Federal Reserve Bank of Dallas

presents

RESEARCH PAPER

No. 9308

On Quantity Theory Restrictions and the Signalling of the Money Multiplier

by

Joseph Haslag
Federal Reserve Bank of Dallas

On Quantity Theory of Restrictions and the Signalling Value of the Money Multiplier

Joseph Haslag, Research Department
Federal Reserve Bank of Dallas

and

Department of Economics
Southern Methodist University

On Quantity Theory Restrictions and the Signalling Value of the Money Multiplier

Joseph H. Haslag

Research Department
Federal Reserve Bank of Dallas

and

Department of Economics
Southern Methodist University

Abstract: This paper examines the issue of which money measure is most closely related to prices. The contribution of this paper lies in examining the appropriate interpretation of results indicating that the money multiplier is significantly related to inflation. The analysis forwarded in this paper provides some indirect evidence as to what interpretation--either broader categories of indebtedness are related to prices or the money multiplier signals shocks to the demand for base money--is appropriate. The evidence bears on the predictions posited in Sargent and Wallace's (1982) paper in which base money is the money measure most highly correlated with prices when quantity theory restrictions are present.

I have benefited from helpful discussions with Scott Freeman, Ken Emery, Rik Hafer, Scott Hein, Greg Huffman, and Evan Koenig. Any remaining errors are solely mine. The views represented in this paper do not necessarily reflect those of the Federal Reserve Bank of Dallas or the Board of Governors of the Federal Reserve System.

What categories of indebtedness are most highly correlated with prices? This question is important for monetary economists, especially policymakers. Unfortunately, theory has very little to say about which categories of indebtedness should be correlated with prices. Instead, identifying the appropriate measure of "money" is an issue left almost exclusively for data to settle.

In this paper, the maintained hypothesis is that base money is the concept of money that is most highly correlated with prices. Sargent and Wallace (1982) showed that base money would be the measure most closely related to prices when quantity theory restrictions are present. The approach taken in this paper is to test the validity of the maintained hypothesis by proceeding in two steps. The first step explores whether there is information present in base money and/or the money multipliers that is important in terms of explaining movements in prices. Specifying both base money and the money multiplier in the same regression permits one to determine whether changes in prices are systematically related to changes in either the money multiplier, base money, both, or neither. The results from the first step, therefore, bear directly on the question of which money measure is most closely related to prices.

The results presented in this paper support the notion that base money is related to prices. Interpreting results that the money multiplier is significantly related to prices, however, requires additional identifying assumptions. One interpretation, of course, is that the categories of indebtedness included in the broader monetary aggregates are correlated with prices (despite the quantity theory restrictions). Alternatively, the money multiplier is a function of currency and excess reserves, which suggests that the money multiplier could serve as a signal of shocks to the demand for base money.

The second step examines the signalling content of the money multiplier. The issue is whether movements in currency and excess reserves account for most of the variation in this multiplier, particularly for those cases in which the multiplier is significantly related to prices. If movements in the money multiplier are largely due to movements in the additional categories of indebtedness, I interpret this as evidence that broader monetary aggregates are the money measures most highly correlated with prices. If, however, currency and excess reserves account for a substantial part of the variation in the money multiplier, such evidence indirectly supports the argument that the money multipliers signal shocks to the demand for base money and hence, that base money includes the categories of indebtedness most closely related to prices.

Three main results are presented in this paper. First, I directly test the maintained hypothesis, Are changes in base money significantly related to changes in inflation? The results support this hypothesis in every model specification. Second, I find that movements in the M1A money multiplier are significantly correlated with changes in the inflation rate. However, one can reject the hypothesis that changes in the M1 and M2 money multipliers help to explain changes in inflation. Third, the evidence suggests that currency and excess reserves account for a large proportion of the variation in the M1A money multiplier. In addition, currency and excess reserves account for a much smaller proportion of the variation in the M1 and M2 money multipliers. The evidence, therefore, suggests that the M1A money multiplier is a stronger signal of shocks to the demand for base money than either the M1 and M2 money multipliers.

The paper contributes to the literature by distinguishing between the explanatory power provided by base money and that provided by information unique to the broader monetary aggregates. Just because M2 is correlated with prices does not imply that all categories of indebtedness included in M2 are correlated with prices. Such a finding may simply reflect the strong correlation between base money and prices. In addition, when information is present in the money multipliers that helps to explain price movements, the paper examines which set of identifying restrictions seem most plausible.

