The Effect of Unanticipated Money on the Money and Foreign Exchange Markets

Authors	Daniel L. Thornton
Working Paper Number	1986-010B
Citable Link	https://doi.org/10.20955/wp.1986.010
Suggested Citation	Thornton, D.L.; The Effect of Unanticipated Money on the Money and Foreign Exchange Markets, Federal Reserve Bank of St. Louis Working Paper 1986-010. URL https://doi.org/10.20955/wp.1986.010

Published In	Journal of International Money and Finance
Publisher Link	https://doi.org/10.1016/0261-5606(89)90038-7

Revised February 1987

UNANTICIPATED MONEY AND THE ANTICIPATED LIQUIDITY EFFECT: SOME FURTHER EVIDENCE

Daniel L. Thornton

Federal Reserve Bank of St. Louis

86-010

This paper investigates the impact of unanticipated changes in the money stock on the money, stock and foreign exchange markets. Nearly all the empirical work to date indicates that both interest rates and the foreign exchange value of the dollar rise and stock prices fall in response to an unanticipated rise in the money stock. These results are broadly interpreted as evidence in support of the so-called "anticipated liquidity effect." This paper employs an alternative methodology to compare the consistency of the response across markets to unanticipated changes in the money stock. The results suggest that these markets do not in fact respond in a consistent fashion necessary to support the anticipated-liquidity-effect hypothesis.

* Research Officer, Federal Reserve Bank of St. Louis. The views expressed here are not necessarily those of the Federal Reserve Bank of St. Louis or the Board of Governors of the Federal Reserve System. I would like to thank Doug Pearce, Rich Sheehan, Geoffrey Wood and members of the macroeconomic workshop at the University of Kentucky for helpful comments and Rosemarie Mueller for her research assistance. Any remaining errors are my own.

1. INTRODUCTION

A considerable amount of empirical research has been devoted to determining why markets react as they do to unanticipated changes in the money stock (M1). While Urich and Wachtel (1981) were primarily concerned with the issue of market efficiency, they attributed the significant positive relationship between Treasury bill yields and unanticipated changes in money to a "policy anticipation effect."[1/] They hypothesized that if the money supply were larger than the market expected based on past experience and policy announcements and if the Federal Reserve was primarily concerned with money growth, the market would anticipate that the Federal Reserve would attempt to reduce the growth of the money supply. Arguing that such policy actions would increase the real federal funds rate via the usual liquidity effect, they hypothesized that other market interest rates would increase in anticipation of Federal Reserve actions. Urich and Wachtel downplayed the possibility that Treasury bill yields might rise because of revised expectations of inflation, arguing that such a reaction is likely to be gradual and delayed. Since then a number of alternative explanations of the market's reaction have been offered.[2/] Nevertheless, the bulk of empirical work has been devoted to distinguishing between the policy anticipation effect or as it is more commonly known, the "anticipated liquidity effect," and the expected inflation effect. While, to date, the evidence does not support either hypothesis unambiguously, there are some important pieces of evidence that are generally considered as support of the anticipated-liquidity-effect interpretation. This evidence consists of consistency of the response of the money, foreign exchange and stock markets to unanticipated increases in M1, and changes in these markets responses to well-documented changes in Federal Reserve operating procedures. The purpose of this paper is to provide a more vigorous test of the consistency of the cross-market response by investigating whether the reported market response to unanticipated changes in M1 occur simultaneously, and to provide alternative tests of a shift in the markets' response to change in Fed operating procedure. We begin with a brief summary of the evidence in support of the anticipated-liquidity-effect explanation.

2. EVIDENCE IN SUPPORT OF THE ANTICIPATED-LIQUIDITY-EFFECT HYPOTHESIS

The first piece of evidence in support of the anticipated-liquidity-effect hypothesis comes from comparing the response of several markets to unanticipated increases in the money stock. Cornell (1982, 1983), Engels and Frankel (1984), Hardouvelis (1984) and Hakkio and Pearce (1986) have shown a significant positive relationship between the foreign exchange value of the dollar to unanticipated changes in the money stock. If the anticipated liquidity effect hypothesis is correct, an unanticipated increase in M1 will cause U.S. nominal and real rates to rise relative to foreign rates, with a concomitant appreciation of the dollar. If the rise in the nominal rate was due to expectations of higher U.S. inflation, the dollar should depreciate.

This evidence is supplemented by empirical analyses of the relationship between unanticipated changes in the money stock and stock prices. Cornell (1983), Pearce and Roley (1983, 1985) and Hafer (1986) report a significant inverse relationship between money shocks and stock prices. These analysts argue that these results are consistent with the anticipated-liquidity-effect hypothesis, noting that expectations of more restrictive policy and higher real interest rates should result in lower stock prices under the assumption that equity and debt are substitutes.[3/] It seems plausible, however, that the anticipation of the Fed restricting money growth in response to a positive money shock may lead to an appreciation in stock prices. For example, if the market believes that variations in money growth are a source of economic instability, the expectation that the Fed will creditably adhere to some money growth objectives might be interpreted favorably in the stock market, even if short-term interest rate rise.

The second piece of evidence concerns changes on the response of these markets to unanticipated changes in money after the Federal Reserve's switch to a monetary targeting operating procedure in October 1979. For example, Cornell (1983) reports a significant break in the response of all three markets with the October 1979 change in the Federal Reserve's operating procedure, reporting no significant effect of money shocks on any of these three markets prior to October 6, 1979 and significant responses in the direction hypothesized by the anticipated-liquidity-effect hypothesis after the October change. Cornell's (1983) result of no significant effect of unanticipated money on the foreign exchange value of the dollar prior to October 1979 and a significant effect thereafter has been confirmed by Engel and Frankel (1984), Cornell (1982), Hardouvelis (1984) and Hakkio and Pearce (1986). The stock market results have also been confirmed by Pearce and Roley (1983, 1985), and Hafer (1986).[4/] The results for the money market are mixed, however. Most researchers report a significant positive relationship between money shocks and interest rates prior to the October 1979 shift in operating procedure [e.g., Belongia and Sheehan (1987), Hardouvelis (1984) and even Cornell (1983)]; however, in all cases the measured effect is stronger after the October 1979 change, both in absolute terms (the magnitude of the coefficients) and relative to the standard errors (the "t-ratios"). Consequently, there is evidence that the reaction of these markets to unanticipated changes in money changed in a way consistent with the anticipated-liquidity-effect hypothesis after the Federal Reserve decided to place increased emphasis on controlling monetary aggregates.[5/]

