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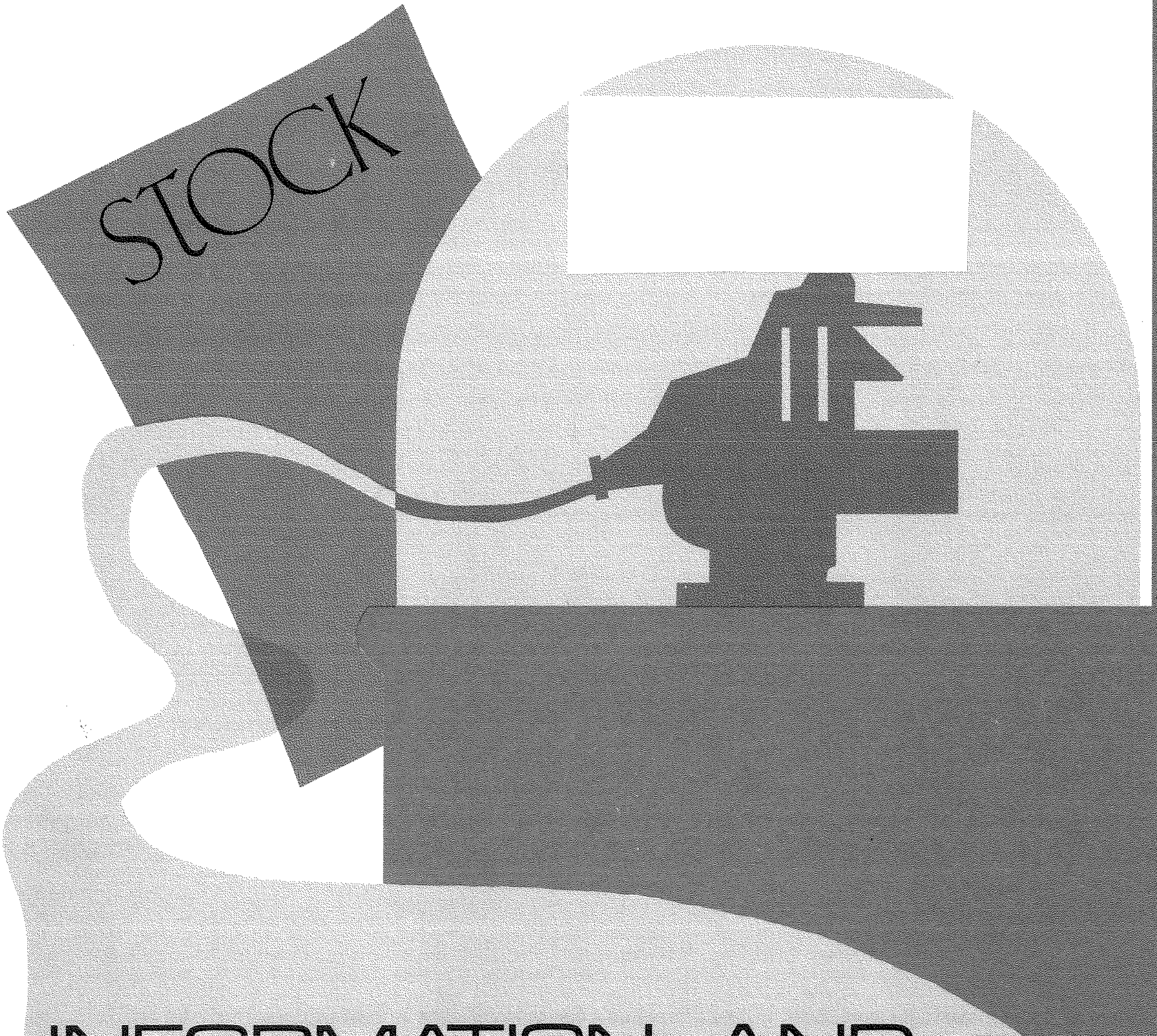

INFORMATION AND MARKET EFFICIENCY

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Practical Monetarism and the Stock Market

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Is today's monetary policy more effective than the monetary policy of earlier decades? Since the 1960's, dramatic changes have occurred in both monetary policy procedures and the amount of information provided by the Federal Reserve to Congress and the public. Still, the language of both Fed critics and advocates is sometimes reminiscent of an earlier time. The new procedures, coupled with the not-so-new debate over policy options, raise a question: are the procedural changes only differences in style, or does monetary policy now affect the economy in a substantially different way than it did in the 1960's?

The changes that led to the present policymaking approach began in 1966, when the Fed began "paying attention to the monetary aggregates." These procedures developed gradually between 1966 and 1975, and the interested reader may find detailed accounts of the development in several sources [c.f. (2), (8), (11)]. Finally, in March of 1975 Congress required the Federal Reserve to "... consult with Congress ... about the Board of Governors' and the Federal Open Market Committee's objectives about the rate of growth or diminution of monetary and credit aggregates in the upcoming twelve months." (9) This Congressional Resolution solidified the Fed's commitment to an approach that assigned great importance to the behavior of various measures of the quantity of money. The Federal Reserve's new procedures have come to be called "Practical Monetarism" by the financial press.

Was the monetary policy of the early '60's, when the Fed did not pay explicit attention to money, really different in economic impact from the practical monetarism of post-1975, or were the changes primarily cosmetic? This question may be subdivided:

1. Does the Fed actually respond to the behavior of the money stock in a way it did not in the 1960's?
2. If the Fed does respond differently, has the change altered the structure of the national economy in any significant way?

This article will utilize the developing theory of efficient markets to show that the Fed's response to growth in M_1 has changed, and as a result, the economic impact of a temporary deviation of M_1 from trend has actually been reversed. Section I shows that the public record is inconclusive about the Fed's attempts to control money. Public pronouncements of Federal Reserve officials suggest that the monetary aggregates are more important in the policy process now than before, but there is no explicit evidence that the behavior of the monetary aggregates changes policy decisions. Furthermore, there is no shortage of criticism of the Federal Reserve on the grounds that the Fed continues to pay insufficient attention to money.

In Section II, the case is made that the Fed today raises interest rates in response to undesirably rapid money growth, whereas it did not do so in the 1960's. This change in response is revealed indirectly, through an analysis of the stock market's response to the money supply. The conclusion is based on the evidence that the stock market today (unlike the 1960's) responds negatively to an increase in the money supply—and the proposition that the stock market is an efficient forecaster of the future economic impact of a change in the money supply, which impact in turn depends on the Federal Reserve's policy reaction.

