 6, 1981 and unity thereafter; and (2) the M1-surprise variable (UM) multiplied by the same dummy variable (D). The first of these two additional arguments permits the intercept term to shift, while the second additional argument permits the estimated response of interest rates to M1-surprises to shift. The t-statistics on these coefficients will indicate whether the estimated shifts are statistically significant.

The regression results are presented in Table 2. The results for the short-term spot interest rate are consistent with the monetization hypothesis. Prior to the Reagan tax cut in mid-1981, a one-percent M1-surprise induced a 44-basis-point increase in the three-month Treasury bill rate. After the tax cut, this policy anticipations effect is estimated to be much smaller—the effect falls by 22 basis points. The same basic result is obtained for the one-year rate, one-year forward: before the tax cut the response was 32 basis points, and after the tax cut it fell by a statistically significant 22 basis points.

The results for the more distant forward rates, however, seem to be inconsistent with the monetization hypothesis. If, in the presence of large defi-

Table 2
Regression Results

$$DA_t = \alpha_0 + \alpha_1 UM_t + \beta_0 D_t + \beta_1 D_t UM_t$$

DA	α_0	α_1	β_0	β_1	$\bar{R}^2$
Sample Period: 10/10/79 to 10/3/82 (135 degrees of freedom)					
Three-Month Treasury Bill Rate	0.06	-0.05	44.21**	-22.45*	0.24
	(1.55)	(0.86)	(6.38)	(1.87)	
One-Year Treasury Rate, One-Year Forward	-0.003	0.004	32.43**	-21.69**	0.28
	(0.13)	(0.009)	(7.25)	(2.82)	
Two-Year Treasury Rate, Five Years Forward	0.017	0.034	9.05**	-5.03	0.02
	(0.65)	(0.87)	(2.03)	(0.66)	
Ten-Year Treasury Rate, Twenty Years Forward	0.004	0.07	10.90	-9.36	0.01
	(0.06)	(0.64)	(0.94)	(0.99)	

$D_t = 0$ in 10/10/79 to 6/30/81, and 1 in 7/6/81 to 10/3/82.

Note: Variables are defined in note to Table 1.

* significant at the 5-percent level (one-tailed test)
** significant at the 1-percent level (one-tailed test)

cits, the public interprets a positive M1-surprise as raising the odds that the Fed is monetizing part of the deficit, then it simultaneously should raise its expectations of future inflation. For this reason, coefficient β_1 in Table 2 for the two-year rate, five years forward (and possibly for the ten-year rate, twenty years forward) should be significantly positive. Instead, it is insignificantly negative—that is, there was no statistically significant shift in the responses of this variable corresponding to the tax cut in mid-1981.

On the basis of the evidence presented, it does not appear that the presence of large structural deficits resolves the inconsistencies that appear to exist in the responses of forward interest rates to M1-surprises. The main mystery that still exists is the following: if a positive M1-surprise after the Fed began exercising better long-run control over M1 in October 1979 caused an increase in inflation expectations, why did it *not* also do so prior to that date, when the Fed's control procedures seemed less well designed to control inflation? The monetization hypothesis holds that some of this inconsistency could be resolved by the presence of large deficits and the fear that they might be monetized after mid-1981, and the lack of large deficits in the earlier period. However, there does not appear to have been a change in the response of inflation expectations to M1-surprises between the two periods.

IV. Conclusion

This paper has examined the responses of interest rates to announcements of changes in M1 that are not anticipated by the market. The findings can be summarized as follows. Short-term spot rates of interest increase in response to a positive M1-surprise, and like earlier studies, we found that the responses became much larger when the Federal Reserve used a nonborrowed reserves-oriented operating procedure in October 1979 to October 1982 than in the earlier Federal funds rate regime. The Fed's current operating procedure, which is oriented around borrowed reserves, seems to be interpreted by the market as a kind of "half-way house" between the previous two regimes. The responses of short-term spot rates are larger than in the funds rate regime, but smaller than in the nonborrowed re-

serves regime. These positive responses of short-term rates, together with their relative sizes in the various monetary policy regimes, strongly suggest that the responses represent a policy anticipations effect. That is, when M1 comes in over expectations, the market expects the Fed to tighten policy to some extent, depending on the policy regime.