The third significant, but somewhat weaker, evidence consists of the change in the markets' response after the October 1982 switch in operating procedure in which M1 was deemphasized. Hein (1987), Belongia, Hafer and Sheehan (1987) report no significant response of short-term interest rates to unanticipated changes in M1 after October 1982. Thus, it appears that the money market stopped responding after the Fed switched back to an interest rate targeting procedure. Unfortunately, the results from the stock and foreign exchange markets do not support this view. Hafer (1986) reports no significant change in the response of stock prices and Hakkio and Pearce (1986) report no significant change in the response of foreign exchange rates after October 1982; however, both report that relative to their standard errors, the effects are smaller.

Because there is no unified theory of the effects of unanticipated changes in the money stock on these markets and of their interdependence,[6/] the anticipated-liquidity-effect explanation rests primarily on the regularity of these empirical results. Though inconclusive, these results tend to give more credibility to this hypothesis rather than the alternatives. However, even casual observation suggests that these results may overstate the case in favor of the anticipated-liquidity-effect explanation. There are a number of instances when the markets either did not respond to an unanticipated change in M1 or responded in a direction opposite that indicated by the anticipated-liquidity-effect hypothesis.[7/] Hence, the current evidence suggesting a consistent response across markets is not strong if all the markets do not respond simultaneously to an unanticipated change in money.[8/] On occasions when there is a statistically significant positive response of market interest rates to an unanticipated increase in money, there should be a similar statistically significant positive response of foreign exchange rates and a negative response of domestic stock prices. Indeed, Pearce and Roley (1985, p. 52) make it a point to note that because the bond market remains open after the money announcement, the market knows that interest rates are "higher (after a positive money surprise) when the stock market opens on the next business day."

Furthermore, if there are occasions with no response or a statistically significant negative response of market interest rates to an unanticipated increase in money, there should be similar responses in the other markets as well. The presence of such a consistent response across markets would provide strong evidence to support the anticipated-policy-effect interpretation of the markets' response to money shocks, however, failure to find such a consistent response, especially in the foreign exchange market, would be extremely damaging to this interpretation.

The consistency of the response across markets must ultimately be investigated by partitioning unanticipated changes in the money, stock and foreign exchange markets into those that are significant and those that are not and by comparing these responses across markets. Hence, a simple procedure for partitioning these data is outlined in section 4. Before discussing this procedure, however, we motivate what follows with a much simpler test of consistency.

3. A SIMPLE TEST OF CONSISTENCY

As a simple test of the consistency of the market response to money shocks, the frequency with which changes in the three-month Treasury bill rate (ΔTB), the trade-weighted exchange rate (ΔTWEX) and the Standard and Poors 500 index of stock prices (ΔSP500) move in directions opposite those anticipated by the policy-anticipation-effect hypothesis was calculated.[9/] For example, we determined the simple proportion of time when the Treasury bill rate and the foreign exchange value of the dollar moved in opposite directions. These proportions were calculated for both money-announcement and no-money-announcement days in order to test whether the proportion of "opposite" movements on days when there is a money announcement is significantly lower than on days when there is no money announcement. The period of analysis is from January 5, 1978, to January 26, 1984. These data are divided into three subperiods--January 5, 1978-October 4, 1979, October 8, 1979-October 6, 1982 and October 8, 1982-January 26, 1984. The middle period is commonly associated with the Fed's targeting of monetary aggregates. The results are reported in table 1. The standard statistic for testing the hypothesis that the true proportion is .5 (against the one-tailed alternative that it is less than .5) is presented in parentheses below the sample proportion, and the standard statistic for testing the equality of the proportions on days when there is and is not a money announcement is presented in the far right-hand column.

The results indicate that these markets tend to move in the direction indicated by the policy anticipation effect more often than if governed by chance alone, especially during the money control period. The tendency to do so on days when there is a money announcement, however, is not significantly greater than on other market days. The only exception is ΔTB and ΔTWEX in the post-October 1982 period. These same variables, however, had the wrong sign more often on money announcement days and the proportion of wrong signs was not significantly below what could be expected on the basis of chance alone during the money stock control period. These data results suggest that responses consistent with the anticipated liquidity effect may be relatively infrequent and, hence, the cross-market response may not be as strong as previous empirical work suggests.

4. A METHODOLOGICAL REVIEW

The effect of an unanticipated change in money on the money market is usually investigated by regressing changes in the three-month T-bill rate between the market close on the day that the weekly money stock numbers are released and the close of the market on the next business day, ΔTB, on the unanticipated change in the money stock, UM. That is, ordinary least squares (OLS) regression is used to estimate:

$$(1) \quad \Delta TB_t = \alpha_0 + \beta UM_t + \epsilon_t \qquad t=1, 2, \ldots, T,$$

where T is the number of mutual observations on the dependent and independent variables, i.e., the number of observed announcements of the weekly money stock, over an interval of calendar time.[10/] This formulation, which implicitly assumes that the one-day change in the T-bill rate can be explained by money shocks and a random error component, has two principal disadvantages. First, if part of this change can be explained by factors not explicitly included in equation (1), it is possible that the effect of such factors might be inappropriately attributed to unanticipated money, if these variables and unanticipated changes in the money stock are contemporaneously correlated. Second, and far more important, this formulation implicitly assumes that all money shocks produce a change in the dependent variable proportionate to the size of the unanticipated change in the money shock. If there are instances when an unanticipated increase (decrease) in the money stock gives rise to expectations of further ease (restraint), or if there are occasions when the market does not alter its perception of policy in response to a money shock, estimates of the coefficient β will be biased—perhaps significantly.