Section III argues that the new emphasis on the monetary aggregates has in fact altered the structure of the economy, and that most econometric models of the monetary-transmission process are mis-specified as a result. This section raises questions about a naive interpretation of the portfolio-adjustment theory of the transmission of monetary policy—namely, that an excess demand or supply of money *precedes* changes in

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long-term interest rates and equity values, which changes in turn influence levels of real economic activity. The empirical work presented here indicates that stock prices and interest rates primarily reflect anticipated trend rates of money growth. Thus, according to a more accurate interpretation of portfolio theory, past rates of money growth affect current real economic activity only if they affect forecasts of future money growth.

I. Recent History of Monetary Policy

By all accounts, the most important and most controversial change in monetary policymaking in the last several decades has been the increasing importance attributed to various measures of money—in particular, the narrowly-defined M_1 measure (currency and demand deposits) and the broader M_2 measure (currency plus all bank deposits except large negotiable CD's). According to the minutes of the Federal Open Market Committee (FOMC), that key policymaking committee clearly has paid greater *attention* to the behavior of M_1 over time. The first such expression of interest occurred in 1966, when a "proviso" clause was first included in the Directive, the document containing the monthly instructions from the FOMC to its operating arm, the System Open Market Account (SOMA). An example of a Directive with a proviso clause was the December 1967 Directive (4):

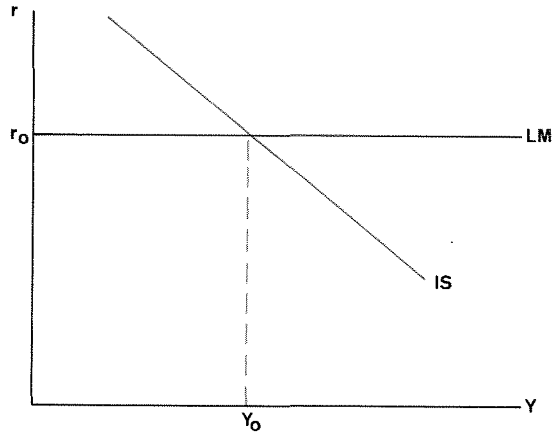
> "..., System open market operations until the next meeting of the Committee shall be conducted with a view to moving slightly beyond the firmer conditions that have developed in money markets ... *provided*, however, that operations shall be modified as needed to moderate any apparently significant deviations of bank credit from current expectations or any unusual liquidity pressures. (emphasis added)"

The proviso clause was the first explicit FOMC recognition of the need to pay attention to unanticipated behavior of the money and credit aggregates during the periods between meetings. But even with that clause, it remained unclear exactly how the information on money included in the Directive would feed into actions of the SOMA and its Trading Desk. For several years, various Directives mentioned growth in money and credit, but did not give the Desk instructions about what to do should the aggregates go off course.

As a result of historical experience, such as the undesirably rapid growth of money supply in the last half of 1968, the FOMC came to place more emphasis on the aggregates. The February 1970 Directive, for example, put the financial community on notice that moderate growth in M_1 and the other aggregates was an important FOMC objective. However, the role of money in the new procedure remained ambiguous. Thus, in his testimony before the Congressional Joint Economic Committee on July 23, 1970, Chairman Burns emphasized that changes in money growth sometimes would have little effect on subsequent FOMC decisions.

> "An impression seems to have prevailed in some quarters that the Federal Reserve had decided to pursue fixed target rates of growth in the monetary aggregates on a more or less continuous basis. This is a misreading of our intent. We believe that the nation would be ill-served by a mechanical application of monetary rules. We know that large, erratic, and unpredictable short-run changes often occur in demands for money and credit. One of the important functions of a central bank is to prevent such short-run shifts from interfering with the

Chart 1



smooth functioning of money and capital markets. We have no intention of abandoning our responsibilities in this area (3)."

By 1975, however, the Federal Reserve had come to focus its stated policy intentions on the monetary aggregates. The FOMC's quarterly choice of growth rates for M_1 and M_2 became an index of FOMC policy intentions in the six to twelve months following their selection.

The present FOMC Directive provides operating instructions to the SOMA in terms of "short-term tolerance ranges," one for the M_1 and M_2 monetary aggregates, and one for the Federal-funds rate. For example, in its July 19, 1977 meeting, the FOMC voted the following Directive:

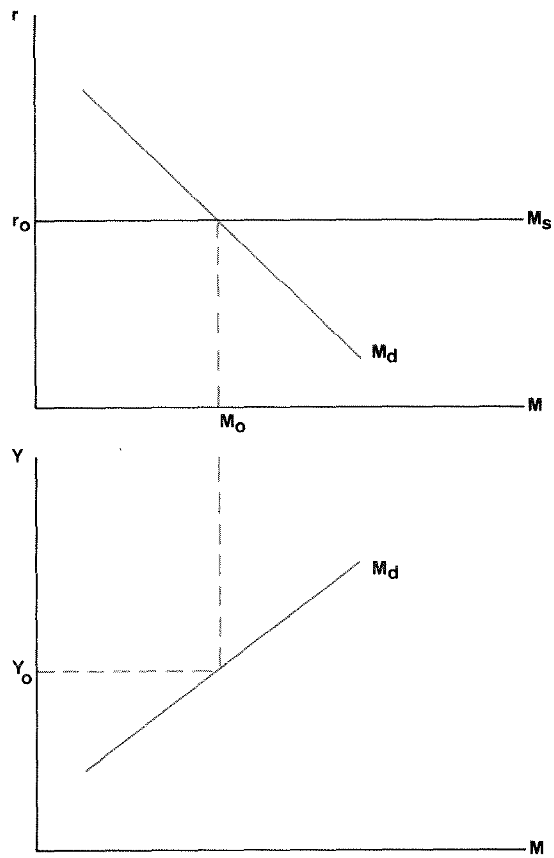
> "Specifically at present, it [the FOMC] expects the annual growth rates over the July-August period to be within the ranges of 3½ to 7½ percent for M_1 and 6½ to 10½ percent for M_2. In the judgment of the Committee such growth rates are likely to be associated with a weekly-average Federal funds rate of about 5⅜ percent. If, giving approximately equal weight to M_1 and M_2, it appears that growth rates over the two month period will deviate significantly from the midpoints of the indicated ranges, the operational objective for the Fedral funds rate shall be modified in an orderly fashion within a range of 5½ to 5¾ percent (5)."

The SOMA's basic task is to achieve, on a weekly average basis, the "midpoint" of the short-term tolerance range for the Federal-funds rate. However, the appropriate SOMA response to unanticipated growth in the monetary aggregates is still not spelled out explicitly in the Directive, although the desirability of *some* response is certainly suggested.