The paper is organized as follows. I briefly review the theoretical and empirical literature in Section 1. Section 2 briefly develops an analytical solution to the inflation rate equation. The empirical results are presented in Section 3, testing for correlation between inflation and both base money and the money multiplier. The forecast error variance of the money multiplier is decomposed in Section 4 to gauge whether currency and excess reserves shocks account for much of the variation in the money multipliers. Section 5 summarizes the results.

1. Theory and Evidence

Sargent and Wallace (1982) examine the issue of which money is most closely correlated with prices in the context of a real bills regime versus quantity theory restrictions. They assume that the price level moves to clear the money market. Sargent and Wallace show that the notion of money corresponding to the sum of outside (base) money and some inside money would be more highly correlated with prices in a real bills regime. When they incorporate quantity theory restrictions, however, outside money is the measure more closely correlated with prices.[1] In the Sargent and Wallace model, either 100 percent reserve requirements or government monopoly in issuing small-denomination currency--the quantity theory restrictions--separate the money market and the private credit, or inside money, market. The upshot is that fluctuations in private credit do not affect the price level in a world with quantity theory restrictions. Without quantity theory restrictions, inside money and outside money are perfect substitutes, resulting in shocks to private credit affecting the price level the same as shocks to outside money.

Sargent and Wallace provide a theoretical framework against which the empirical work can be interpreted. It seems reasonable to characterize the government as having a monopoly in issuing small-denomination currency. Hence, one of Sargent and Wallace's quantity theory restrictions is present, and the theory would predict that base money is the money measure most highly correlated with prices.

The empirical evidence on this subject is somewhat mixed. Fama (1982), King and Plosser (1984), and Boschen and Talbot (1991) find evidence consistent with the predictions from a model with quantity theory restrictions; base money is most highly correlated with inflation. However, Hallman, Porter, and Small (1991) find evidence that a broader aggregate, namely M2, is most highly correlated with prices. Darby, Mascaro, and Marlow (1989) find that inflation equations using the M1A measure--M1 less other checkable deposits--show no signs of structural instability and result in lower prediction errors. At first glance, both the Hallman et al. and Darby et al. findings would seem to indicate that the Sargent and Wallace predictions are not supported in the data. Note that neither set of findings disentangles the base money part from the money multiplier part, leaving the question of whether it is base money or the additional categories of indebtedness that is the driving force behind the significant correlations.

As mentioned above, I first separate base money and the money multiplier, thus testing for the independent contributions from each source. For cases in which the money multiplier is significantly related to prices, I propose an alternative interpretation of such findings that is consistent with binding quantity theory restrictions. Specifically, recall that the money multiplier is a function of currency and excess reserves. Holding the quantity of base money constant, changes in currency and excess reserves are interpreted changes in the demand for these components of base money. Thus, the money multiplier is potentially a noisy signal of changes in the demand for base money. The novel approach taken in this paper is that one can examine the signal content of the money multipliers by estimating how much of the variation is due to innovations in currency or excess reserves. Provided the signal-to-noise ratio is high enough, the information present in the money multiplier is consistent with base money being the money measure most highly correlated with prices. In this interpretation, an inflation-rate model with Sargent-Wallace quantity theory restrictions is not necessarily inconsistent with the presence of any explanatory power present in the money multiplier.

2. A Quantity Theory Model of Inflation

In this section, I follow the outline used in Fama (1982), specifying a simple quantity theory-rational expectations model of money demand. Regardless of which money measure one uses, the researcher faces an identification problem; both supply shock and demand shock signals need to be extracted from one observation. In this setup, the growth rate of base money is used to identify supply shocks. The presumption is that base money is exogenous.[2]

In Fama's framework, one needs to specify a money demand equation in order to identify the demand shocks. In addition to the standard set of variables included in money demand specifications, the money multipliers for the broader aggregates are included. The rationale is that the broader monetary aggregates are the sum of (the log of) base money and the multiplier. Moreover, changes in either currency or excess reserves will result in changes in the money multiplier. Insofar as movements in currency and excess reserves are largely demand driven, the money multiplier is a noisy signal of money demand shocks. In this way, one can integrate any apparent information contained in the broader aggregates into a quantity theory framework in which base money is the measure that is most highly correlated with prices.