To see this, consider the alternative specification

$$(2) \quad \Delta TB_t = \alpha_0 + \alpha_1 I_{t-1} + \sum_{i=1}^{T} \beta_i UM_{it} + \epsilon_t \qquad t=1, 2, \ldots, N,$$

where N denotes the number of market days (less one) in some calendar period and, as before, T denotes the number of days in this time interval when there are observations on UM. I_{t-1} represents the information available at the beginning of the period.

Equation (2) is the same as equation (1) if $\beta_1 = \beta_2 = \ldots = \beta_T$, $\alpha_1 = 0$ and if N-T observations on the dependent variable, for which there is no corresponding money surprise, are deleted. Hence, the standard formulation begins by imposing a number of restrictions a priori.

As an alternative to the usual methodology, we begin by estimating equation (2) and test the significance of each unanticipated change in the money stock. Such a procedure amounts to testing whether the T-bill rate changes significantly from its average change over the period on the day following the money announcement.[11/] While it is possible to test for these "individual effects," the test has low power because of the unit sample size associated with each individual change. While there are a number of techniques that could be used to investigate the variability of the response of markets to money shocks, the approach outlined here is particularly useful because it allows us to partition UM into sets with differential effects and, more importantly, because it allows us to isolate those unanticipated changes in the money stock that produce the largest effect in particular markets so that cross-market comparisons can be made.[12/]

To illustrate the procedure, equation (2) is estimated and a set of all the β's that are significant at some preselected significance level are identified. The UMs are then partitioned into those that are individually significant, UM-A, and all others, UM-B. The following equation

$$(3) \quad \Delta TB_t = \alpha_0 + \alpha_1 I_{t-1} + \mu_1 UM\text{-}A + \mu_2 UM\text{-}B + \varepsilon_t ,$$

is estimated and the hypothesis that $\mu_2 = 0$ is tested. If the hypothesis is rejected, the elements of UM-B are again tested individually. Those that are significant at some predetermined significance level (higher than for the initial regression) are included in the "A" group, and the process is repeated. Each time the significance level for being included in the A group is increased. The process continues until the UMs have been partitioned into sets such that the hypothesis $\mu_2=0$ cannot be rejected.

While this process is systematic, it is somewhat arbitrary because the choice of the initial and subsequent significant levels and because some of the elements of UM-B if included in UM-A could increase the marginal significance of the coefficient on UM-A. Furthermore, the procedure involves pre-testing. While at present there are no specific ways to deal with such problems, the reported standard errors of the coefficients on the final equation are in general smaller than the true standard errors of the multi-step estimator; hence, it should not represent a serious problem in this case.[13/] With these caveats, this approach provides a pragmatic and reasonably efficient method of investigating the consistency of the response across markets and for investigating possible asymmetric effects of unanticipated changes in the money stock.[14/]

5. AN APPLICATION TO THE MONEY MARKET

The above procedure was applied to daily changes in the three-month Treasury bill rate (3:30 p.m. New York close) and the median forecast error of the weekly change in the M1 money stock (measured in billions of dollars) obtained from Money Market Services, Inc.[15/] OLS estimates of equation (1) for the three periods discussed above are presented in table 2. The results indicate there is a significant, albeit varied, positive relationship between ΔTR and UM during the three periods.[16/]

A visual inspection of the correlogram of the residuals from the estimates of equation (1) indicates serial correlation during all three periods.[17/] The correlograms for the last two periods suggest the errors follow an AR(1) process, while those of the first indicated spikes at lags of six and seven.

These equations were reestimated allowing for the autoregressive error processes. The autoregressive term is designed to capture the effects of past information not fully reflected in the dependent variable, i.e., I_{t-1}. These results are presented in table 3. A visual inspection of the correlograms of the residuals from these equations (as well as the Q-statistics) indicates that the error terms are white noise.[18/] In each case, including the autoregressive term(s) reduces both the estimates of β and the corresponding t-statistics. Thus, past behavior of ΔTB has some persistent effect on its current behavior; however, the impact on the estimated effect of unanticipated money is negligible.

Equation (2) is then estimated, and the process outlined in section 3 is carried out. In the initial pass the significance level for being included in UM-A was set at 5 percent and was augmented by 5 percentage points for each successive pass.[19/] The results are summarized in tables 4-6. During the period from January 1978-October 1979, T equaled 88; however, there were only three occasions where there is an individually significant response of market interest rates at the 5 percent level.[20/] When these three observations are separated from the others, the remaining group produced no significant effect on the T-bill rate. Thus, while the estimates of equation (1) indicate (and a number of other studies have found) that the market responded in a statistically significant way to unanticipated changes in the money stock over this period, the result appears to be an artifact of the sensitivity of least squares to outliers--unusual movement in market interest rates were associated with fewer than 3.5 percent of the unanticipated changes in the money stock.

For the October 1979-October 1982 period, it took four passes to obtain a set B such that the null hypothesis $\mu_2=0$ could not be rejected. In all, T equaled 149 during this period. Of these, 51 were statistically significant; however, 12 had a negative coefficient, leaving only 39 with the hypothesized positive coefficient. The ones with positive coefficients are included in UM-A, while the ones with negative coefficients are included in UM-AN. The results are reported in table 5. The second equation presents estimates of each marginal group, with the A category partitioned into those included at each pass, and the AN category is partitioned into those included during the first pass, UM-AN5, and those included in all subsequent passes, UM-AN>5. While the results indicate considerable variability in the parameter estimates, F-tests for the equality of various combinations of these parameters within each class could not reject the null hypothesis of equality at the 5 percent level, although some are rejected at the 10 percent level.

Table 6 presents estimates over the post-October 1982 period. During this period T equaled 67. It took two passes to partition UM into the A and B sets, and all of the individually significant coefficients were positive. Furthermore, a test of the hypothesis that UM-A5 = UM-A10 is rejected at the 5 percent level, indicating a "within-the-period" differential effect of unanticipated money.