The lack of an explicit link in the Directive between the aggregates target and the funds-rate target, as well as occasional statements by Fed officials, raises the question of whether the Federal Reserve actually responds more than before to unintended growth in the monetary aggregates. Former Federal Reserve insiders sometimes suggest that the monetary aggregates are not given much attention in practice. James Pierce, former associate economist for the FOMC, is quoted to this effect in the March 27, 1978, issue of *Fortune* magazine:

> "...The Fed still conducts its business virtually the same way it always has. When Congress passed its 1975 resolution, it intended the Fed to pay more attention to the growth of the monetary aggregates—M_1, M_2, etc.—and less attention to stabilizing interest rates. Since 1975 the Fed has paid more and more lip service to the monetary aggregates... (10)"

Chart 2

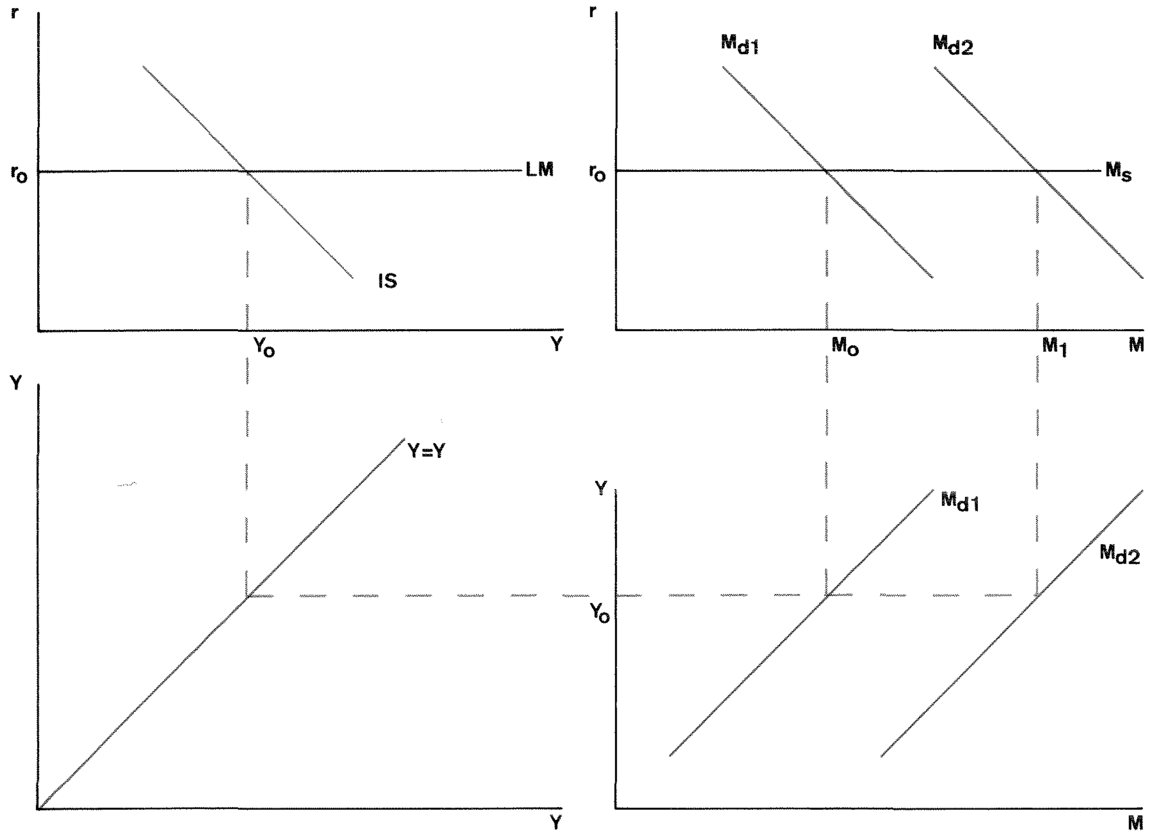


II. Has the Fed's Behavior Changed?

In the economics textbooks, the Fed is described as having two options when implementing policy: 1) control interest rates, or 2) control the money stock. In reality, however, the second option is not a simple one under the current institutional framework. The amount of money (M_1) is jointly determined by the Fed, the commercial banks and the public at large. Moreover, it is partly estimated, rather than measured, by the Fed, so the word "control" is not quite applicable. A better description would be to say that the Fed has the choice either of changing interest rates, or of not changing them, in response to unanticipated behavior of the money stock. In this section we argue that the Fed has recently "controlled" the money stock to some degree—that is, the Fed has changed its interest-rate plans in response to unanticipated changes in M_1—in ways that it did not during the 1960's.

This argument is based upon the changes that have occurred over time in money–stock market relationships. Most economists agree that the stock-market response to M_1 is important evidence of M_1's impact on economic activity in general, because the stock market is an efficient market. That is, stock-market behavior reflects accurate forecasts (rational expectations) of future economic activity. In the words of William Poole, "The validity of the rational-expectations (efficient market) hypothesis as applied to prices in active auction markets has been extensively tested. Numerous investigators have analyzed an enormous amount of data using many different statistical techniques, and no serious departure

Chart 3



from the predictions of the hypothesis has been found (12)."

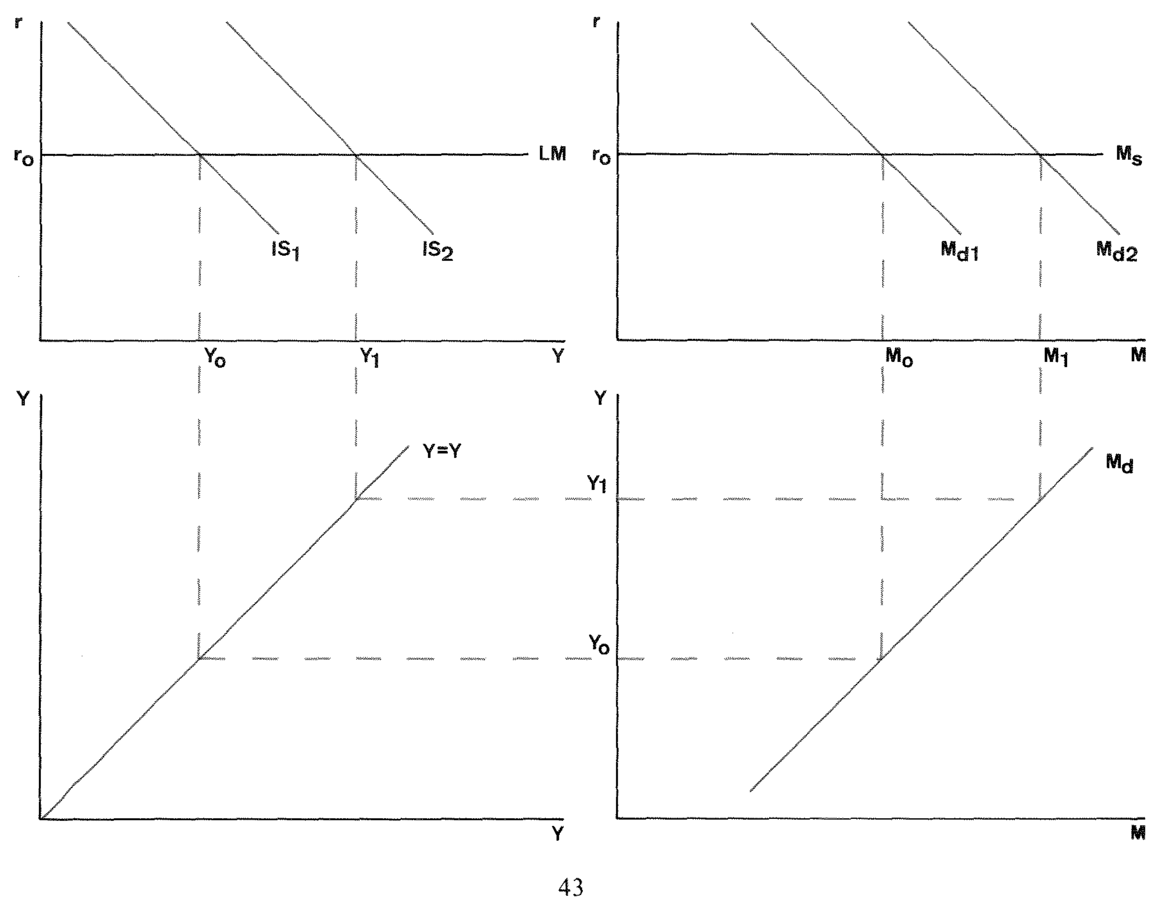
According to the efficient-market hypothesis, all relevant available information affecting a firm's future net revenues is accurately reflected in its current stock value. With an efficient stock market, the market's response to a change in the money supply occurs as soon as market participants compute the economic impact of a change in M_1. In particular, an efficient stock market would adjust for any change in Federal Reserve response to M_1 growth.

