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MONETARY POLICY AND REAL INTEREST RATES: NEW EVIDENCE FROM THE MONEY STOCK ANNOUNCEMENTS

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Abstract

This paper presents new evidence on how asset prices respond to new information about the money stock. It shows that the information content of money stock announcements and the response of asset prices to new information in the announcements vary with changes in the monetary policy regime, the Federal Reserve operating procedures, and the reserve accounting rules. While previous studies have examined how asset prices respond to the money stock announcements under the interest-rate targeting procedure and the nonborrowed reserve procedure, we have included new evidence from the borrowed reserve targeting procedure under both lagged and contemporaneous reserve accounting rules. Looking at how both forward exchange rates and other asset prices respond to the announcements, we distinguish between periods when the asset-price response reflected a change in the real interest rate and those when it reflected a change in the inflation premium. Finally, we show that the new contemporaneous reserve accounting rules have greatly reduced the information content of the money stock announcements.

I. Introduction

The explicit examination of expectations has been a recent important development in economic theory and policy. Studies have emphasized the importance of the market's perception of and reaction to new information about economic policy. In particular, in the area of monetary economics, one of the ongoing debates has been over whether monetary policy can affect long-term real interest rates. The resolution of this debate depends, to a large extent, on how markets respond to perceived changes in monetary policy. While there have been many theoretical and empirical studies of this issue, the most recent examination can be found in several papers that investigate the response of asset prices to weekly money stock announcements.[1]

The announcement studies are based on the efficient market hypothesis, which states that the current asset price will reflect all publicly available information. Changes in prices should reflect only new information. The empirical model used in studies of money stock announcements takes the following form:

(1) $\Delta A_{it} = a_0 + a_1 UM_t + a_2 EM_t + e_t,$

where

ΔA_{it} = change in the ith asset price from before the announcement to after the announcement,

UM_t = surprise in the money stock announcement at time t,

EM_t = expected change in the money stock at time t, and

e = random error.

If the efficient market hypothesis is true, if we have accurate measures of

expectations, and **if** the money stock is an important factor in determining the price of the asset, then a_1 will be significant and a_2 will be zero.

A result common to all of these announcement studies is that estimates of a_1 are positive when interest rates are used as the dependent variable in equation 1. Several hypotheses have been presented to explain this positive correlation between money stock surprises and changes in interest rates. These hypotheses can be classified into two broad categories. The first attributes the positive value of a_1 to an inflation premium that changes because the money stock surprise is treated as a money supply shock. The second attributes the positive value of a_1 to a policy anticipation effect. The money stock surprise is treated as a money demand shock that is expected to be offset by future policy actions.

In this paper we provide new evidence to explain how asset prices have responded to surprises in the money stock announcement over the past seven years. Our sample period, September 1977 to September 1984, was determined by the availability of survey data on the expected change in the money stock. The period includes important changes in monetary policy and operating procedures. We distinguish between policy regime changes and operating procedure changes, which are not necessarily the same. The two may be the same **if** the central bank is overly concerned about short-run money market conditions or **if** the short-run operating procedure is not constrained by some long-run objectives.' We define a policy regime change as a change in the objective function of the policy authority. **If** the objective function is a weighted average of different goals, then the policy change may be a shift in the relative weights for the different goals. Changes in operating procedures may lead to changes in the response of short-term asset prices to the money

stock announcements, but the response should be short-lived if there is no change in the objective function. In this case, there is not likely to be a response by long-term asset prices.

In October 1979 there was an apparent change in both the monetary policy regime and the short-run operating procedure. The Federal Reserve switched from a policy that had led to accelerating inflation to a policy that led to decelerating inflation. The Federal Reserve also switched from the federal funds operating procedure before October 1979 to the nonborrowed reserve operating procedure after October 1979. There was also another change in operating procedures in October 1982: the Federal Reserve switched from nonborrowed reserve targeting to borrowed reserve targeting, which, as we show below, is an interest-rate smoothing procedure. In this paper we show that the pattern of asset price reactions to money stock innovations in the post-October 1982 period has not returned to the pattern that prevailed in the pre-October 1979 period. Evidently, market participants believe the Federal Reserve has maintained a disinflationary policy despite its returning to an interest-rate smoothing procedure.

There was also an institutional change that should have an effect on how asset prices respond to the money stock announcements. On February 2, 1984, the Federal Reserve switched reserve accounting rules; the lagged reserve accounting rules (LRR) that prevailed before February 2, 1984, were replaced by almost contemporaneous reserve accounting rules (CRR). We explain how the change in rules has greatly reduced the information content of the money stock announcements.

In the literature review we show that existing hypotheses are inadequate to explain the pattern of results that has emerged from past empirical studies. In this paper we add a new market, the forward exchange rate, and a

period of new evidence from yet another change in operating procedures. This new evidence lends support to the following conclusions:

First, the strength of the reaction of the federal funds rate and other short-term interest rates to the money stock announcements depends on the prevailing operating procedure and the reserve accounting rules.

Second, in the pre-October 1979 period of an inflationary policy, money stock surprises contained information about future inflation rates. Interest rates and exchange rates reacted to the money stock surprises, because private agents revised their inflationary expectations upward. Under lagged reserve requirements, surprises in M1 reflected money demand shocks. The Federal Reserve automatically accommodated these shocks in the short run. Over the long run, policy allowed an upward drift of the monetary targets. This behavior led the market to believe that money stock innovations would eventually lead to an upward revision of money targets and, consequently, higher inflation.

Third, in the post-October 1979 period, the Federal Reserve's monetary policy changed to one of disinflation. The rapid deceleration of inflation early in this period has been followed by low and relatively unchanged inflation rates in the last two years. In this period, the reaction of nominal interest rates and the dollar exchange rates to money stock surprises reflected changes in the market's assessment of current and future real interest rates. This assessment resulted from the perception that the monetary authorities would not fully accommodate the unusual and persistent money demand shocks that occurred during this period. These money demand shocks originated in portfolio disturbances associated with the rapid decrease in inflation, financial innovations, and deregulation.

We have organized the paper as follows: Section II contains a discussion of the information content of money stock announcements and a critical review of major hypotheses, including recent findings from the foreign exchange market. Section III sets out our hypotheses explaining how asset prices react to money stock announcements under alternative policy regimes and operating procedures. Section IV includes empirical evidence about the response of short-term interest rates, long-term interest rates, forward interest rates, spot exchange rates, and forward exchange rates to money stock surprises in four separate sub-periods between September 1977 and September 1984. This section also includes concluding comments.

II. The Issues Surrounding the Effects of Money Stock Announcements

The Information Content of Weekly Announcements

A common error in the literature on the effect of money stock announcements is the reference to them as a supply effect. Nichols, Small, and Webster (1983) correctly point out that the weekly Federal Reserve release of the M1 data is an announcement of the preliminary estimate of the change in the money stock for the week ended eight days to ten days earlier. The announcement of the change in the money stock provides new information about the quantity of money. It does not distinguish between demand and supply shocks, nor does it distinguish between temporary and permanent shocks.