The picture of the relationship between unanticipated money and interest rates one gets from reviewing tables 4-6 is different from that indicated in previous studies. In particular, there is considerable asymmetry in the response of market interest rates to unanticipated changes in money. Indeed, the predominant result is that market interest rates do not respond in a statistically significant way to unanticipated changes in the money stock. Furthermore, during the period of money stock control there were a few occasions when interest rates were inversely related to unanticipated changes in the money stock.

The fact that interest rates respond only infrequently to unanticipated changes in the money stock suggests that the changes on these occasions are somehow different from the others. One possible explanation is that most money stock forecast errors are relatively small and that the market responds only to large errors. Indeed, Roley (1983, p. 344) states that "money market announcements have become one of the main events in financial markets if for no other reason than the fact that significant movements in interest rates have been associated with large unanticipated changes in the money stock." (The emphasis is mine.)[21/]

In order to investigate this possibility, the mean, standard deviation and range of UM for the A, B and AN groups are calculated along with the same statistics for the absolute value of UM. These statistics are presented in table 7. While the average value of UM for the A group is larger (even in absolute terms) than that of the B group, the difference is not statistically significant. Moreover, the ranges indicate that there are unanticipated money stock changes in the B group that are as large or larger than those in the A group. Hence, while the size of the error may be important, it is clearly not an important determinant of whether the market responds to an unanticipated change in the money stock.[22/]

The fact that the average value of UM-A is substantially larger than that of UM-B suggests that the significant money surprises tend to be positive. This is confirmed by a comparison of the proportion of positive money shocks given in each partition; however, again differences between the A and B sets are not statistically significant.

6. UNANTICIPATED MONEY AND THE STOCK AND FOREIGN EXCHANGE MARKETS

If the anticipated-policy-effect hypothesis is correct, the coefficients on the UM-A partitions given in tables 4-6 should be positive and statistically significant if ΔTWEX replaces ΔTB as the dependent variable and negative and significant if ΔSP500 replaces ΔTB as the dependent variable. Correspondingly consistent results should be obtained for the coefficients on UM-B and UM-AN partitions. Hence, as a test of the consistency of the response across markets, the equations reported in tables 4-6 were estimated with ΔSP500 and ΔTWEX replacing ΔTB as the dependent variable. In the case of ΔSP500, the correlogram indicated first-order serial correlation during the first two subperiods so that these equations include the dependent variable lagged, DV_{t-1}. The results are reported in tables 8-10.

If only the basic equations with UM-A, UM-B and, where relevant UM-AN, are considered, the results tend to support the anticipated-policy-effect hypothesis during the post-October 1979 period. The coefficients on UM-A are significant with the anticipated sign while the coefficients on UM-B are not. The coefficients on UM-AN have the anticipated sign, but are not significant at the 5 percent level (although for the stock market equation, this coefficient is significant at the 10 percent level).

When the estimates of the equations with a detailed breakdown are considered, however, the results are much less encouraging to this interpretation, especially as far as the stock market is concerned. Those included in group A during the first pass were significant with the anticipated sign; however, those included in subsequent passes were not. The reverse is true for the AN group.

Given the rather mixed nature of the results reported in tables 8-10, the procedure outlined in section 3 was applied separately to both the ΔSP500 and the ΔTWEX. The results for ΔSP500 are presented in table 11. It took only one pass to partition the data into the A and B sets for all three time periods. For the 1978-79 period there were only three money surprises that were individually significant; however, none of these were the same as the three money surprises that moved the money market during this period.

During the 1979-82 period, there were eleven individually significant money surprises; two of these moved the stock market in a direction opposite of what was anticipated. Similar results were obtained for the 1982-84 period. During this period nine were significant, with two of these in the AN group.

The results for ΔTWEX are presented in table 12. During the pre-October 1979 period there was only one individually significant money surprise, and it was in a direction opposite of what was anticipated. During the 1979-82 period there were 26 individually significant ones with about 40 percent of these (10) being in the AN group. During this period it took two passes to partition the data into the A and B groups, and the estimates of those included in the first pass and those included in the second pass show a significant difference in the impact of money surprises on ΔTWEX. The results for the post-money target period show that the proportion that were individually significant with the anticipated sign were about the same as in the preceding period, i.e., (7/66) ≈ (16/149), while the proportion that were significant with the opposite sign were substantially fewer, 2 of 66.

Again the results indicate that unanticipated changes in money impact the stock and foreign exchange markets infrequently. There are individually significant effects in the anticipated direction less than 11 percent of the time, much less than the 25 percent for the bond market.

In terms of the consistency of the effect, these results are particularly damaging to the expected-liquidity-effect interpretation. Table 13 shows the number of unanticipated money surprises in both the A and AN groups for ΔTB, ΔSP500 and ΔTWEX for all three periods and the number in both of these groups that intersect across markets. (The numbers in parentheses indicate the number of times within the class of intersecting points where the markets moved in the direction opposite what is indicated by the anticipated-liquidity-effect hypothesis, e.g., interest rates and stock prices both rise). There were relatively few instances when two of the three markets moved significantly together, and even fewer cases when all three markets moved together. Indeed, there were only two possible such instances in each of the last two periods. A closer look reveals there were only two dates, January 29, 1982 and October 8, 1982, where all three markets showed statistically significant movement in the direction hypothesized by the expected-liquidity-effect hypothesis.[23]

7. CONCLUSIONS

The empirical results presented in this paper suggest that the following conclusions can be drawn. First, the statistically significant effect of unanticipated changes in the money stock on the money and stock markets reported here and elsewhere during the pre-October 1979 period are likely due to the sensitivity of least squares to outliers. There was no frequent statistically significant response in any of the markets considered to unanticipated changes in the money stock during this period.

Second, there is evidence that the money, stock and foreign exchange markets all responded to unanticipated changes in the money stock during the post-October 1979 period. The frequency of this response, however, indicates that it is not as robust as previous empirical evidence would seem to indicate.

Third, while the response of the money market to unanticipated changes in the money stock tends to increase with the magnitude of the change in the unanticipated change in the money stock, this effect is not statistically significant. Hence, the assertion that markets respond to large money shocks is without justification.