We attempt to show here that the Federal Reserve, under certain circumstances, is the decisive factor in determining the economic effects of a given change in M_1. Next, we present evidence of a reversal, since 1970, of the stock market's response to M_1 changes. Since that turning point, increases in the money supply have tended to have negative rather than positive impacts on stock prices. This suggests a shift over time in both the Fed's response and the economy's response to changes in M_1.

Consider the standard IS-LM model of income determination (Chart 1). Income (Y) and interest rates (r) are determined by joint equilibrium of the markets for goods and services (IS) and for money (LM). The IS curve represents various equilibrium combinations of interest rates and income in the market for goods and services. The curve is negatively sloped to indicate that households and firms will purchase relatively more goods and services if interest rates decline, other things equal. The LM curve represents various combinations of interest rates and income that lead to equilibrium in the money market. It is sometimes constructed with an upward slope and sometimes horizontally, depending on the Fed's behavior. In this case the LM curve is horizontal, because the Fed controls interest rates over the very short-run.

The short-run structure of the money market

Chart 4



may be summarized by: 1) a standard money-demand function, where money demand is directly proportional to nominal income and inversely related to interest rates; and 2) a horizontal short-term money-supply function, where the Federal Reserve implements policy by choosing a particular level of the Federal-funds rate and supplying the cash necessary to maintain this level. Chart 2 summarizes the money market under these conditions, with equilibrium interest rate r_0 and income y_0.

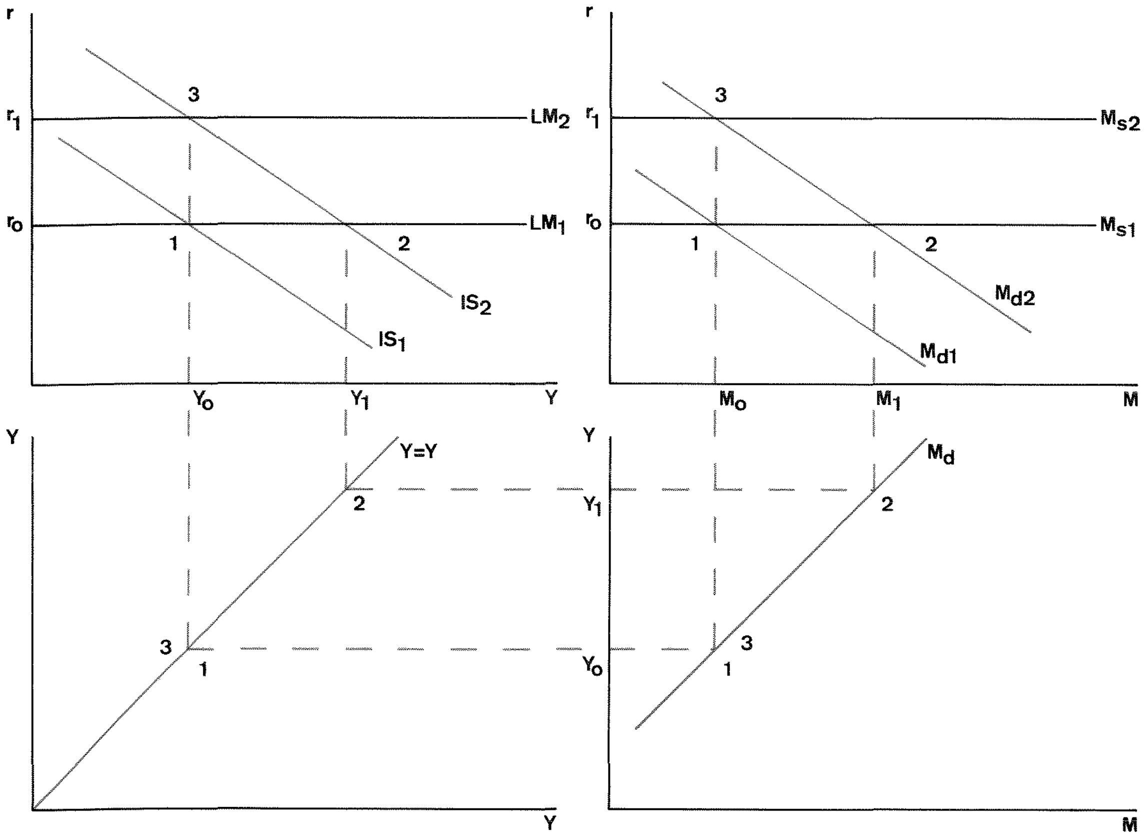
Consider first a policy where the Fed does not respond to changes in the money supply. If there were an unanticipated increase in the money supply, would income be permanently higher as a result? The answer depends on the source of the increased money.

One possible source would be an upward shift in the demand for money at old levels of income (Chart 3). Such a change in money demand would mean more money, an increase from M_0 to M_1, but the IS-LM relationship would be unaffected and income and interest rates would be unchanged.