If the weekly M1 growth series has a deterministic trend, then weekly variations in M1 should be the result of temporary shocks and the weekly announcements should provide little information about future levels of money and prices. If so, the observed response of asset prices to money stock announcements may result from market over-reaction. This hypothesis is

offered by Shiller, Campbell, and Schoenholtz (1983). If the weekly M1 growth series has a stochastic trend, then weekly variations in M1 could be the result of permanent shocks, and the weekly announcements could contain useful information about future levels of money and prices. In this case, the market reaction is appropriate.

We use Nelson and Plosser's (1982) method to test whether a series has a deterministic or a stochastic trend. Two models of the weekly money stock series are shown below. The first is a model with a deterministic trend:

$$(2) \quad m_t = c + bt + u_t;$$
$$\varphi(B)u_t = \Theta(B)a_t; \quad a_t \sim iid(0, \sigma^2).$$

The second is a model with a stochastic trend:

$$(3) \quad m_t = m_{t-1} + u_t;$$
$$\varphi(B)u_t = \Theta(B)a_t; \quad a_t \sim iid(0, \sigma^2).$$

In each case, φ and Θ satisfy conditions for stationarity and invertibility. In model 2 the surprise in the money stock announcement will be a transitory random error, likely to be offset in future deviations of money from trend. In model 3 a surprise in M1 is permanently incorporated in the level of M1. The Federal Reserve's policy of rebasing targets at the end of each targeting period lends credence to the second model.

If model 2 is accurate, then weekly variations in M1 should have little information about future levels of money and prices. Federal Reserve officials have maintained for some time that such is the case. In a letter to Senators Jake Garn and William Proxmire, Federal Reserve Chairman Paul Volcker (1981) wrote:

> There is nearly unanimous agreement by all observers that weekly money statistics are extremely erratic, and therefore, poor indicators of underlying trends. While monthly data can often deviate considerably from such trends, the weekly observations are particularly "noisy." Week-to-week changes are quite large and

recent estimates indicate that the "noise" element--attributable to the random nature of money flows and difficulties in seasonal adjustment--accounts for plus or minus **$3.3** billion in weekly change two-thirds of the time. Such a large erratic element appears intrinsic to money behavior, rather than implying poor underlying statistics.

This interpretation of the "noise" in M1 data suggests that weekly M1 announcements contain little information about future levels of the money stock or prices. This interpretation implies that there is a deterministic trend in the money supply. If so, the variance of forecast errors at period t+n is bounded for all n.

If model 3 is accurate, the variance of the forecast error is unbounded as $n \to \infty$, and the latest change in M1 may be an important bit of information in forming predictions about long-run levels of M1. The market will use all of the information it has to make long-term forecasts of M1. When the long-run objectives of policy are unclear, the weekly statistics become more important. The Federal Reserve can make the weekly statistics less relevant by announcing and following credible long-run policies.

The test is calculated from the following regression:

$$(4) \quad m_t = \mu + \gamma t + \rho_1 m_{t-1} + \sum_{i=2}^{k} \rho_i (m_{t-i+1} - m_{t-i}) + e_t,$$

where

m = natural log of M1,

μ = constant,

t = time, and

e = random error.

Here k is large enough to remove the systematic component from the error term. The test is based on the assumption that only autoregressive terms are

needed to obtain satisfactory representations of the error term. Nelson and Plosser (1982) show that the test of whether a time series has a deterministic or a stochastic trend can be reduced to a test of whether the autoregressive process generating the time series has a root equal to unity. They show that ρ_1 of equation 4 is equal to the sum of the autoregressive parameters, the φ_i. Under the null hypothesis that the time series has a stochastic trend, this sum will equal unity. The results of this estimation, shown in table 1, support the hypothesis that the weekly M1 data are generated by model 3. The relevant statistic for our purposes is τ, which is the t-statistic for the hypothesis that $\rho_1 = 1$. Fuller (1976) shows the distribution of τ under the hypothesis that $\rho_1 = 1$. For the sample size of 100, the 0.05 critical value is -3.45; for a sample size of 250, the 0.05 critical value is -3.43. Dickey and Fuller (1979) provide Monte Carlo evidence on the power of the test.

Using both the expected and the first-published data on M1, we cannot reject the hypothesis that the autoregressive processes generating the data contain a root equal to unity. These results are consistent with the hypothesis that the weekly money stock data contain important information about future levels of M1. Of course, whether the announcements contain information about future prices depends on whether the stochastic trend is caused by non-stationarity in the nominal money supply or in the real money demand function. An examination of this issue is provided in the discussion below.

Table 1   Testing for an Autoregressive Root Equal to Unity in the Stochastic
Process Generating Weekly Money Stock Data

m_t	Pre-October 1979		Post-October 1979	
	Jan 5, 1978 − Oct 4,1979		Feb 8, 1980 − Sept 20, 1984	
	log (M1^a)	log (M1^e)	log (M1^a)	log (M1^e)
μ (t)	0.872 (2.02)	0.563 (1.96)	0.454 (2.51)	0.365 (2.47)
γ (t)	0.000176 (1.93)	0.000112 (1.85)	0.000119 (2.43)	0.000095 (2.36)
ρ_1 (τ)	0.850 (-2.01)	0.903 (-1.96)	0.921 (-2.51)	0.937 (-2.45)
k	14	14	14	14
$\bar{R}^2$	0.972	0.987	0.997	0.998
SEE	0.00554	0.00377	0.00518	0.00425

Notes: The t-statistics are shown in parentheses. M1^a is the first
published figure for M1. M1^e is the sum of the previous period M1^a and
the change predicted by the participants in Money Market Services weekly
survey.   The second sample period begins in February 1980, after the change in
the definition of M1. In no case can we reject the hypothesis that
$\rho_1 = 1$.   The 0.05 critical value for τ is -3.43 for sample sizes of 100.

Critical Review of the Literature

Extensive research on the topic of the money supply announcements over the
last five years has led to a predominance of four main hypotheses. The first
hypothesis asserts that a surprise in the money stock announcement contains

information about future money supply growth. Cornell (1983a) calls it the expected inflation hypothesis, in which a positive money stock surprise will be incorporated in future levels of the money supply. As a result, interest rates rise to reflect an inflation premium, and the dollar depreciates against major foreign currencies. However, the spot exchange rate does not depreciate in the pre-October 1979 period as this hypothesis predicts. Furthermore, the spot value of the dollar appreciates following the money stock announcement in the post-October 1979 period. Also, this hypothesis does not explain why long-term interest rates and forward interest rates react more strongly in the post-October 1979 period than in the pre-October 1979 period. To explain the stronger reaction of long-term rates in the later period, advocates of the expected inflation hypothesis have to assume that the October 6, 1979, change in the operating procedure led to a decline in the Federal Reserve's concern about inflation.

The second hypothesis assumes that money stock surprises contain information about money demand shocks. This is called the policy anticipation hypothesis. Works by Urich and Wachtel (1981), Urich (1982), and Roley and Walsh (1983) are based on the assumptions that prices are fixed and that the Federal Reserve uses a partial adjustment procedure to achieve its monetary targets. The public expects deviations of the money stock from the preannounced targets to be offset gradually. Under nonborrowed reserve targeting, an exogenous demand shock will automatically force more banks to go to the discount window. This shock will be completely offset if the Federal Reserve maintains its nonborrowed reserve target. Under targeting of the federal funds rate, the shocks initially will be accommodated but could be offset eventually if the Federal Reserve were willing to adjust the federal funds rate target promptly. Therefore, given price rigidity, a positive money

stock surprise would generate anticipation of future tightening of money growth, which would raise short-term real interest rates via the liquidity effect and long-term real interest rates via the expectations theory of the term structure. The change in real interest rates would induce international capital flows that would result in a dollar appreciation.[3] The duration and strength of the policy anticipation effect would depend on how long it takes the Federal Reserve to offset past deviations from the target and the degree of price rigidity.