Fourth, there is some evidence of asymmetry not only between the pre- and post-October 1979 periods as others have reported, but also within the post-October 1979 period.

Fifth, there is essentially no consistency in the response of all three markets to unanticipated changes in the money stock. There were only two instances of the 215 money surprises during the post-October 1979 period when all three markets moved significantly in the direction consistent with the expected-liquidity-effect explanation. Hence, the evidence in support of the anticipated-liquidity-effect hypothesis is considerably weaker than previous work suggests. Even if the possibility that the procedure used here might tend to understate the number of such intersection points is allowed for, the evidence on this point is strong. Because support of the anticipated-liquidity-effect hypothesis is based solely on the ex post consistency of the response across markets, these results weaken significantly this explanation of why markets respond to unanticipated changes in money. The statistically significant positive relationship between unanticipated changes in the money stock and interest rates could be due to heightened expectations for inflation.

While these results do not necessarily rule out the liquidity-effect-hypothesis, they do suggest that there are at least three separate conditioning effects (one for each market) which work in conjunction with unanticipated changes in the money supply to produce a significant market response. This result is not very satisfying because these conditioning factors are at this point unidentified. One possibility may be that markets may respond only to unanticipated changes in the money supply that are viewed as permanent. Those viewed as transitory have no significant effect.[24/] Another is that the market must be preconditioned by other signals that the Federal Reserve or the Administration supplies to the public.[25/] Of course, the possibility remains that it is not unanticipated changes in the money stock per se that affect the market, but rather some other factor(s) that sometimes just happen to occur simultaneous with the Federal Reserve's announcement of the weekly M1 numbers. These possibilities constitute an agenda for further research.

FOOTNOTES

1/ See Urich and Wachtel (1981, pp. 1063-64) for a complete discussion.

2/ See Cornell (1983) for a discussion and sources of the principle alternatives.

3/ See Pearce and Roley (1985, p. 52) and Cornell (1983, p. 647) for their rationalization of the stock market response.

4/ Actually both researchers find a significant effect for the Standard and Poors 500 index prior to October 1979 at the 10 percent level of significance. Also, Hafer investigates five indices, and finds a significant effect, at the 5 percent level, for only the transportation index.

5/ The fact that the money market responded when the Federal Reserve was interest rate targeting is still troublesome.

6/ For example, Meese and Rogoff (1983) find that models that attempt to explain movements in the exchange rate using variables like the real interest rate differentials do not perform better than a rudimentary univariate time series model.

7/ Such possibilities are not evident from much of the empirical work reported. For example, Cornell (1983b) reports a 30.46 basis point change in the T-bill rate for a one percentage point increase in unanticipated money for the period from October 11, 1979-December 18, 1981. This coefficient has a reported standard error of 14.2 basis points. Given these reported numbers, the likelihood of a zero or negative response is exceedingly small. This likelihood is even smaller, if one accounts for the errors in Cornell's original work, see Falk and Orazem (1985) and Cornell (1985).

8/ There are some other anomalies, however, they are not of concern for this paper. See Cornell (1983), Loeys (1985), and Hardouvelis (1984) for a discussion of some of these.

9/ I would like to thank Doug Pearce for suggesting this test as a way to motivate the paper.

10/ Early work, e.g., Urich and Wachtel (1981), was primarily concerned with a test of market efficiency and, hence, expected money was included as a regressor in this equation. The evidence on this issue is mixed, with Belongia and Sheehan (1987), Hein (1985), Gavin and Karamouzis (1984) and Urich and Wachtel (1984) all reporting a significant effect for anticipated money. The results for unanticipated money are essentially unaffected by the presence or absence of this variable, so this issue is not pursued here.

11/ This is only strictly true if $\alpha_1 = 0$. In this case, equation (2) can be written in mean-deviation form, $(\Delta TB - \overline{\Delta TB})_t = \alpha_0 + \sum_{i=1}^{T} \beta_i (1-1/N)) UM_{it} + \varepsilon_t$, where $\Delta TB = \sum_{t=1}^{N} \overline{\Delta TB} / N_t$.

The t-statistic for β_i, τ_i, is:

$$\tau_i = \frac{[\frac{(N-1)}{N} UM_i \, \Delta TB_i]}{[\frac{(N-1)}{N} UM_i]^2} \div \hat{\sigma} \frac{(N-1)}{N} UM_i]$$

$$= \Delta TB_i / \hat{\sigma}, \ i=1, 2, \ldots, T \ .$$

Note that $\hat{\sigma}$ is calculated on the basis of all N observations, not just the T observations associated with the money announcements. However, since the T money announcement days are fit perfectly, $\hat{\sigma}$ is really based on only the N-T non announcement days. This could affect the partition here if the variance differed significantly on money announcements and non-money announcement days. If the variance was larger on the money announcement days, however, it would mean that the procedure used here would identify too many significant market effects. Hence, it should not be a factor in interpreting these results. Dufour (1980) suggests a similar procedure for forecasting purposes.

12/ For example, Loeys (1985) employs "moving" regressions to capture the time-varying movement in the parameters. While this procedure is useful, the lack of independence in the samples makes intersample comparisons difficult (indeed none are made); the procedure does not capture zero or "negative responses to unanticipated changes in money unless they are clustered and most importantly, it does not really allow for a detailed comparison of the consistency across markets--though some comparisons can be made. Alternatively, Hein (1987) and Belongia, Hafer and Sheehan (1987) use dummy variables to partition the sample period to investigate differential effects. Here the partitioning is arbitrary and the procedure has the same limitations as the moving regression except that comparative tests are easier to perform. Belongia, Hafer and Sheehan also use random coefficient regression, but this suffers from the same problems.

13/ It is recognized that much published work is the result of significant, though often unreported, pretesting [e.g., see Cooley and LeRoy (1981)]. Moreover, the pretesting problem could be mitigated by choosing a much higher initial signature level, however, the reader might not have been sure I chose the level without first peeking at the results. Hence, I decided simply to use conventional significance levels so the reader knows the exact amount of pretesting involved. See Fomby, et. al. (1984), for a discussion of the preliminary test estimator problem and for examples of such problems in applied economic work.