A second possible source would be an increase in money demanded due to an outward shift in the IS curve (Chart 4). An unanticipated increase in money of this sort would tend to be associated with higher future income. Except in those cases where the increased quantity of money is due to an upward shift in money demand, there is a positive probability of greater future income with a surprise increase in money. In Appendix I this proposition is demonstrated analytically.

Now suppose the Fed becomes sensitive to the behavior of money under a policy of practical monetarism. In this situation, an unanticipated increase in the money supply would lead the Fed to increase its funds-rate target. But if the source of the increased money was a shift in the IS curve, the increase in the funds-rate target would

Chart 5



tend to offset the otherwise higher level of future income (Chart 5). The chart shows (1) the initial equilibrium, (2) the equilibrium after the surprise increase in the supply of money due to the shift in the IS curve, and (3) the equilibrium at old levels of income and higher interest rates after the Fed responds to the unanticipated change in money by raising the funds-rate target.

As our analysis suggests, the IS-LM model does not by itself lead to any single conclusion about the future of interest rates and income following an unanticipated change in money, independently of Federal Reserve policy. The effect of an increase in M_1 depends on whether or not the Fed intends to offset this increase by returning to former money-growth rates. If the Fed does not raise interest rates in this situation, an increase in money will tend to result in more rapid income growth and unchanged interest rates. If the Fed does respond to increased M_1 growth, future income will remain unchanged and future interest rates will tend to rise.

The effect of an increase in M_1 upon an efficient stock market depends upon the policy choice made by the Federal Reserve. The efficient stock market equates the value of stock to the discounted value of future net earnings of the firm

$$V_t = E_0 + \frac{E_1}{1 + r} + \frac{E_2}{(1 + r)^2} + \ldots$$

where

V_t = value of a share of stock at time t

E_i = earnings per share of stock at time (t + i)

r = rate of interest

Consider the case where the Fed sets its interest-rate targets independently of money growth (Chart 6). In the short run, earnings depend on demand-induced changes in aggregate spending. Although policy-induced increases in aggregate demand will eventually affect costs as well, the initial effect of an increased rate of income

Chart 6

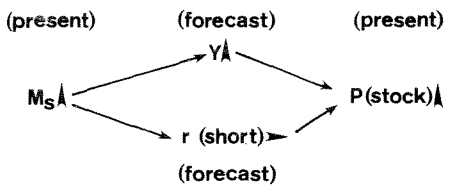
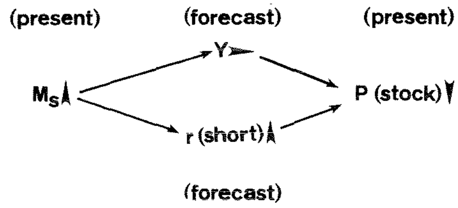


Chart 7

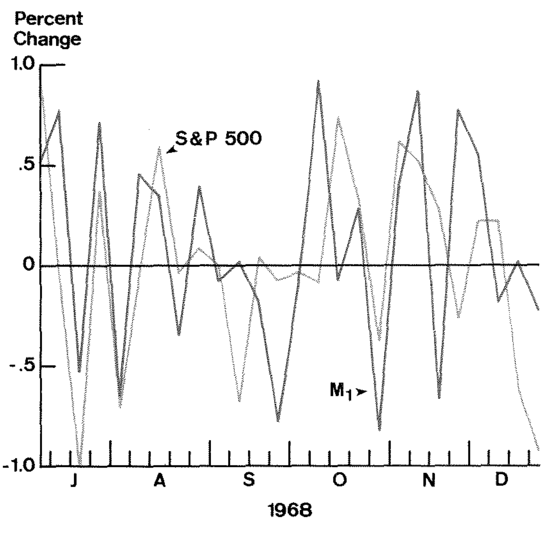


growth will be an increase in the firm's net earnings. Thus, if the Fed does not respond to increased M_1, the resulting higher income and unchanged interest rates would lead to an increase in stock prices.

Next, consider the case where the Fed raises its interest-rate targets in response to money growth (Chart 7). Income and expected earnings would not increase. Instead, the stock market would anticipate a rise in interest rates, which would tend to raise the discount applied to future earnings and to lower the value of stock. Thus, efficient-market-determined stock values, like economic developments, depend in the last analysis upon the Fed's response to money growth. If the market expects the Fed to offset a given increase in M_1 growth, the result would be lower stock values.

Chart 8

M_1 and STOCK PRICES
June 27 - December 27, 1968



Most empirical studies of the subject, based entirely or predominantly upon 1960's data, have found a positive correlation between changes in the money supply and changes in stock prices. Most of these studies have utilized monthly or quarterly average behavior of the two variables, but similar results have been obtained with weekly-change data for second-half 1968—specifically, the Federal Reserve's money data released each Thursday after the stock-market close, and the closing stock-price data released the following Friday (Chart 8). However, a completely different picture emerges when we compare the same two variables in a more recent period, the first half of 1977 (Chart 9). In this period, we observe a negative rather than a positive relationship between money and stock prices.

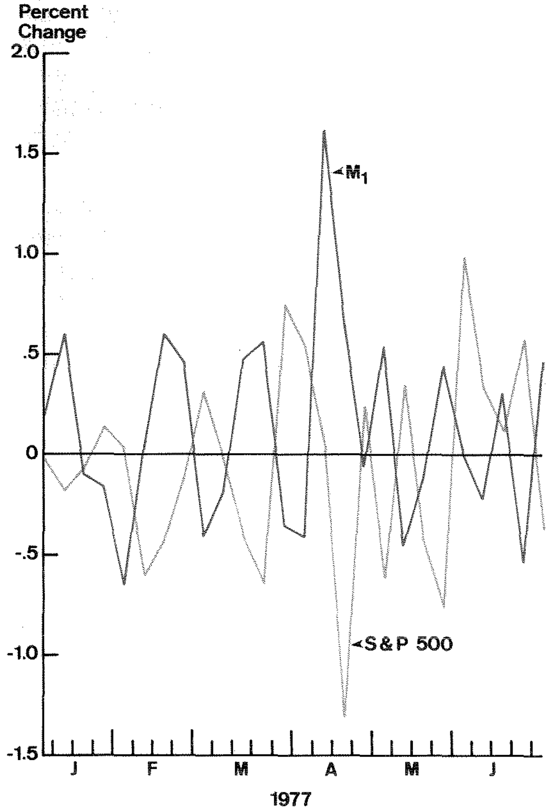
To capture the entire effect of the monetary impact on the stock market, we may have to take account of microeconomic as well as macroeconomic effects. According to a micro approach, an unexpected increase in current money balances in an individual portfolio leads to an undesirably high ratio of money to other assets. As a result, savers attempt to reduce their holdings of other types of assets so as to restore their money-earning assets ratios to preferred levels.