This hypothesis is not consistent with the empirical evidence. The inconsistency lies in the reaction of the forward interest rates. Shiller, Campbell, and Schoenholtz (1983) and Hardouvelis (1984) have shown that longer-term forward interest rates react strongly to money stock announcements. The policy anticipation hypothesis explains the result only if the liquidity effect lasts for several years.

The third hypothesis is a synthesis of the first two. Hardouvelis (1984) and Loeys (1984) argue that the liquidity effect dominates in the short run and the inflation premium effect dominates in the long run. Following a positive surprise in the money stock, short-term nominal interest rates rise because the market expects the Federal Reserve to offset partially the deviations above the money supply target. However, because the Federal Reserve is not expected to offset the money stock surprise completely, inflationary expectations and long-term interest rates rise. In addition, Hardouvelis shows that the reactions of the spot exchange rates and the expected spot exchange rates five years ahead, which are derived from an open interest rate parity condition, support his hypothesis. The spot values of the dollar against several foreign currencies appreciate, and the expected future spot rates depreciate. However, the expected future spot rates are

constructed on the implicit assumption that real interest rates are fixed. These results cannot be used to distinguish between the policy anticipation and the inflation premium hypotheses, because the inflation premium hypothesis was implicitly assumed in the construction of the expected spot exchange rate.

There is another drawback in this third hypothesis. Cornell (1983b, p. 655) points out that "it is intuitively difficult to understand how the same announcement leads agents to expect monetary restriction in the short run, but monetary ease in the long run." The Hardouvelis argument that the significant response of long forward rates in the post-October 1979 period reflects an inflation premium is not satisfactory. The period before October 1979 was more inflationary, yet empirical evidence indicates a weak reaction of forward interest rates to money stock announcements during the period. The Hardouvelis hypothesis is not consistent with this evidence. Furthermore, there is no economic theory to explain why the spot and expected spot exchange rates would move in opposite directions following a surprise in the money stock announcement. The explanation given by Hardouvelis is plausible. However, this explanation is based on an arbitrary expectation of a future reversal of policy, which is not refutable.

The fourth hypothesis, outlined by Nichols, Small, and Webster, is called the real activity hypothesis.[4] They argue that if prices are fixed and the Federal Reserve pursues a policy of constant money growth, money stock surprises provide information about current and future real money demand growth that results from real-sector disturbances. A positive money stock surprise signals to the market participants stronger current and future money demand growth relative to the given money supply growth. As a result, current and expected future real interest rates rise to clear the money market.

On the empirical level, the hypothesis suffers because M1 growth was strong in late 1981, 1982, and early 1983 while real activity was surprisingly weak; yet, this was the period when the relationship between money stock surprises and interest rates was strongest. Furthermore, this hypothesis cannot explain why interest rates respond to money stock surprises in the pre-October 1979 period when the Federal Reserve was accommodating money demand shocks. On the analytical level, the assumption of price rigidity is not necessary to explain why the surprise in the money stock announcement leads to changes in expected real interest rates.

Evidence from the Foreign Exchange Market

Since the evidence of the reaction of interest rates to the money stock announcements was insufficient to distinguish between competing hypotheses, researchers were encouraged to look at a cross section of markets. Engel and Frankel (1984) use evidence from the spot market for exchange rates to distinguish between the expected inflation hypothesis and the policy anticipation hypothesis. This subsection shows that the assumption of price rigidity introduced by Engel and Frankel is not necessary to explain the appreciation of the dollar following a positive money stock surprise. Also, the information provided by the spot exchange rate is incomplete and, under certain conditions, may be misleading.

A fully developed version of the Engel-Frankel model includes:

$$(5) \quad m_t - p_t = -\lambda i_t + a_t,$$

$$(6) \quad i_t = r_t + p^e_{t+1} - p_t,$$

$$(7) \quad i^*_t = r^*_t + p^{e*}_{t+1} - p^*_t,$$

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where

m_t and p_t = logs of the money supply and the price level,

i_t = short-term interest rate,

a_t = influence of real income and other exogenous shifts in money demand,

r_t = real interest rate,

e = expected variable, and

$*$ = foreign country variable.

Equation 5 is a Cagan-type money demand equation. Equations 6 and 7 show the Fisher relationships for the home country and the foreign country. Expected inflation is represented by $p^e_{t+1} - p_t$. Normalizing so that $p^{e*}_{t+1} - p^*_t = 0$, and assuming that $r_t = r^*_t$, we obtain the following expression from equations 5 through 7:

$$(8) \quad m_t - p_t = -\lambda(p^e_{t+1} - p_t + i^*_t) + a_t.$$

Solving 5 for p_t through the method of recursive substitution, we obtain the following expression:

$$(9) \quad p_t = \frac{1}{1+\lambda} \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^j (E_t m_{t+j} - E_t a_{t+j}) + \lambda i^*_t.$$

Assume that a positive money stock announcement in period **t** leads the market to revise upward its expectations concerning current and future money demand changes. If the Federal Reserve is following a credible policy of price stability, the announcement will not affect the market's expectations with regard to future money supply changes. The new price level (p'_t) will be equal to:

$$(10) \quad p'_t = \frac{1}{1+\lambda} \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^j (E_t a_{t+j} - E'_t a_{t+j}) + \lambda i^*_t.$$

Subtracting equation 9 from equation 10 yields equation 11:

$$(11) \quad p_t' - p_t = \frac{1}{1+\lambda} \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^j (E_t a_{t+j} - E_t' a_{t+j}).$$

Because $E_t' a_{t+j}$ is greater than $E_t a_{t+j}$ for every value of t, the $p_t' - p_t$ difference is negative; i.e., the price level will fall. Note that if the exchange rate is determined by purchasing power parity, the exchange rate equation can be written in log form as follows:

$$(12) \quad p_t = p_t^* + e_t.$$

The reduction in the domestic price level will lead to a dollar appreciation, given that p_t^* remains unchanged. Similarly, it can be shown that the future price level, p_{t+1}, will fall. If the forward exchange rate is an unbiased predictor of the future spot rate, and if the latter is determined by the price level differential in period $t+1$, the forward exchange rate will appreciate.

Walsh (1984) argues that the change in operating procedures in 1979 caused a change in the parameters of the money demand function. Whether due to the inflation policy change or the operating procedure change, there appears to have been an increase in the interest elasticity of money demand sometime after October 1979.[5] If there was an increase in λ, the change in the price level shown in equation 11 would be larger following a surprise increase in $E_t a_{t+j}$.

In sum, it has been shown that if a money stock surprise signals a persistent money demand shock originating in a portfolio disturbance and if the Federal Reserve is following a fixed money growth rule, the spot and forward exchange rates will appreciate. There is no need to assume price rigidity to obtain this result.