The interpretation of the responses of long-term rates is not as straightforward. Earlier studies have found a highly significant, and surprisingly large, positive response of long-term interest rates, even out to maturities of thirty years, in response to M1 surprises in the post-October 1979 period, but little effect before. These responses sometimes have been interpreted as demonstrating changes in inflation expectations. It is difficult to imagine why a single weekly M1 figure would have a substantial impact on long-run inflation expectations. To cast more light on this issue, we examined the responses of forward rates of interest far in the future. It does appear that inflation expectations were affected by M1-surprises after October 1979, but these effects seem to extend out only about seven years, and to be of a fairly reasonable size. Thus, the responses of 30-year bonds does not suggest that expected inflation thirty years hence has changed. Instead, the responses reflect changes in real interest rates currently and in the near future, and inflation expectations out to about seven years.

This combination of responses is consistent with the view that the market believes the Fed has attempted to control M1 somewhat cautiously. A positive M1-surprise apparently causes the market to expect some tightening action by the Fed, but not enough tightening action to prevent a moderate increase in inflation. This interpretation is confirmed by the result that when the Fed switched from a nonborrowed reserves- to a borrowed reserves-oriented operating procedure, the policy anticipation effect became smaller and the inflation expectations effect larger. The market's apparent perception that there would be a less aggressive tightening of policy when M1 increased unexpectedly therefore corresponded to the anticipation that inflation would increase by more than it would have in the earlier policy regime.

The remaining puzzle about M1-announcement effects is that there appears to have been no response in inflation expectations prior to October 1979, when the Fed used a funds rate operating procedure. Since that procedure involved only a very small policy anticipations effect, one might expect a large inflation expectation effect, especially compared with the period after October 1979 when the Fed explicitly pursued an anti-inflation policy.

This paper hypothesized that the lack of a strong inflation expectation effect may be related to the change in fiscal policy regimes in mid-1981, when expected future structural budget deficits clearly became "large." It is possible that the public fears monetization of the government debt when deficits are large, and that a positive M1-surprise tends to add to this fear. Conversely, the lack of large deficits in the funds rate regime might help explain the lack of an inflation expectation effect. The results for short-term spot rates seem to confirm this hypothesis, but those for expected future interest rates do not. Further research will be required to solve the money supply announcement puzzle completely.

FOOTNOTES

1. See Cornell, 1983, for a review of this literature.

2. See DeRosa and Stern, 1977.

3. See Judd, 1982.

4. Cornell, 1983, discusses two other theories. The real activity hypothesis argues that the demand for money is a function of expected future income, and that an M1-surprise causes an upward revision in estimates of expected future income. As a consequence, interest rates rise when M1 rises more than expected. Cornell also discusses the risk aversion hypothesis, which argues that an unanticipated increase in M1 reveals that aggregate risk aversion has increased.

5. See Hardouvelis, 1982.

6. *Ibid*

7. For example, the ten-year rate, twenty-years forward is calculated as a duration weighted average of the difference between the thirty-year spot rate and the twenty-year spot rate. The linear approximation enters the formula for calculating duration. This method also is employed in Loeys, 1984, which came to the present author's attention as this paper was going to the printer.

8. See Wallich, 1984.

9. See Hamburger and Zwick, 1981, McMillian and Beard, 1982, and Niskanen, 1978.

REFERENCES

Bradford Cornell, "The Money Supply Announcement Puzzle: Review and Interpretation," **American Economic Review**, September 1983, pp. 644-57.

Paul DeRosa and Gary Stern, "Monetary Control and the Federal Funds Rate," **Journal of Monetary Economics**, April 1977, pp. 217-30.

Gikas Hardouvelis, "Interest Rate Volatility, Fed Credibility, and the Weekly Monetary Announcements," unpublished manuscript, University of California, Berkeley, 1982.

Michael J. Hamburger and Burton Zwick, "Deficits, Money and Inflation," **Journal of Monetary Economics**, January 1981, pp. 141-50.

Richard B. Hoey and Helen Hotchkiss, "Decision-Makers Poll," A. G. Becker Paribas, Inc., December 21, 1983, pp. 3-5.

John P. Judd, "An Examination of the Federal Reserve's Strategy for Controlling the Monetary Aggregates," **Economic Review**, Federal Reserve Bank of San Francisco, Fall 1982, pp. 7-18.

Jan G. Loeys, "Market Perceptions of Monetary Policy and the Weekly M1 Announcements," Working Paper No. 84-2, Federal Reserve Bank of Philadelphia.

W. Douglas McMillin and Thomas R. Beard, "Deficits, Money and Inflation Comment," **Journal of Monetary Economics**, 1982, 10, pp. 273-277.

William A. Niskanen, "Deficits, Government Spending, and Inflation," **Journal of Monetary Economics**, 1973, 4, pp. 591-602.

Henry Wallich, " Recent Techniques of Monetary Policy," **Economic Review**, Federal Reserve Bank of Kansas City, May 1984, pp. 21-30.