Changes in the money supply could have both kinds of effects. Microeconomic effects, which can occur at any time, involve market participants as they make portfolio decisions that directly affect stock prices and perhaps ultimately the economy as a whole. Macroeconomic effects, which occur only at one specific time, involve market participants as they adjust their economic forecasts in response to new money data. The microeconomic effects of money growth are always positive, while the macroeconomic effects may be either positive or negative.

If the micro effects are dominant, then the behavior shown in the charts would represent only irrelevant "announcement effects" and would be

Chart 9

M_1 and STOCK PRICES
January 6 - June 30, 1977



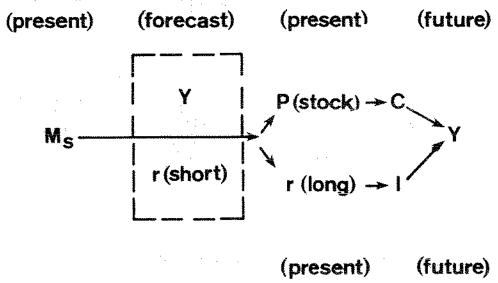
dominated by the "actual effects" of the money-stock price relationship. But a separate statistical analysis (Appendix II) supports the thesis suggested by the charts -- namely, that the inverse macro relationship dominates the positive micro relationship. This inverse relationship is evident in the 1973-77 period, and especially in 1975-77. The statistical evidence also suggests that, because of changing Federal Reserve behavior, the market has reversed the macroeconomic effects expected from unanticipated changes in M_1.

III. Transmission of Money Growth to the Economy

What is the mechanism that transforms changes in money into changes in the level of economic activity? Chart 10 indicates that changes in money immediately affect stock prices and long-term interest rates, because these changes cause market participants to revise their forecasts of future income and interest rates.

If holders and prospective holders of long-term bonds decide that short-term rates will rise more than originally anticipated, they will bid up long-term rates as a means of arbitraging the higher expected short-term yield. This change in short-

Chart 10



term rate forecasts also would increase the discount on future corporate revenues and reduce stock values.

Consider the 1960's-style response to a surprise increase in M_1 (Chart 11). Since market participants would expect the Federal Reserve to accommodate such unanticipated increases, the result would be higher forecasts of income and unchanged forecasts of interest rates. These forecasts would tend to push stock valuation upward, and leave long term rates unchanged. The booming stock market stimulates consumer spending, which leads to higher levels of income.

Next, consider the 1970's-style response to a surprise increase in M_1 (Chart 12). Since market participants would expect the Fed to offset such unanticipated increases, they would revise their short-rate forecasts upward but leave income forecasts unchanged. The initial effects

Chart 11

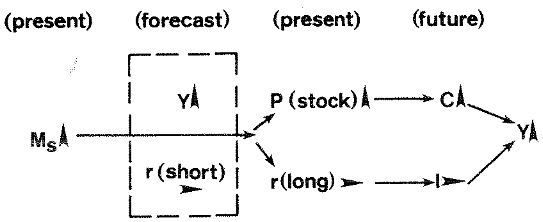
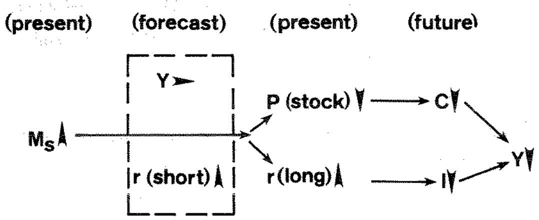


Chart 12



would be higher long rates and lower stock prices, which in time would tend to reduce consumption and investment and therefore reduce income.

The stock market's recent behavior casts doubt on the idea that the portfolio-adjustment process is primarily a response to a disequilibrium amount of money in current portfolios. The evidence suggests that a change in the *anticipated* rate of money growth is more important than *current* monetary changes in explaining portfolio adjustment. In the 1960's, an unexpected increase in money had a positive impact on the stock values, because it suggested accelerated future money growth (due to accelerated future GNP growth). In the 1970's, however, a similar increase in money was contractionary, because it meant slower future money growth (due to the Fed's raising of interest rates at current GNP growth rates).

If changes in anticipated future rates of money growth are more important than current changes, the emphasis should be on *anticipated* future excess supplies. Then the substitution of equities for money that would drive the system into equilibrium would be a substitution of future claims to money for current holdings of equity -- in other words individuals would tend to buy equity on credit. Replacing a current excess supply of money with a future excess supply would make the inverse money-stock price relationship consistent with the portfolio-adjustment model.

IV. Summary and Conclusions

The apparent reversal in the stock market's response to a change in money should ease the Fed's attempt to reduce fluctuations in income. In the case of an unanticipated decline in M_1, market participants would expect the Fed to lower interest rates as a means of offsetting the associated decline in income, and thus they would act to push equity values upward and to reduce long-term interest rates. Rising stock values would increase net wealth and therefore increase consumption spending out of net wealth, thus bringing about the beneficial effect on income growth desired by the Fed. Similarly, long-term rates would tend to fall in anticipation of the Fed's intention to reduce future short-term rates. This decline in long-term rates would increase investment expenditures, again moving the economy in the direction desired by the Fed.

However, the effect of efficient auction markets upon the economy can be a two-edged sword. Suppose the Fed made an error the stock market was aware of -- for example, by choosing a "wrong" money growth target that led to a higher growth in income than the Fed desired. Market participants then would re-evaluate firms' expected revenues, and stocks would appreciate in value. Likewise, traders would reduce the levels of expected short-term interest rates, bringing long-term rates down. Both results would exacerbate the initial policy mistake and lead to excessive growth in income.

The stock market thus can be a useful indicator of the impact of monetary policy. If the actions of policymakers are consistent with their desires, the stock market should reflect this fact. In contrast, if their policy is more restrictive than desired, the results would be seen in an undesirably weak stock market.

Most past studies of relationships between the stock market and other economic variables have focused upon past events that have affected present stock values. But if the stock market is efficient, this is not the right order of influence. With an efficient market, the key influence is the *future* behavior of key economic variables -- or at least the best available estimate of their behavior.

As a consequence, the stock market can help judge the future course of monetary policy. According to the evidence developed here, the Fed's response to unanticipated behavior of M_1 has changed substantially—so substantially, in fact, as to *reverse* the earlier implication of how changes in money growth would affect the average firm's future net income.

In addition, the market's response to M_1 has an economic impact all its own. This helps the Fed in achieving its goals when the Fed's estimate of future economic activity coincides with the market's estimates. However, the market will thwart the Fed's intentions when it thinks the Fed's forecasts are mistaken.