As alluded to above, one of the predictions coming from Sargent and Wallace is that the presence of quantity theory restrictions results in prices responding to changes in the supply of base money relative to the demand for base money. Formally, this model is expressed in growth rates as:

$$(1) \qquad \pi_t = \alpha(0)(H^s - H^d),$$

where π denotes the inflation rate; H is the rate of change in high-powered money, with superscripts s and d denoting supply and demand, respectively, and $\alpha(0) = 1 - \alpha_1 L - \ldots - \alpha_q L$, with α_j being a scalar for all j = 1, 2, ..., q; and L is the lag operator. The intuition behind equation (1) is simple: the price level moves to clear the market for high-powered money, and the effects of shocks to the money market are distributed over time. An equally valid interpretation of equation (1) is that the distributed lag terms represent an error-correction mechanism in which the inflation rate is approaching its long-run equilibrium value.

An identification problem exists because one must extract both the demand shock and supply signals from one value of base money. An attempt to solve this problem uses a two-step procedure to obtain separate demand and supply shock signals (see Fama (1982)). The strategy first specifies a money demand function and then substitutes the money demand relationship into an inflation rate equation.

In addition, Fama adopted a Fisherian rational expectations model of money demand in which current and future economic activity along with an opportunity cost variable were included in the specification. The monetary and real sectors are assumed to be dichotomized, implying that real activity is determined outside of the money market. Within the money market, the price level is the key endogenous variable. The interest rate variable is assumed to be exogenous, serving two functions in Fama's analysis--a forward-looking agent's rational forecast of future economic activity and the opportunity cost of holding money.

I extend Fama's model of money demand to include variables that proxy for shocks to the demand for base money. Formally, the rate of change in the demand for nominal money balances is represented as follows:

$$(2) \qquad H^d = a_1 S_t - a_2 R_t + a_3 \rho_t + a_4 z_t + a_5 \pi_t,$$

where S is the rate of change in the appropriate scale variable, R is the interest rate, ρ is a measure of reserve requirements, and z denotes shocks to the demand for base money. With an eye toward estimating this relationship, the variables specified here are stationary.[3] The coefficients, a_i, i = 1, 2, ..., 5, are assumed to be positive. For simplicity, I assume that $a_5 = 1$, implying that equation (2) is the demand function for real money balances. Equation (2) is Fama's money demand specification, adding the policy variable that directly affects the demand for base money and a term to capture shocks to the demand for base money.

Formally, substituting equation (2) into equation (1), one gets the following inflation rate expression:

$$(1') \quad \pi_t = \alpha(0)[H^s - (a_1 S_t - a_2 R_t + a_3 \rho_t + a_4 z_t)] + \alpha(1)\pi_t,$$

where $\alpha(1) = - \alpha_1 L - \alpha_2 L - \ldots - \alpha_q L$. In equation (1'), changes in the inflation rate are positively related to changes in the supply of base money and interest rate, while inflation is negatively related to the scale variable, reserve requirements, and money demand shocks. The dynamics are captured through the inclusion of contemporaneous and lagged values of the variables included inside the brackets and lagged values of the inflation rate.

3. Estimation

In this section, equation (1') is estimated. Before estimating the inflation rate equation, two measurement issues need to be resolved. First, one of the measures of money demand shocks used in this paper is the money multiplier.[4] Note that the money multiplier is represented as a function of the currency-to-deposit and excess-reserve-to-deposit ratio.[5] As households wish to hold more money balances, the currency-to-deposit ratio increases. Similarly, the excess-reserve-to-deposit ratio increases as depository institutions seek more liquidity in the form of reserves. For example, an increase in base money demand results in a decline in the money multiplier. In other words, if the money multiplier serves as a signal of money demand shocks, increases in the money multiplier will signal declines in base money demand. Hence, the money multiplier will be inversely related to the z variable in equation (2), and one would expect changes in the money multiplier to be positively related to changes in the inflation rate.

Second, the measure of reserve requirement ratios is the Reserve Step Index (RSI) constructed by Haslag and Hein.[6] As it is constructed, a decrease in reserve requirements, for instance, results in a higher value of RSI. Thus, with an inverse relationship between RSI and reserve requirement variable in equation (1'), one would expect RSI to be positively related to changes in the inflation rate.

The data are quarterly and span the period 1959:1-1991:2. In line with the money demand specification in percentage-change terms, the data are first differenced. Specifically, I take first differences of the log levels for the price level, high-powered money, the money multiplier, consumption (or real GDP), and take first differences of the levels for the interest rate and RSI.