14/ A somewhat less efficient alternative would be to sequentially move through the data by selecting in the A group the individual term with the largest "t-statistic" and continuing to add observations to the A group until either (a) one could not reject the hypothesis that $\mu_2=0$ or (b) until the "t-statistic" on μ_1 began to get smaller.

15/ See Hafer (1982) for a complete description of the Money Market Services, Inc. data and of the stock price data used in the next section.

On a few occasions changes in the discount rate occurred simultaneous with the Fed's announcement of weekly M1. No attempt was made to account for this; however, it is extremely unlikely that the qualitative results are sensitive to this.

16/ These results are consistent with those of other researchers. See Sheehan (1985, p. 31) for a summary.

17/ This observation is substantiated by the usual Q-statistic.

18/ This is not true for the 1978-79 period; however, because the results were so insensitive to the specification of the error process and are generally uninteresting, no further effort was expended to correct this problem.

19/ If $\alpha_1=0$, it is not necessary to reestimate the equation each time because the UMs are orthogonal to each other. When $\alpha_1\neq0$, however, this is strictly speaking not the case because the UMs are not orthogonal to I_{t-1}. As a practical matter, however, it would have made little difference in the result had we not reestimated equation (2) each time.

20/ The number of announcement weeks differ from the number of calendar weeks in the period for two reasons. First, there are occasions when because of a holiday there was no money announcement during a particular calendar week. Second, there were a few occasions when the median forecast change was exactly equal to the announced change in the money stock so that UM was zero. These instances were treated as if there were no observations for UM on those dates.

21/ Others who have hinted to this possibility include Hakkio and Pearce (1985, p. 623).

22/ This conclusion is corroborated by the usual direct tests of nonlinearity by including a quadratic term in UM in the equation. This was done for equation (1) and the partitioned equation (3) for all three markets. The results were largely indeterminate with the coefficient on the quadratic terms usually being insignificant; however, in nearly all cases, they were opposite in sign of the coefficient on UM, indicating that, if anything, the response is less than proportional to the size of the error.

23/ The other two possible dates were March 14, 1980, and January 21, 1983. On the former date, UM was classified in the AN group for both ΔSP500 and ΔTWEX, but in the A group for ΔTB. For the latter date, UM was in the A group for ΔSP500 and ΔTWEX, but in the B group for ΔTB.

24/ Brunner, Cukierman and Meltzer (1980) argue that the market should respond to both permanent and transitory shocks because of what they term "permanent-transitory confusion." If the results reported here are due to the market viewing some shocks as transitory, they are at odds with the hypothesis put forth by Brunner, Cukierman and Meltzer.

25/ Havrilesky (1986) has constructed an index at signals from the Administration to the Federal Reserve.

REFERENCES

Belongia, Michael T., and Richard G. Sheehan. "Informational Efficiency of Weekly Money Announcements: An Econometric Critique," forthcoming in the Journal of Business and Economic Statistics (1987).

Brown, W. W., and G. J. Santoni. "Monetary Growth and the Timing of Interest Rate Movements," Federal Reserve Bank of St. Louis Review (August/September 1983), pp. 16-25.

Brunner, Karl A., Alex Cukierman and Allan H. Meltzer. "Stagflation, Persistent Unemployment and the Permanence of Economic Shocks," Journal of Monetary Economics (October 1980), pp. 467-92.

Cagan, Phillip, and Arthur Gandolfi. "The Lag in Monetary Policy as Implied by the Time Pattern of Monetary Effects on Interest Rates," American Economic Review (May 1969), pp. 277-84.

Cooley, Thomas F., and Stephen F. LeRoy. "Identification and Estimation of Money Demand," American Economic Review (December 1981), pp. 825-44.

Cornell, Bradford. "The Money Supply Announcement Puzzle: Reply," American Economic Review (June 1985), pp. 565-66.

______. "Money Supply Announcements and Interest Rates: Another View," Journal of Business (January 1983a), pp. 1-23.

______. "The Money Supply Announcements Puzzle: Review and Interpretation," American Economic Review (September 1983b), pp. 644-57.

______. "Money Supply Announcements, Interest Rates, and Foreign Exchange," Journal of International Money and Finance (August 1982), pp. 201-08.

Dufour, Jean-Marie. "Dummy Variables and Predictive Tests for Structural Change," Economic Letters (3: 1980), pp. 241-47.

Engel, Charles M., and Jeffrey A. Frankel. "Why Money Announcements Move Interest Rates: An Answer from the Exchange Rate Market," Journal of Monetary Economics (January 1984), pp. 31-39.

Falk, Berry, and Peter F. Orazem. "The Money Supply Announcement Puzzle: Comment," American Economic Review (June 1985), pp. 562-64.

Gavin, William T., and Nicholas V. Karamouzis. "Monetary Policy and Real Interest Rates: New Evidence from the Money Stock Announcements," Federal Reserve Bank of Cleveland Working Paper 8406 (1984).

Graham, Fred C. "A Note on the Vanishing Liquidity Effect," Economic Inquiry (July 1986), pp. 497-503.

Hafer, R. W. "The Response of Stock Prices to Changes in Weekly Money and the Discount Rate," Federal Reserve Bank of St. Louis Review (February 1986).

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

Hardouvelis, Gikas A. "Exchange Rates, Interest Rates, and Money-Stock Announcements: A Theoretical Exposition," Journal of International Money and Finance (December 1985a), pp. 443-54.

______. "Macroeconomic Information and Stock Prices," unpublished manuscript, Columbia University (1985b).

______. "Market Perceptions of Federal Reserve Policy and the Weekly Monetary Announcements," Journal of Monetary Economics (September 1984), pp. 225-40.

Havrilesky, Thomas. "Monetary Policy Signaling from the Administration to the Federal Reserve," unpublished manuscript (1986).

Hein, Scott E. "The Response of Short-Term Interest Rates to Weekly Money Announcements: A Comment," Journal of Money, Credit and Banking (May 1985), pp. 264-71.