Furthermore, studies that examine the reaction of spot exchange rates to money stock announcements ignore the effects of foreign exchange intervention by monetary authorities the day after the money stock announcement. To illustrate this point, assume that the monetary authorities intervene based on the following rules:

(13) $I_t = a + b M_t^S$,

(14) $I_t^* = c + d M_t^S$,

where

> I_t = amount of dollar intervention by the United States the day after the announcement,
>
> M_t^S = money stock surprise, and
>
> I_t^* = amount of dollar intervention by West Germany the day after the announcement.

Although the exchange rate and intervention are interdependent, for the sake of simplicity we can write the following equation:

(15) $e_t = \delta_0 + \delta_1 (I_t + I_t^*) + \delta_2 Z_t + u_t$,

where

> e_t = exchange rate on the day following the announcement, and
>
> Z_t = other relevant variables on the day following the announcement.

Equation 15 states that on the day following the announcement the exchange rate will be determined by domestic and foreign intervention and all other relevant factors represented by the vector Z.

The observed relationship between a positive money stock surprise and an appreciating dollar may be spurious. If the Federal Reserve expects the dollar to depreciate sharply following a positive money stock surprise, it may purchase dollars heavily the next day--perhaps jointly with the West German

authorities. If so, the appreciation of the dollar was not caused by the announcement effect but by intervention; the Engel and Frankel and the Hardouvelis interpretations thus may be incorrect.

Testing for the significance of this hypothesis is extremely difficult because of simultaneity problems. However, for the Engel and Frankel sample period (October 1979 to August 1981), the correlation coefficient between the money stock surprise and U.S. intervention on the following day is -0.106, relatively small. The negative sign implies that following a positive money stock surprise, the United States sold dollars, which would moderate the dollar appreciation. This is consistent with the notion that central banks "lean against the wind" in their intervention policy, and it makes the Engel and Frankel findings more credible. The United States has practically ceased intervention in the foreign exchange markets under the Reagan administration. However, the West German and other European monetary authorities have continued intervening regularly, which still raises some questions about the interpretation of results from the spot reaction of the spot exchange rate to money stock announcements.

Finally, researchers have ignored the information contained in the changes of the forward exchange rate. The advantages of examining the reaction of forward exchange rates are twofold: changes in the forward exchange rates following a money stock surprise are free of the influence of intervention, and the examination of the simultaneous reaction of the spot and forward exchange rates provides useful information as to the nature and persistence of a shock.

III. The Role of Policy Regimes and Operating Procedures

The empirical studies cited above do not distinguish clearly between the different policy regimes and the various operating procedures that may be used to achieve the different policies. In theory, there is little a priori reason to make the distinction. If a regime were defined in terms of a policy objective function and a structural model, then any change in the objective function or in the structure, including a change in the short-run policy reaction function, would lead to a change in the reduced-form equations for asset prices. In practice, changes in very short-run operating procedures may have little effect on asset prices if the objective function and other structural parameters remain fixed. Many different operating procedures could be used to achieve the same objectives; or, one operating procedure could be used to achieve very different objectives. Our hypothesis is that the Federal Reserve emphasized non-price objectives before October 1979. During this period the Federal Reserve used an interest-rate targeting procedure to achieve the monetary targets. After October 1979 the Federal Reserve put more emphasis on ending inflation and adopted a policy that led to decelerating inflation. At the same time the Federal Reserve switched to a nonborrowed reserve operating procedure in which it tried to control the money supply by controlling nonborrowed reserves directly and by applying administrative pressure at the discount window.

The nonborrowed reserve procedure was officially abandoned in October 1982. Since that time, the Federal Reserve has used a borrowed reserve targeting procedure. It is shown below that a borrowed reserve procedure may be described as an interest-rate smoothing procedure. However, the return to

an interest-rate smoothing procedure does not necessarily mean that the
Federal Reserve has returned to an inflationary policy regime.

The Policy Regime

The policy regime, defined in this study by the objectives of policy,
should have an important effect on the pattern of responses by asset prices to
a surprise in the money stock announcement. In the pre-October 1979 period,
the surprises in the money stock mainly reflected money demand shocks that on
average carried M1 to or above the upper limit of the target range. Instead
of offsetting these deviations from the monetary target, the Federal Reserve
allowed the monetary targets to drift upward. This policy led the market to
believe that a positive money stock surprise would lead to a shift in the
money supply function, regardless of the origin of the shock. A positive
money stock surprise was an indication of future inflation; one expected
interest rates to rise and the dollar to depreciate in response to a higher
inflation premium.

In the post-October 1979 period, the Federal Reserve announced that it was
placing more emphasis on ending inflation. The Federal Reserve also switched
operating procedures. The nonborrowed reserve procedure allowed the Federal
Reserve a method of inducing large interest-rate changes in response to
deviations of money from target. Under this procedure, the Federal Reserve
was able to reverse deviations of M1 from the target path more quickly. Thus,
the change in procedures lent credibility to the Federal Reserve's
announcement that it had switched to a policy of disinflation.

After 1980, the actual inflation rate began to fall more quickly than
expected. Inflation expectations were lowered, and there was a large increase
in the demand for money. In the classical model, a one-time lowering of the

inflation rate requires a one-time decline in the price level--or a compensating increase in the nominal money supply--to clear the market for real balances. In this period there was a rapid decline of inflation below the rate that was thought to be consistent with the Federal Reserve's monetary targets, and there was a large positive drift in M1 above the targets in both 1982 and 1983.

This one-time shift in the demand for real balances described above is a temporary phenomenon. Mundell (1963) and Tobin (1965) argue that a reduction in the equilibrium inflation rate can also raise the trend in the growth rate of money demand; this results from a wealth effect.[6] At a lower expected inflation rate, the higher demand for the real balances will lead to a leftward shift in the demand for real savings and to an increase in the real interest rate.

During this period there was another important factor that should have led to an increase in the demand for money--the end of the prohibition against explicit interest-rate payments on checkable deposits in January 1981. This change also was expected to have both temporary and permanent effects on the growth of the demand for M1. When depository institutions were allowed to pay interest on checkable accounts, there should have been a one-time shift of funds out of passbook savings and other sources of wealth into M1. This large transitory shift of funds was expected to be followed by a permanent increase in the growth rate of the demand for M1, resulting from the permanent reduction in the opportunity cost of holding checkable deposits.[7]

In sum, these changes could have been expected to increase the demand for real balances. As long as the Federal Reserve was expected to maintain its disinflation objective, it was not expected to accommodate fully future increases in money demand. Therefore, a positive money stock surprise was

seen as a relative increase in money demand, leading to an increase in the real interest rate. If this hypothesis is correct, then in the post-1979 period we expect an increase in both short- and long-term interest rates and a significant appreciation in both spot and forward exchanges following a surprise increase in the money stock.

The Operating Procedure

Monetary policy actions influence market variables directly through their effect on the reserve market and indirectly through their effect on expectations. We have examined the indirect effect. This subsection describes the direct effect by analyzing a typical bank's use of information in the money stock announcement under alternative reserve accounting rules and operating procedures. Between September 1968 and February 1984, banks were required to hold reserves against deposits on a lagged basis; i.e., average daily reserves held in any given week were used to meet reserve requirements calculated from deposit levels of two weeks earlier. This lag was instituted in 1968 to give individual banks precise knowledge about the level of their reserve requirement. The lag also gave the Federal Reserve time to collect information about aggregate reserve demand.