Note that in equation (1'), the same number of lagged values are included in the specification for each right-hand-side variable. In other words, the theory posits that if there are seven lagged values of base money growth, there should be seven lagged values of the interest rate, inflation rate, etc. For parsimony, I estimate the versions of equation (1') with contemporaneous values of the exogenous variables and one lagged value of the inflation rate. This specification captures inflation rate dynamics in response to movements in the exogenous variables and thus, does not violate the basic intuition behind equation (1).

To account for the inflation rate dynamics proposed in equation (1), I include several lags of the inflation rate as right-hand-side variables. Lag length was determined using both the Akaike and the Schwartz criteria. The results obtained using the Akaike and Schwartz criteria are not substantially different from those in which only one lagged value of inflation is included in the regression. To save space, I only report the results with one lagged value of inflation included.

I estimate equation (1') using the 3-month Treasury bill rate as the interest rate variable, high-powered money as the sum of total reserves and currency held by the nonbank public, the GDP fixed-weight deflator as the price level, and real consumption spending as the scale variable.[7] The money multiplier is then the money supply divided by the quantity of high-powered money. Mankiw and Summers (1986) argue that consumption is a superior scale variable in money demand regressions. I use both consumption spending and real GDP growth as the scale variables.

Table 1 reports the results from estimating equation (1'). In Table 1, the M2, M1, and M1A money multipliers are used as signals of shocks to the demand for base money. The Newey-West procedure is applied to the variance-covariance matrix so that Aitken's Theorem holds. In addition, the evidence suggests that the estimated relationships are stable over the sample period.

Table 1 shows that the estimated coefficients generally have the anticipated sign. In particular, the coefficient on the contemporaneous value of base money growth is significant and positive in every model specification. The measure of changes in reserve requirements is significant in the M2 money multiplier equation but not when other money multipliers are specified. This is rather weak evidence supporting the hypothesis that changes in reserve requirements are important factors explaining movements in the demand for base money. The scale variable, especially consumption, and the interest rate are significantly related to changes in the inflation rate. Overall, the evidence is consistent with the notion that the model is appropriately identifying money supply and demand shocks.

What about the relationship between the money multipliers and the inflation rate? Table 1 also shows that there is information present in the growth rate of the M1A money multiplier that helps to explain movements in the inflation rate. (Since equation [a] is nested in equation [c] the misspecification bias may be inflating the standard errors and hence, explain why the coefficient on the M1A money multiplier is not significant in equation [a]). As such, the data seem to support the findings of Darby et al. regarding the close relationship between M1A and prices. The evidence also points out that neither the M1 nor the M2 money multiplier is significantly related to the inflation rate. Despite the somewhat fragile relationship, there is a need to examine the signalling content of the M1A money multiplier. The findings presented thus far are consistent with two hypothesis: demand deposits are highly correlated with prices, or the M1A money multiplier is a strong signal of shocks to the demand for base money.[8]

In the next section, I will attempt to address these anomalous interpretations. I estimate VARs, impose some identifying restrictions, and estimate the variance decompositions. The idea is that the various components of base money contribute to the variability of the money multipliers. If currency and excess reserves account for most of the forecast error variation in the M1A money multiplier and very little of the variation in the other money multipliers, this evidence would indirectly support the notion that M1A possesses a strong signal of base money demand shocks.

4. Analyzing the Relative Variances

The basic question here is, How much does variation in currency and excess reserves account for variation in the money multipliers? As is well known, the multiplier is a nonlinear function of its elementary components, currency and excess reserves, and other deposit categories. This makes carrying through a linear operator, such as the expectations operator, impossible. An alternative way is to use the VAR methodology, which makes decomposing the forecast error variance quite easy. The VAR methodology, which is a linear regression technology, does not perfectly match the nonlinear relationships among the money multiplier and its elementary components. Correspondingly, one should interpret these results as a first approximation of the percent of the forecast error variance explained by shocks to the elementary components of the money multipliers.

The evidence from the single-equation models of inflation suggests that information from the M1A money multiplier is useful in explaining movements in inflation. Identifying the contribution that each elementary component makes to the variability in the money multiplier is like extracting the signal of demand shocks from the noise. To illustrate: The supply of currency is elastic, implying that movements in the quantity of currency reflects shifts in the demand curve. Holding the supply of base money fixed, an increase in currency indicates an increase in the demand for base money. Similarly, I assume that changes in excess demand indicate increased bank demand for excess reserves. The demand for base money is positively related to revealed changes in the quantity of currency and the quantity of excess reserves.