Loeys, Jan G. "Changing Interest Rate Responses to Money Announcements: 1977-1983," Journal of Monetary Economics (May 1985), pp. 323-32.

Meese, Richard A., and Kenneth Rogoff. "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?," Journal of International Economics (February 1983), pp. 3-24.

Melvin, Michael. "The Vanishing Liquidity Effect of Money on Interest: Analysis and Implications for Policy," Economic Inquiry (April 1983), pp. 188-202.

Mussa, Michael. "Empirical Regularities in the Behavior of Exchange Rates and Theories of the Foreign Exchange Market," Carnegie-Rochester Conference Series on Public Policy (Autumn 1979), pp. 9-57.

Pearce, Douglas K., and V. Vance Roley. "The Reaction of Stock Prices to Unanticipated Changes in Money: A Note," Journal of Finance (September 1983), pp. 1323-333.

______. "Stock Prices and Economic News," Journal of Business (January 1985), pp. 49-67.

Roley, V. Vance. "The Response of Short-Term Interest Rates to Weekly Money Announcements: A Note," Journal of Money, Credit, and Banking (August 1983), pp. 344-54.

Sheehan, Richard G. "Weekly Money Announcements: New Information and Its Effects," Federal Reserve Bank of St. Louis Review (August/September 1985), pp. 25-34.

Shiller, Robert J., John Y. Campbell and Kermit L. Schoenholtz. "Forward Rates and Future Policy: Interpreting the Term Structure of Interest Rates," Brookings Papers on Economic Activity (1: 1983), pp. 173-217.

Smith, Warren L. "The Instruments of General Monetary Control," National Banking Review (September 1963), pp. 47-76.

Urich, Thomas J., and Paul Wachtel. "Market Response to the Weekly Money Supply Announcements in the 1970s," Journal of Finance (December 1981), pp. 1063-72.

______. "The Effects of Inflation and Money Supply Announcements on Interest Rates," Journal of Finance (September 1984), pp. 1177-88.

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

Table 1
Sign Tests for Money Announcements

Variables	Money-announcement days	No-money announcement days	z 1/
	January 5, 1978-October 4, 1979		
ΔTB/ΔTWEX	.545 (0.84)	.505 (0.18)	0.67
ΔTB/ΔSP500	.386* (-2.14)	.459 (-1.47)	-1.22
ΔTWEX/ΔSP500	.591* (1.71)	.529 (1.08)	1.04
	October 8, 1979-October 6, 1982		
ΔTB/ΔTWEX	.450 (-1.22)	.398* (-4.95)	1.15
ΔTB/ΔSP500	.349* (-3.69)	.420* (-3.88)	-1.58
ΔTWEX/ΔSP500	.423* (-1.88)	.460* (-1.95)	-0.81
	October 8, 1982-January 26, 1984		
ΔTB/ΔTEX	.349* (-2.45)	.485 (-0.47)	-1.97*
ΔTB/ΔSP500	.318* (-2.96)	.427* (-2.27)	-1.60
ΔTWEX/ΔSP500	.455 (-0.73)	.516 (0.51)	-0.88

1/ Test statistics of the equality of proportions, asymptotically distributed N(0, 1)

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

Table 2
OLS Estimates of Equation (1)

Period	Const.	UM	$\bar{R}^2$	SE
January 5, 1978 - October 4, 1979	0.011* (2.35)	0.019* (2.75)	0.0148	0.1011
October 8, 1979 - October 6, 1982	-0.010 (1.00)	0.075* (7.85)	0.0752	0.2765
October 8, 1982 - January 26, 1984	0.001 (0.30)	0.034* (6.70)	0.1196	0.0801

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 3
OLS Estimates of Equation (2)

Period	Const.	ΔTB_{-1}	ΔTB_{-6}	ΔTB_{-7}	UM
January 5, 1978 - October 4, 1979	.014* (2.91)		-0.130* (2.76)	-.147* (3.10)	.017* (2.59)
October 8, 1979 - October 6, 1982	-.009 (0.92)	.100* (2.82)			.071* (7.43)
October 8, 1982 - January 26, 1984	.001 (0.24)	.098 (1.87)			.033* (6.47)

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 4
Estimates of Equation (3) for January 5, 1978–October 4, 1979 Period

Const.	ΔTB_{-6}	ΔTB_{-7}	UM-A5	UM-B	$\bar{R}^2$	SE
.012*	-.126*	-.113*	.112*	.005	.1033	.0964
(2.47)	(2.74)	(2.44)	(5.79)	(0.74)		

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 5
Estimates of Equation (3) for October 8, 1979-October 6, 1982 Period

Const.	ΔTB-1	UM-A	UM-B	UM-AN	UM-A5	UM-A10	UM-A15	UM-A20	UM-AN5	UM-AN >5	$\bar{R}^2$	SE
-.014	.129*	.182*	.020	-.374*							.2035	.2568
(1.51)	(3.89)	(12.11)	(1.84)	(5.22)								
-.015	.130*		.020		.182*	.400*	.145*	.257*	-.627*	-.337*	.2061	.2563
(1.57)	(3.92)		(1.84)		(10.96)	(3.14)	(3.63)	(2.95)	(3.18)	(4.38)		

F(3)# = 1.51 test UM-A5=UM-A10=UM-A15=UM-A20
F(1) = 2.88** test UM-A5=UM-A10
F(1) = 3.65** test UM-A10-UM-A15
F(1) = 1.37 test UM-A15=UM-A20
F(1) = 1.88 test UM-AN5=UM-AN >5

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

** Indicates statistical significance at the 10 percent level

\# Indicates number of restrictions tested

Table 6
Estimates of Equation (3) for October 8, 1982-January 26, 1984 Period

Const.	ΔTB_{-1}	UM-A5	UM-A10	UM-B	$\bar{R}^2$	SE
-.001 (0.28)	.109* (2.19)	.078* (8.33)	.047* (3.83)	.009 (1.43)	.2162	.0756

F = 4.22*, test that UM-A5 = UM-A10

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 7
Descriptive Statistics for Unanticipated Money