APPENDIX I

In this appendix we derive the economic impact of unanticipated changes in the money supply under two different monetary-policy procedures, using the IS-LM model:

$$y_t = a_o + a_1 r_t + p_1 y_{t-1} + e_t$$

$$m_t = b_o + b_1 y_t + b_2 r_t + p_2 m_{t-1} + u_t$$

y_t = nominal income in period t

m_t = amount of money in period t

r_t = interest rate in period t

e_t, u_t = independent normally distributed random variables with mean zero and variances σ_e^2 and σ_u^2 respectively.

First we consider a monetary policy which is formulated independently of changes in M, so that the course of future interest rates will not be influenced by an unanticipated increase in the money supply. Stock-market participants, knowing this, will assume future interest rates unchanged. In forming estimates of the unanticipated increase in current income associated with the surprise increase in money, traders may base their initial income forecast, y_o, upon an IS curve relationship and upon an LM curve relationship:

$$\text{IS} \qquad \Delta\hat{y}_o = 0$$

$$\text{LM} \qquad \Delta\hat{y}_o = b_1^{-1}\Delta m_o$$

in order to minimize the variance, the two forecasts would be weighted according to the size of the associated forecast errors:

$$\hat{y}_o = c_1\,(0) + c_2\,(b_1^{-1}\,\Delta m_o)$$

where

$$c_1 = \frac{(b_1^{-1})^2\sigma_u^2}{(b_1^{-1})^2\,\sigma_u^2 + \sigma_e^2}$$

$$c_2 = \frac{\sigma_e^2}{(b_1^{-1})^2\,\sigma_u^2 + \sigma_e^2}$$

After this inital period, the increased income associated with the unanticipated increase in money will result from the auto-correlation in income implicit in the IS curve:

$$\Delta y_i = p_1 \Delta y_{i-1}$$

So that $\Delta y_i = p_1^i c_2 b_1^{-1} \Delta m_o$.

Since $p_1, c_2, b_1^{-1} > 0$,

$$\frac{\Delta y_i}{\Delta m_o} > 0, \frac{\Delta r_i}{\Delta m_o} = 0.$$

Next, we consider a monetary policy where interest rates respond to unanticipated changes in the money supply. The first-round effect of this surprise change is the same as before. However, the Fed is now using the minimum variance estimate of the current increase in income derived above, and attempting to offset its effect on future income by raising interest rates. This increase in interest rates is:

$$\Delta r_1 = -a_o^{-1} p_1 \hat{\Delta y}_o$$

The resulting equations for changes in interest rates and income associated with the unanticipated change in the money supply is:

1) $\hat{\Delta y}_o = c_2 b_1^{-1} \Delta m_o$

2) $\hat{\Delta y}_i = 0 \quad i = 1, 2, \ldots$

3) $\hat{\Delta r}_1 = -a_1^{-1} c_2 b_1^{-1} \Delta m_o$

$\qquad c_2, b_1^{-1} > 0, a_1^{-1} < 0$

4) $\hat{\Delta r}_i = 0 \qquad i = 2, \ldots$

APPENDIX II

This appendix contains a time-series analysis of the impact of a given percentage change in the money supply upon stock prices.

A convenient way of expressing the value of a share of stock, V_t, at any point in time is:

$$V_t = \sum_i (R_i - C_i) \frac{1}{(1 + r)^{(t-i)}}$$

$$i = t, t + 1, \ldots$$

where R_i = anticipated revenues in period i
C_i = anticipated costs in period i
r = the interest rate.

This in turn provides us with a formula for the change in the price of a share of stock in a given time period:

$$\Delta V_t = \sum_i \Delta (R_i - C_i) \frac{1}{(1 + r)^{t - i}} - D_t$$

where D_t = dividends paid during period t.

That is, the change in share prices in any period ${}_{t-1}\Delta_t$ is the change in the present value of anticipated net revenues less the dividends paid during the period.

Adding dividends to both sides:

$$E_t = D_t + \Delta V_t$$

$$= \sum_i \Delta (R_i - C_i) \frac{1}{(1 + r)^{t - i}}$$

$$= f({}_{t-1} X_t) + E$$

where

E_t = earnings due to holding a share of stock during the period from time t−1 to time t.

E = anticipated earnings due to holding a share of stock at time t−1.

${}_{t-1}X_t$ = vector describing the information important to stockholders that is learned between time t−1 and time t.

Given an efficient stock market, money-supply changes also affect stock values to the extent that they affect the "best" forecasts of real economic variables. This means that money-supply behavior that does not *change* the economic forecast also has no impact on the value of stock. While money changes might affect real economic activity with a time lag, they would affect *forecasts* of future economic activity immediately, and so the effect on the stock market would also be immediate. Similarly, the part of a change in the money supply that was expected to occur would already be included in current economic forecasts, and hence would already be reflected in stock values at the time it occurs. So only unanticipated money changes have any impact upon stock values. Therefore, in an efficient stock market, changes in stock values between, say, time t−1 and time t would *not* be related to:

1) money-supply changes that occur prior to time t-1, and
2) money-supply changes that occur after time t−1 but are anticipated at time t−1.

In short, the only changes in the money supply that potentially affect stock values are those that are unexpected and occur during the same time period as the change in stock values.

To develop an appropriate measure of the change in stock values, we used an updated version of the Standard and Poor Index of the end-of-the-month return to stock. (Ibbotson and Sinquefield, "Stocks, Bonds, Bills, and Inflation: Year by Year Historical Returns (1926-1974)," *Journal of Business,* Vol. 4a). It was then necessary to develop an appropriate measure of the new information provided by M_1 during the month in which stock values were affected—that is, M_1 data available to financial-market participants at the time, rather than later revisions. For this reason, M_1 data were based on last-Wednesday-of-the-month releases from the Federal Reserve Statistical Release H-6, Table 1.

In order to find the unanticipated change in the money supply over a given time period, we first had to develop some sort of estimate of the anticipated change in M_1. If stock-market participants are rational, they would at least use all the information provided by the past behavior of the money supply itself. In other words, to the extent that money growth follows predictable patterns, past values are useful in forecasting the future money supply. We use the standard Box-Jenkins analysis to develop the information from past money-supply behavior efficiently.

Since the basic hypothesis was that monetary-policy techniques had shifted between the 1960's and the 1970's (particularly after 1975), it seemed logical to form different estimates of anticipated money for the different periods considered. Initially, three time periods were examined: January 1960 - December 1969, January 1970 - December 1976, and January 1973 - December 1976 (Table 1). The table describes lags at which significant autocorrelation existed between the M_1 change in a given month and M_1 changes k months in the past. (Significance was based on one standard deviation of the asymptotic distribution of the autocorrelation term, under the null hypothesis that inter-period changes in M_1 are independent. With independence, autocorrelation terms are asymptotically normal with zero mean and variance 1/N where N is the size of the sample.)