In February 1984, the Federal Reserve implemented a return to almost contemporaneous reserve accounting. The banking system had objected to this switch on the grounds that it would be costly to set up the information systems necessary to monitor deposit levels on an instantaneous basis. As a concession to this issue, the Federal Reserve chose a form of CRR that was not truly contemporaneous; instead, the lag was reduced from fourteen days to two days.

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The new rules included other changes. One was a lengthening of the reserve accounting period from one week to two weeks. Banks now post reserves averaged over two weeks ending on a Wednesday, against deposits averaged over two weeks ending on a Monday. Banks have two days to measure transactions deposits and adjust their reserve positions accordingly. Only reserve requirements against transactions deposits are contemporaneous.

There was also a change in the timing of the weekly money stock announcement. The announcement was moved up one day to Thursday, 4:30 pm EST. Even though the Federal Reserve required banks to speed up the collection and reporting of deposit data, the actual data released on Thursday are "older" than data that had been released on Friday. Under the lagged reserve accounting rules, the weekly money stock data released on Friday referred to the average daily level of M1 for the week ending on Wednesday, nine days earlier. Under the new arrangement, the data released on Thursday refer to the average daily level of M1 for the week ending Monday, ten days earlier.

On the last day (Wednesday) of the weekly settlement period, all banks have to meet their reserve requirements. This is an unusual market; we can think of no other where all firms are required to adjust inventories to pre-specified levels at the same time. Early in the reserve accounting period, before the money supply announcement, each bank could calculate its own reserve requirement, but it did not know aggregate reserve demand. Under lagged reserve accounting rules, the announcement of M1 was made nine days after the end of the deposit computation period, but five days before the end of the reserve maintenance period. Consequently, the money stock announcement contained information about the aggregate demand for reserves in the

settlement period ending five days hence. Under contemporaneous reserve accounting rules, the announcement of M1 is always made after the reserve market clears.

To explain the reaction of the federal funds rate to the money stock announcement, we will look at three factors: the reserve accounting rules, the nonborrowed reserve operating procedures, and the timing of the release of information about the money stock. Under the federal funds rate targeting procedure and lagged reserve accounting, the market had quite good information about the reserve supply function. The Federal Open Market Committee (FOMC) set narrow limits within which the federal funds rate was allowed to fluctuate. The manager of the open market desk at the Federal Reserve Bank of New York (hereafter referred to as the desk) would enter the market to sell securities if the federal funds rate fell below the lower limit; he would enter the market to buy securities whenever the federal funds rate traded above the upper limit. This intervention throughout the trading day sent an immediate signal to the market about the limits on the operating target. The FOMC directed the desk to set a narrow range for the federal funds rate, but the range was conditioned on objectives of the FOMC, usually on the growth of the monetary aggregates relative to short-run paths that were set at the FOMC meetings. However, changes in the limits for the federal funds rate range were small and infrequent. As a result of this procedure, the market not only knew the current target, but also it could forecast short-term interest rates several weeks in advance with small errors. The weekly money stock announcement was important in predicting the reserve supply function only in so far as the federal funds rate limits were expected to be changed in response to a deviation of the money stock from the desired path.

The reserve market is shown in panel a of figure 1. The reserve supply
function R_B^s represents the end-of-period position of the reserve supply
curve expected by market participants before the money supply announcement.
Likewise, R_B^d represents the reserve demand function before the money
stock announcement. The reserve supply function is infinitely elastic
reflecting the fact that the Federal Reserve accommodated short-run changes in
the demand for reserves. The reserve demand curve is inelastic because of
lagged reserve requirements. The actual federal funds rate target before the
announcement is FF*. It is also the rate that is expected to prevail through
the end of the reserve maintenance period.

Suppose there is a large unexpected increase in M1 that shifts the
expected end-of-period reserve demand curve to the right. Early in the next
trading day, the market would learn whether this increase were enough to
induce the desk to shift the reserve supply curve. If the desk intervened to
prevent a rise in interest rates, the quantity of reserves supplied would rise
to accommodate the increase in demand. Because the public expected the
Federal Reserve to accommodate unexpected shifts in money demand, the federal
funds rate would be unchanged. However, we might expect longer-term interest
rates to rise if the market participants expected this increase in supply to
lead to inflation, or if they expected the Federal Reserve to raise the
interest-rate operating range in future weeks. During this period the
importance of the money stock announcement was limited by the
information-transmitting aspects of the interest-rate operating procedure.

When the FOMC announced a change in operating targets on October 6, 1979,
there was a dramatic change in the information flow to the market about the
relative position of the reserve supply function. Following an FOMC meeting,
the Federal Reserve staff of economists constructed paths for nonborrowed
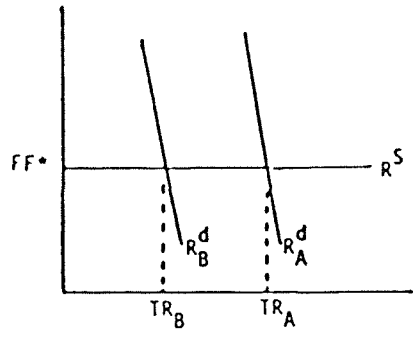
Panel a: Federal funds Rate Target (FF*)
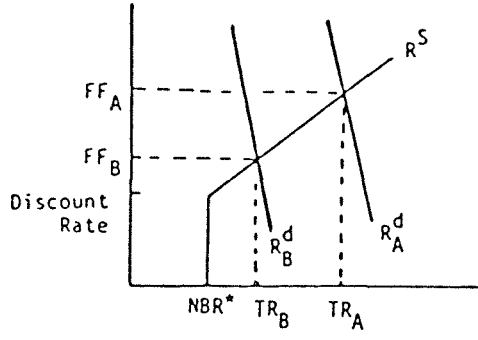
Panel b: Nonborrowed Reserves Target (NBR*)
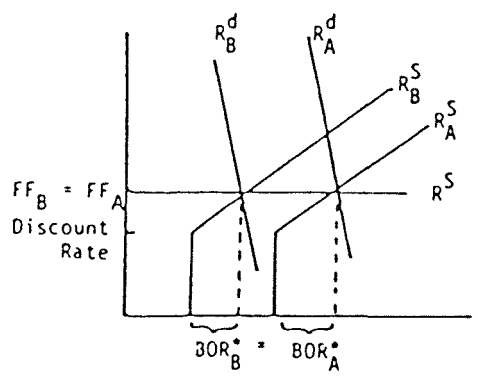
Panel c: Borrowed Reserves Target (BOR*)

Figure 1

reserves based on a short-run path for M1 and an initial borrowing assumption. The procedure was to maintain the path for nonborrowed reserves and allow unexpected changes in total reserve demand to feed into the discount window. The nonborrowed reserve path was adjusted automatically in response to unexpected changes in the multiplier. Sometimes, though not often, the nonborrowed reserve path was adjusted judgmentally for policy reasons, such as the behavior of the broader aggregates or some other economic variable.[8]

The reserve supply function is shown in panel b of figure 1. Market participants estimated expected nonborrowed reserve targets (NBR*) using information about the annual monetary targets, minutes from past FOMC meetings, and recent information about M1. Neither market participants nor the Federal Reserve had accurate information about the demand for borrowed reserves. Federal Reserve administrative guidelines discouraged banks from borrowing at the discount window. Therefore, it took a greater spread between the federal funds rate and the discount rate to induce more banks to borrow at the window.[9] An unexpectedly large increase in the money stock induced a corresponding shift in the expected reserve demand curve. Expectations about the cost of federal funds adjusted to reflect new information about the aggregate demand for reserves. In panel b of figure 1, it is clear that a surprise increase in the demand for reserves, from R_B^d to R_A^d, caused the federal funds rate to rise from FF_B to FF_A.