Variable	Mean	Standard deviation	Minimum	Maximum	Positive
		January 5, 1978 - October 4, 1979			
UM	-.30	1.58	-4.80	3.50	.41
UM-A	1.77	2.83	-1.50	3.50	.66
UM-B	-.37	1.49	-4.80	3.40	.40
AUM	1.29	.96	.10	4.80	
AUM-A	2.77	1.10	1.50	3.50	
AUM-B	1.23	0.91	.10	4.80	
		October 8, 1979 - October 6, 1982			
UM	.31	2.37	-4.90	8.50	.53
UM-A	.69	2.69	-3.50	8.30	.62
UM-AN	-.38	1.01	-2.40	1.20	.25
UM-B	.25	2.35	-4.90	8.50	.53
AUM	1.87	1.49	.10	8.50	
AUM-A	2.10	1.78	.10	8.30	
AUM-AN	.87	0.59	.20	2.40	
AUM-B	1.89	1.40	.10	8.50	
		October 8, 1982 - January 26, 1984			
UM	.32	1.92	-3.50	4.90	.56
UM-A	1.17	2.16	-2.50	4.90	.67
UM-B	.00	1.75	-3.50	4.80	.52
AUM	1.57	1.14	.10	4.90	
AUM-A	2.01	1.37	.10	4.90	
AUM-B	1.41	1.02	.10	4.80	

Table 8
Estimates of ΔSP500 and ΔTWEX Based on the Partition of UM for ΔTB Equation from Table 4: January 5, 1978 - October 4, 1979

Dependent variable	Const.	DV_{t-1}	UM-A	UM-B	$\bar{R}^2$	SE
ΔSP500	.030 (0.89)	.138* (2.90)	-.059 (0.42)	-.106* (2.11)	.022	0.703
ΔTWEX	-.028 (1.43)		-.056 (0.71)	-.022 (0.77)	.001	0.401

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 9
Estimates of ΔSP500 and ΔTWEX Based on the Partition of UM for ΔTB Equation from Table 5: October 8, 1979–October 6, 1982

Dependent variable	Const.	DV_{t-1}	UM-A	UM-AN	UM-B	UM-A5	UM-A10	UM-A15	UM-A20	UM-AN5	UM-AN>5	$\bar{R}^2$	SE
ΔSP500	.042 (1.00)	.127* (3.55)	-.226* (3.39)	.611 (1.92)	-.085 (1.73)							.034	1.139
ΔSP500	.043 (1.03)	.123* (3.43)				-.250* (3.39)	.680 (1.20)	-.110 (0.62)	-.537 (1.38)	.132 (0.15)	.682* (2.00)	.034	1.139
ΔTWEX	.040 (1.88)		.111* (3.26)	-.186 (1.14)	.036 (1.42)							.014	.584
ΔTWEX	.037 (1.75)				.036 (1.44)	.103* (2.75)	.627* (2.19)	.002 (0.03)	.640* (3.26)	-1.537* (3.46)	.016 (0.10)	.039	.577

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 10
Estimates of ΔSP500 and ΔTWEX Based on the Partition of UM for ΔTB Equation from Table 6: October 8, 1982 - January 26, 1984

Dependent Variable	Const.	UM-A	UM-A5	UM-A10	UM-B	$\bar{R}^2$	SE
ΔSP500	.135 (1.66)		-.452* (2.49)	-.345 (1.46)	-.102 (0.84)	.018	1.46
ΔSP500	.135 (1.66)	-.412* (2.86)			-.102 (0.84)	.021	1.46
ΔTWEX	.029 (0.96)		.143* (2.09)	.197* (2.22)	.073 (1.60)	.026	.55
ΔTWEX	.029 (0.96)	.163* (3.00)			.073 (1.60)	.029	.55

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 11
Estimates of Equation 3 for ΔSP500

Period	Const.	$\Delta SP500_{t-1}$	UM-A	UM-B	UM-AN	$\bar{R}^2$	SE
January 5, 1978 - October 4, 1979	.023 (0.70)	.125* (2.66)	-.924* (3.98)	-.067 (1.41)		.0505	.6931
October 8, 1979 - October 6, 1982	.056 (1.35)	.117* (3.34)	-.657* (5.41)	-.076 (1.86)	1.944* (3.65)	.0680	1.1188
October 8, 1982 - January 26, 1984	.109 (1.41)		-1.222* (5.71)	-.097 (0.99)	1.800* (3.53)	.1174	1.3842

Absolute value of the t-statistic in parentheses

* Indicates statistical significance at the 5 percent level

Table 12
Estimates of Equation 3 for ΔTWEX

Period	Const.	UM-A	UM-B	UM-AN	UM-A5	UM-A10	$\bar{R}^2$	SE
January 5, 1978 - October 4, 1979	-.031 (1.63)		-.017 (0.64)	-.934* (3.53)			.024	.395
October 8, 1979 - October 6, 1982	.041* (2.02)	.400* (7.41)	.039 (1.86)	-.649* (6.53)			.116	.553
	.039 (1.92)		.039 (1.89)	-.649* (6.58)	.637*1/ (7.50)	.244*1/ (3.52)	.130	.549
October 8, 1982 - January 26, 1984	.025 (0.84)	.419* (5.21)	.065 (1.73)	-.802* (3.23)			.104	.529

1/ F-statistic for the hypothesis that UM-A5 = UM-A10 is 12.91*

Table 13
Summary Results for all Three Markets

Dependent Variable	UM-A	UM-AN	ΔSP500	ΔTWEX
		January 5, 1978 - October 4, 1979		
ΔTB	3	0	0	0
ΔSP500	3	0	-	0
ΔTWEX	0	1	-	-
		October 8, 1979 - October 6, 1982		
ΔTB	39	12	8(1)	10(2)
ΔSP500	9	2	-	2
ΔTWEX	16	10	-	-
		October 8, 1982 - December 26, 1984		
ΔTB	18	0	3	1
ΔSP500	7	2	-	2
ΔTWEX	7	2	-	-