Table 1
Structure of Autocorrelation (up to 20 lags) of M_1 Percentage Change (monthly) in Different Time Periods

Test statistic $N^{-1/2}$ =	.091	.109	.145
Sample period:	Jan. 1960 - Dec. 1969	Jan. 1970 - Dec. 1976	Jan. 1973 - Dec. 1976
	2	1	1
	3	4	4
	4	7	7
	6	8	8
	11	11	11
Significant	17	12	15
autocorrelations	18	14	17
at k =	19	15	
		17	
		19	

Based on these results, we constructed the following equations (see Table 2) for the purpose of estimating anticipated money. Q statistics indicate that an χ-square test will permit acceptance of the hypothesis that the residuals of the anticipated money series are uncorrelated. Thus, we may reject the hypothesis that there is more information about the current change in M_1 contained in past behavior of M_1 after the adjustment.

After forming monthly forecasts of M_1 change based upon the information contained in past money behavior, we subtract the forecasts from the actual change to get some measure of the surprise change in M_1. We can then compare the unanticipated change to the change in stock valuation to determine if there is a relationship between the two variables. Most recent studies of this relationship have been based upon data from the 1960's and early 1970's. The evidence they present is not conclusive, but they generally support the proposition that the market for stock is efficient, according to the criterion that "old" M_1 data has no identifiable effect on the stock market. (See for example Rogalski and Vinso, *Journal of Finance,* September 1977 for an examination of the efficiency with which the stock market uses monetary data.) Our evidence on the subject is also not conclusive, at least for the 1960-69 period. In that period, surprise changes in the money supply apparently had some predictable relationship to changes in stock values in future periods. However, later data show no such relationship, and therefore support the efficiency hypothesis (Table 3).

Table 2

Filter for M_1 Change (percent) for 1960 - 1969

Equation Lag	2.	3.	4.	6.	9.	11.
Coefficient	−0.10181	−0.27571	0.09436	−0.26240	−0.12015	−0.11795

Autocorrelations of Residuals											Q Statistics
1 − 10	0.06	0.02	−0.02	0.00	0.05	0.03	0.01	−0.02	0.03	0.00	0.999
11 − 20	−0.00	−0.05	0.01	−0.07	0.06	0.07	0.13	0.03	−0.08	0.10	7.091

Summary Statistics
Variance of Residuals = $.1257 \times 10^{-4}$, degrees of freedom = 113
Durbin-Watson Statistic = 2.097
$R^2 = .155$

Filter for M_1 Change (percent) 1970 - 1976

Equation Lag	1.	4.	7.	8.	9.	11.
Coefficient	0.16914	0.04699	0.19062	0.06291	−0.26921	−0.24289

Autocorrelations of Residuals											Q Statistics
1 − 10	−0.02	−0.07	0.01	−0.01	−0.02	−0.03	0.02	0.08	−0.03	−0.04	1.417
11 − 20	0.03	−0.13	−0.06	0.10	−0.15	0.08	0.18	−0.00	0.03	−0.05	9.466

Summary Statistics
Variance of Residuals = 0.0422×10^{-4}, degrees of freedom = 77
Durbin-Watson Statistic = 1.920
$R^2 = .125$

Filter for M_1 Change (percent) 1973 - 1976

Equation Lag	1.	2.	4.	5.	7.	8.
Coefficient	0.29351	0.31124	0.53073	−0.37976	0.04356	−0.00996

Autocorrelations of Residuals											Q Statistics
1 − 10	−0.04	−0.01	0.09	0.03	−0.02	−0.09	−0.00	0.07	0.09	−0.01	1.466
11 − 20	0.09	−0.10	0.05	0.03	−0.25	−0.03	0.20	−0.07	−0.05	−0.11	8.207

Summary Statistics
Variance of Residuals = 0.2729×10^{-4}, degrees of freedom = 41
Durbin-Watson Statistic = 1.964
$R^2 = 0.269$

Other studies have found a significant relationship between changes in the stock values in a given week and unanticipated M_1 changes in following weeks — a sort of reverse causality running from the stock market to the money supply. One reasonable explanation for this behavior is that stock-market participants can find available other (non-money) information useful in forecasting future M_1 changes prior to the publication of M_1 data. In this case, changes in stock values will tend to precede unanticipated changes in the money supply, because market participants are partly able to anticipate them.

In all three periods, we found some indication of a relationship between present stock prices and future changes in the money supply, but the relationship was stronger after 1970. In the case of the 1975 to 1976 residuals, significant relationships appear to exist between changes in the value of stock and unanticipated money and next week's unanticipated money. This result is consistent with the hypothesis of an efficient stock market that believes unanticipated increases in the money stock have an adverse effect upon the discounted net earnings of the average firm.

Table 3
Correlations of Unanticipated Monthly Percentage Change in M_1 with Monthly Percentage Change in Stock Values at Various Leads and Lags

I. January 1960 – December 1969

a) contemporaneous correlation p = 0.117*

b) correlation between stock and M_1 i periods in the past

i =	1	2	3	4	5	6	7	8	9	10	χ^2
p =	0.111*	0.217*	0.034	0.090	−0.044	−0.053	0.005	0.077	−0.069	−0.121	11.67

c) correlation between stock and M_1 i periods in the future

i =	1	2	3	4	5	6	7	8	9	10	χ^2
p =	0.061	0.025	−0.112*	−0.003	0.014	0.017	−0.037	−0.366*	0.072	−0.042	19.02

*significant with critical value $1/\sqrt{N}$ = .096

II. January 1973 – December 1976

a) contemporaneous correlation p = −0.107

b) correlation between stock and M_1 i periods in the past

i =	1	2	3	4	5	6	7	8	9	10	χ^2
p =	−0.091	−0.060	−0.192*	0.215*	0.159*	0.190*	0.054	−0.146*	0.058	−0.195*	9.39

c) correlation between stock and M_1 i periods in the future

i =	1	2	3	4	5	6	7	8	9	10	χ^2
p =	−0.417*	−0.061	−0.124	−0.049	−0.132	−0.095	0.095	0.092	−0.195*	−0.050	13.18

* significant with critical value $1/\sqrt{N}$ = .144

III. Residuals from January 1975 - December 1976 based on anticipated money series constructed using January 1973 - December 1976 M_1 data.

a) contemporaneous correlation p = −.368*

b) correlation between stock and M_1 i periods in the past

i =	1	2	3	4	5	6	χ^2
p =	−0.115	−0.169	−0.059	0.135	0.003	0.188	1.958

c) correlation between stock and M_1 i periods in the future

i =	1	2	3	4	5	6	χ^2
p =	−0.461*	−0.086	−0.232	−0.135	0.163	0.012	7.648

* significant with critical value $1/\sqrt{N}$ = .209

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