An important aspect of the nonborrowed reserve operating target is the automaticity in the response of interest rates to a deviation of M1 from the short-run path. Under this procedure, deviations of the other aggregates are automatically accommodated by the weekly multiplier adjustments to the nonborrowed reserve path.

In the second half of 1982, the FOMC decided that it did not wish to react automatically to deviations of M1 from path. This decision was based on the uncertainty surrounding financial innovations, changing regulations, and the unusual behavior of M1 velocity. In October 1982, the FOMC adopted a procedure based on a target for borrowed reserves and an assumption (prediction) about excess reserves. Under LRR, the Federal Reserve had relatively accurate information about reserve demand. The desk set nonborrowed reserve targets each week based on a forecast of reserve demand and the borrowing target chosen by the FOMC. Each week, the desk adjusted the nonborrowed reserve path (NBR) to accommodate the shift in reserve demand. The procedure is portrayed in panel c of figure 1. The announcement of an unexpectedly large increase in M1 was accompanied by a compensating shift in NBR so that the borrowing target was maintained. On a weekly average basis this procedure looked much like the interest-rate operating procedure that was in effect before October 1979. One difference was that any rotation of the borrowing demand curve led to a different federal funds rate.

During the nonborrowed reserve procedure, the Federal Reserve entered the market once a day, usually between 11:30 am and noon. The operation was primarily defensive; i.e., it was a response to movements in the uncontrollable sources of reserve supply. To a large extent, that intra-week procedure was continued with the borrowing target. The market participants did not know the exact amount of the borrowing target, nor did they know the exact location of the borrowing function. Consequently, they could not narrow down a small range for the funds rate as they had done prior to October 1979. The weekly averages were very stable, but daily volatility made it more difficult for the market to perceive changes in the stance of policy than had been the case when the federal funds rate was the operating target.

Nevertheless, on a weekly basis, the borrowing target could be described as a federal funds rate smoothing procedure. Because of lagged reserve requirements, the money stock announcement still contained information about the aggregate demand for reserves. However, because of borrowed reserve targeting, market participants expected the Federal Reserve to accommodate an unanticipated shift in the demand for reserves by adjusting nonborrowed reserves. Therefore, one would expect no significant reaction of the federal funds rate to money stock announcements.

Finally, the recent change in the reserve settlement rules has important implications for the effect of money stock announcements on the federal funds rate. Before February 2, 1984, the deviation of the money stock announcement from the expected level gave the market two types of information: the first was information about the aggregate quantity of reserves that would be demanded over the next few trading days; the second was information about the position of the money stock relative to the perceived policy target. Under the hypothesis that prices in efficient markets aggregate information, the money stock announcements no longer include new information about aggregate reserve demand. That information will already be apparent from the interest rates that prevailed during the reserve settlement period that will have ended before the money stock data are released. The market will also have better information about the money stock relative to the perceived policy target. To some extent it will be inferred from the information in aggregate reserves. Furthermore, banks installed new information-gathering systems to meet reserve requirements on a contemporaneous basis. Many arrangements have been made by banks and private firms to pool deposit information in a way that mimics the process of deposit data collection used by the Federal Reserve. These factors

suggest that there will not be a significant correlation between surprises in the money stock announcements and subsequent changes in asset prices.

IV. Empirical Results

The empirical results presented in this section are based on estimates of the parameters of equation 1, shown in the introduction. The assets included in this study are the federal funds rate, a trade-weighted daily average; the coupon-equivalent yield on three- and twelve-month Treasury bills; and the constant maturity yield on three-year, seven-year, and thirty-year Treasury bonds.[10] (See appendix A for a detailed description of the data.) The money stock announcement was made at 4:15 or 4:30 pm EST. Estimates of a_1 and a_2 for domestic interest rates are reported in the top of tables 2 and 3.

We have followed the suggestion of Shiller, Campbell, and Schoenholtz by including the forward interest rates implied by the expectations theory of the term structure. We use Shiller's (1979) duration-adjusted linear approximation to construct the implied forward rates. Estimates of a_1 and a_2 for the implied forward rates are shown in the middle of tables 2 and 3. In addition, we examine the reactions of the dollar/mark spot rate, the three-month dollar/mark forward rate, and the twelve-month dollar/mark forward rate to money stock announcements. These results are shown in the bottom of tables 2 and 3.

The full sample period starts on September 28, 1977, and ends on September 21, 1984. We assume that there was a switch from a policy that led to accelerating inflation before October 1979 to a policy that emphasized disinflation after October 1979.[11] The estimation period includes three different operating procedures: a federal funds rate operating procedure from

Table 2   Impact of Money Stock Surprises on Asset Prices (a_1)

Dependent variable	LRR			CRR
	Federal funds	Non-borrowed reserves	Borrowed reserves	Borrowed reserves
Federal funds rate	0.018 (0.87)	0.378[a] (4.04)	0.098 (1.50)	0.043[a] (0.34)
3-month Treasury	0.072 (3.11)	0.364 (6.58)	0.190 (5.77)	0.019 (0.45)
12-month Treasury	0.072 (4.73)	0.338 (7.59)	0.216 (5.62)	0.020 (0.32)
3-year govt. bond	0.041[a] (4.63)	0.263 (7.43)	0.185 (5.11)	-0.001 (-0.02)
7-year govt. bond	0.027 (3.42)	0.188 (6.60)	0.185 (5.94)	-0.002 (-0.03)
30-year govt. bond	0.016 (2.95)	0.115 (4.48)	0.150 (4.86)	-0.016 (-0.27)
9-month forward rate 3-month ahead	0.072 (4.80)	0.329 (7.35)	0.225 (5.43)	0.020 (0.27)
2-year forward rate 1-year ahead	0.018 (1.69)	0.219 (6.48)	0.167 (4.41)	-0.014 (-0.19)
4-year forward rate 3-years ahead	0.016 (1.49)	0.101 (3.90)	0.185 (5.86)	-0.003 (-0.04)
23-year forward rate 7-year ahead	0.007 (0.97)	0.013 (0.65)	0.108 (3.01)	-0.036 (-0.59)
Dollar/mark spot exchange rate	0.105 (1.08)	-0.438 (-3.82)	-0.607 (-3.19)	0.117 (0.30)
Dollar/mark 3-month forward exchange rate	0.134 (1.35)	-0.343 (-3.12)	-0.556 (-2.95)	0.131 (0.33)
Dollar/mark 12-month forward exchange rate	0.369 (2.44)	-0.221 (-2.08)	-0.476 (-2.61)	0.182 (0.45)

a Indicates significant first-order autocorrelation. These parameters were estimated using a Cochrane-Orcutt procedure. The t-statistics are shown in parentheses.

Table 3   Impact of Expected Money Stock Changes on Asset Prices (a_2)

Dependent variable	Operating target			
	LRR			CRR
	Federal funds	Non-borrowed reserves	Borrowed reserves	Borrowed reserves
Federal funds rate	-0.021 (-0.81)	-0.167[a] (-1.03)	-0.033 (-0.47)	-0.324[a] (-2.36)
3-month Treasury	-0.045 (-1.61)	-0.310 (-3.28)	-0.050 (-1.41)	-0.085 (-1.85)
12-month Treasury	-0.037 (2.03)	-0.231 (-3.03)	-0.079 (-1.90)	-0.094 (-1.34)
3-year govt. bond	-0.030[a] (2.95)	-0.140 (-2.30)	-0.083 (-2.12)	-0.069 (-0.94)
7-year govt. bond	-0.015 (-1.58)	-0.136 (-2.81)	-0.093 (-2.76)	-0.068 (-.92)
30-year govt. bond	-0.013 (-1.90)	-0.167 (-3.79)	-0.067 (-2.00)	-0.100 (-1.49)
9-month forward rate 3-month ahead	-0.035 -1.91	-0.204 (-2.66)	-0.089 (-1.98)	-0.097 (-1.16)
2-year forward rate 1-year ahead	-0.019 (-1.47)	-0.085 (-1.47)	-0.085 (-2.08)	-0.084 (-0.66)
4-year forward rate 3-years ahead	-0.009 (-0.66)	-0.133 (-2.98)	-0.105 (-3.06)	-0.066 (-0.80)
23-year forward rate 7-years ahead	-0.011 (-1.29)	-0.207 (-4.19)	-0.035 (-0.90)	-0.146 (-2.12)
Dollar/mark spot exchange rate	-0.068 (-0.58)	0.522 (2.66)	-0.606 (-3.19)	0.010 (0.02)
Dollar/mark 3-month forward exchange rate	-0.05 (-0.42)	0.462 (2.45)	-0.102 (0.79)	0.011 (0.03)
Dollar/mark 12-month forward exchange rate	-0.075 (-0.41)	0.429 (2.36)	0.153 (0.77)	0.047 (0.11)

a.   See fn a, table 2.

the beginning of the sample period until October 6, 1979; the nonborrowed reserve operating procedure from October 6, 1979, until October 5, 1982; and the current borrowed reserve operating procedure that was adopted in October 1982. There are two reserve accounting regimes: lagged reserve requirements before February 2, 1984, and contemporaneous reserve requirements afterward.

September 1977 to October 1979

The results from the pre-October 1979 period provide support for the hypothesis that the money stock announcement during this period contained information about future inflation. The estimate of a_1 was positive and significant at a 5 percent critical level for all of the domestic interest rates except the federal funds rate. The lack of response of the federal funds rate was expected. The market anticipated that the Federal Reserve would accommodate the unexpected shifts in the demand for reserves; consequently, the cost of obtaining reserves the remaining days of the settlement week was expected to remain relatively unchanged. All of the implied forward rates responded positively to the money stock surprises, but only in the case of the three-month ahead, nine-month rate was the response significantly different from zero at the 5 percent level.

By themselves the interest-rate results are consistent with almost any of the alternative hypotheses. Following the suggestion of Engel and Frankel, we look at the reaction in the spot dollar/mark exchange market. Although the dollar depreciated following a positive money stock surprise, the response in the spot market was not statistically significant. The dollar also depreciated in the three- and twelve-month forward exchange markets following a positive surprise in the money stocl: announcement. The response of the twelve-month forward exchange rate is statistically significant at the 5

percent level. These findings provide support for the inflation premium hypothesis over the policy anticipation hypothesis and for our assumption that the pre-October 1979 period can be characterized as an inflationary monetary policy regime.

October 1979 to October 1982

During the period of the nonborrowed reserve operating procedure, the reactions of all domestic interest rates were much greater than before. In the earlier period, a 1 percent positive surprise in the money stock led to a 7-basis-point increase in the three-month Treasury bill rate and a 1.5-basis-point increase in the thirty-year Treasury bond rate. In the period of nonborrowed reserve targeting, the reactions of these rates were considerably stronger, 36 and 11.5 basis points, respectively. Furthermore, the response of the federal funds rate to money stock surprises was stronger and statistically significant at the 5 percent level. Participants in the reserve market understood that a positive surprise in the aggregate demand for reserves within the settlement week would lead to a higher cost of borrowing reserves for the remainder of the settlement week.

There was also a dramatic change in the response in exchange markets. The spot and forward dollar exchange rates appreciated sharply against the mark following a positive money stock announcement. This was a sharp reversal from the earlier period. Engel and Frankel attributed this reversal in the spot market to a change in the real interest rate caused by expected liquidity effects. This explanation is inconsistent with the significant reaction of the forward interest rates several years out and the twelve-month ahead forward exchange rates. Furthermore, it does not explain the significant depreciation of the forward exchange rate in the earlier period.

We attribute the appreciation of the dollar and the strong upward reaction of interest rates subsequent to a positive money stock surprise during this period to the policy regime change. Money stock announcements provided the market with information about persistent money demand shocks that the Federal Reserve was not expected to accommodate fully. Following a positive money stock surprise, the market revised upward its assessment of current and future real interest rates, leading to an appreciation of the spot and forward values of the dollar.

October 1982 to February 1984

The next period is interesting, because it allows us to test whether the change in the operating procedure can be viewed as a change in the policy regime. After October 1982, the Federal Reserve began to target borrowed reserves. Since this is an interest-rate smoothing procedure, the federal funds rate was not expected to respond to the announcements. The response of the federal funds rate during this period was statistically insignificant.

The pattern of responses of interest rates and exchange rates is similar to the one observed in the period of nonborrowed reserve targeting. The longest-term interest rates and the forward exchange rates react more strongly in this period than they did during the nonborrowed reserve operating procedure. This suggests to us that the strong response of asset prices, other than the federal funds rate, resulted from disinflation policy and not from the change in operating procedures. The dramatic difference between the pattern of responses under borrowed reserve targeting procedures and under the interest-rate targeting procedures suggests that the operating procedure did not determine the policy regime for this sample period.

February 1984 to September 1984

As predicted, the money supply announcements appear to be irrelevant. Estimates of a_1 are not statistically significant for any of the assets we examined. This "surprise" we measure includes information that has been revealed in the clearing of the reserve market before the money stock is announced. Furthermore, each individual participant now hrings better (local) information to the reserve market clearing. Under CRR, banks have had to upgrade their own deposit-monitoring systems. Banks and information-service companies such as Money Market Services have developed more scientific information-pooling systems to replicate the Federal Reserve's procedure for constructing the first-published M1 data.

The Rationality of the Survey Forecasts

The estimates of a_2 are shown in table 3. According to the efficient market hypothesis, this coefficient should be zero. However, we find that the coefficient is significantly less than zero in many cases across all regimes. We suggest that the negative sign results because the survey is an inefficient forecast of the expected change in M1. The agents participati'ng in the survey are only a subset of those participating in the market. The median survey of their opinions is less efficient than the market opinion embedded in the interest rate just prior to the announcement.[12] This market opinion is a trade-weighted opinion of all the participants in the market. Since this interest rate enters the dependent variable with a negative sign, we get a negative sign for a_2.

Conclusion

Our main objective in this paper is to explain the changing patterns of response by asset prices to money stock announcements during several subperiods between 1977 and the present. Previous work in this area has not distinguished between policy regimes and operating procedures. Furthermore, we can now include evidence from a new operating procedure and new reserve accounting rules. We also include information from the forward exchange market. By taking account of forward exchange rates and the institutional, procedural, and policy changes, we are able to resolve ambiguities that remain in published work.

First, we show that the pattern of response of the federal funds rate to money stock surprises during different subperiods over the last seven years depends on the Federal Reserve's operating procedure and the reserve accounting rules. Second, we show that a change in the operating procedure does not necessarily imply a change in the monetary policy regime. In this context, we show that the positive response of asset prices to money stock surprises in the pre-October 1979 period resulted from an inflation premium. In contrast, the response of asset prices to money stock surprises in the post–October 1979 period resulted from a change in the expected real interest rate.

Appendix A   Data Sources

M1

M1 is the figure first published by the Federal Reserve in the H.6 press release. The expected change in M1 is calculated using the median of a survey taken by Money Market Services. The expected changes (MMSP) are in billions of dollars. The expected change in M1 (EM in the text) is calculated as:

$$EM_t = \log (M1_{t-1} + MMSP_t) - \log (M1_{t-1}),$$

where t refers to the week of the announcement rather than the statement week for which M1 was calculated. The surprise in M1 (UM in the text) is calculated as:

$$UM_t = \log (M1_t) - \log (M1_{t-1} + MMSP_t).$$

We have used first-published numbers rather than revised numbers in making these calculations. This amounts to treating the revision as an unexpected change. Roley (1982) shows results that are invariant to the use of first-published or revised data. He concludes that the revisions should not be treated as unexpected changes in M1. However, he excluded the October to December 1979 period. When this period is included, we find that the revisions have the same effect on asset prices as the unexpected changes in M1.

We used the M1 series that was published in the H.6 release. When the definition of M1 changed, our measure changed. Overlapping data were used to splice the series in early 1980 when the Federal Reserve changed the definition of M1 to include other checkable deposits.

Interest Rates and Exchange Rates

The interest rates and exchange rates come from the data banks of Data Resources Inc. The original source for the interest rates is the H.15

release. The original source for the exchange rates is the Bank of America.
Since the H.6 release (Money Announcement) was made on various days throughout
the sample period, we collected daily data. A "before-announcement" rate was
taken as the last available value before the announcement. The
"after-announcement" rate was taken as the first available value after the
announcement. There is always at least a 24-hour span between the "before"
and "after" quote. The major effect of this procedure is to reduce the R^2
in the estimate of equation 1 in the text. There is no reason why the
parameters of equation 1 should be biased unless there are other factors that
are correlated with the surprise in the money stock announcement. Details for
each of the asset prices are listed below:

Federal funds rate. The effective federal funds rate is a trade-weighted
average for the day.

Treasury bills. The three- and twelve-month Treasury bill yields are
based on the bid quotes at the close of the New York market (4:00 pm EST).

Treasury coupons. The three-, seven-, and thirty-year yields are based on
the bid quotes at the close of the New York market. We have used yields
calculated at "constant maturity" from the Treasury's daily yield curve.

Implied forward rates. These rates are calculated using the following
formula from Shiller, Campbell, and Schoenholtz (1983):

$$f^{(n,m)} = [D_{m+n} R_t^{(m+n)} - D_n R_t^{(n)}]/ [D_{m+n} - D_n],$$

where

$$f_t^{(n,m)} = \text{linearized approximation to the } n \text{ period ahead } m \text{ period}$$
forward rate,

$R_t^{(i)}$ = yield on an i-period bond at time t, and

D_{m+n} = duration of bonds maturing in m+n periods.

D_i is calculated from the following formula:

$$D_i = (1-g^i)/(1-g); \ o \leq i,$$

where

$g = 1/(1+\bar{R})$, and

$\bar{R}$ = mean R for each sub-sample period between September 1977 and

September 1384.

Of course, the f $^{3/4)}$ forward rate is calculated directly from the

formula for the implied forward rate as there are no coupons on Treasury

bills. The values for $\bar{R}$ and D_i are given in Table Al.

Table Al   Assumed values for $\bar{R}$ and D_i

Maturity		$\bar{R}$	D_i
Sept 1977 - Oct 1979	3 year	8.536	2.770
	7 year	8.533	5.549
	30 year	8.609	11.556
Oct 1979 - Oct 1982	3 year	13.020	2.668
	7 year	12.827	5.017
	30 year	12.437	8.772
Oct 1982 - Feb 1984	3 year	10.424	2.726
	7 year	10.980	5.233
	30 year	11.136	9.560
Feb 1984 - Sept 1984	3 year	12.315	2.683
	7 year	12.777	5.024
	30 year	12.753	8.600

Dollar/mark exchange rates. The foreign currency exchange rates are

expressed as bids reflecting opening prices in the New York markets.

Rates are quotes in U.S. terms (dollars per deutschemark). The dependent

variable in the text is the first difference of the logarithm.

Footnotes

1. See, for example, Cornell (1983b), Engel and Frankel (1984), Hardouvelis (1984), Loeys (1984), Roley (1983), Shiller, Campbell, and Schoenholtz (1983), Urich and Wachtel (1981), and Urich (1982).

2. Hoehn (1984) presents a traditional macroeconomic model with rational expectations and a highly detailed monetary sector. He shows that the reduced-form equations for the price level, output, and the interest rate change when the operating procedures change.

3. See Engel and Frankel (1984).

4. Cornell (1983b) suggests a risk-premium hypothesis. We have not included it because he did not find evidence to support it. Furthermore, Makin (1983) shows that the theoretical effect of policy uncertainty on asset prices is ambiguous. In his empirical work he finds a sign opposite to that predicted by Cornell.

5. See Brayton, Farr, and Porter (1983) for an econometric study of this issue.

6. An explicit derivation of the relationship between the real interest rate and the Mundell-Tobin wealth effect is provided in Makin (1983).

7. See fn 5.

8. See Stevens (1981) for a detailed description of policy during the first two years of the nonborrowed reserve targeting procedure.

9. Goodfriend (1983) uses a micro-based model to show that the borrowing relation is non-linear. He shows that it is a function of past and expected future borrowing, which depends on the expected future federal funds rate.

10. See appendix A for a detailed description of data. The maturities used in this study were chosen because Shiller, Campbell, and Shoenholtz (1983) and Loeys (1984) have found that there tends to be a similar response among securities with maturities between one and three years, between three and seven years, and again with maturities over seven years.

11. While the empirical evidence presented below lends credence to this assumption, there is supporting evidence. Bagshaw and Gavin (1984) show that after 1979 the Federal Reserve deviated from its M1 target only during periods when there was an offsetting shift in velocity. This was a marked change from the 1976 to 1979 period during which M1 grew above target, reinforcing the inflationary effects of unexpected increases in velocity growth.

12. See Roley (1983) for empirical support of this hypothesis.

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