Accordingly, if currency or excess reserves explain a large proportion of the variation in the M1A money multiplier, such evidence would be consistent with the notion that the significant relationship between changes in the money multiplier and inflation is chiefly due to innovations in the demand for base money. Alternatively, if demand deposits account for most of the variation in the money multiplier, the case is strengthened for interpreting the regression results as supporting a significant correlation between demand deposits and prices.

Both the M1 and M2 money multipliers are statistically insignificant, yet currency and excess reserves are present in these multipliers. To further support the "demand shock" interpretation, the M1 and M2 money multipliers would be noisier signals of currency demand shocks.

Formally, note that the M1A money multiplier is represented as:

$$(1+k)/(k+e+r_0),$$

where k is the currency-to-demand deposit ratio, e is the excess-reserve-to-demand deposit ratio, and r_0 is the reserve requirement ratio used as the base period in constructing the adjusted monetary base (see footnote 5). From this representation, one sees that the variability in k and e account for 100 percent of the variation in the M1A money multiplier. Thus, the question is whether currency, excess reserves, or demand deposits account for most of the variation in the multiplier.

I estimate the following VAR systems: [curr, er, dd, mm1a] and [curr, er, dep, mm1], where curr = currency, er = excess reserve, dep = total checkable deposits, dd = demand deposits, mm1 = M1 money, multiplier, and mm1a = M1A money multiplier. Each VAR system consists of the money multiplier and its elementary components. One should not interpret the VAR systems as economic models since important factors such as interest rates and income are omitted from the specification. Instead, the VAR and variance decomposition are a statistical technique. Presumably, changes in prices and income are responsible for movements in the elementary factors included in the money multiplier. Ultimately, it is proportion of the forecast error variance that innovations to currency and excess reserves explain which I am interested. (The estimated parameters from the VAR are available from the author upon request.)

One must make identifying assumptions on the contemporaneous relationships between the reduced-form errors from the VAR in order to calculate the variance decomposition. The structure chosen here is the familiar Choleski decomposition, which specifies a recursive structural model. The ordering for this recursive system is the same as the order in which the variables are listed; that is, [curr, er, dep, mm1], and [curr, er, dd, mm1a] for the models with the M1 and M1A money multipliers, respectively.

With currency listed first, the interpretation is that the reduced-form errors from the currency equation are structural disturbances. Listing excess reserves second implicitly specifies that the reduced-form errors from the excess reserves equation is a (contemporaneous) function of currency innovations plus a structural disturbance term. Next, the reduced-form errors from the demand deposit equation are related to innovations in currency and excess reserves. Lastly, errors from the reduced-form model of M1A money multiplier are specified as functions of innovations to currency, excess reserves, and demand deposits.

In the case of the M2 money multiplier, the multiplier is a function of small-time accounts, money market mutual funds, and savings accounts, each divided by total checkable deposits. The strategy taken in this paper is to see how much of the forecast error variance in the M2 money multiplier is due to innovations in the currency-to-checkable deposit ratio and the excess-reserve-to-ratio deposit. Clearly, the variance decomposition represents the maximum proportion of the forecast error variance that could be due to innovations in currency and excess reserves. If the proportion of the variance due to the k- and e-ratio is large, then further investigation would be warranted.

The decompositions for 5-, 10-, and 20-step-ahead forecasts error variances are reported in Table 2 for the M1A, M1, and M2 models. The most interesting finding in Table 2 is that innovations in currency account for approximately 40 percent of the variation in the k-ratio, while innovations in excess reserves account for over 80 percent of the variation in the e-ratio. Together, innovations in currency and excess reserves would appear to account for a substantial portion of the forecast error variance in the M1A money multiplier.

To adequately judge the signal content of base money demand shocks in the M1A money multiplier, it is necessary to see how much of the variation in the M1 and M2 money multipliers is due to currency and excess reserves. Table 2 shows that innovations to currency account for 16 percent of the variation in the k-ratio in the M1 money multiplier, and innovations in the e-ratio account for 30 percent of the variation in the e-ratio. Note that M1 also includes other checkable deposits in the denominator of the k- and e-ratios. Total checkable deposits--the sum of demand deposits plus other checkable deposits--differs from demand deposits after the enactment of the Monetary Control Act of 1980. The evidence that innovations in currency and excess reserves explain a much smaller proportion of the forecast error variance probably reflects the added noise coming from the other checkable deposit category. In short, the k- and e-ratios in the M1 money multiplier possess a weaker signal content of base money demand shocks relative to the M1A money multiplier.

Table 2 also shows that currency and excess reserves did not account for much of the variation in the M2 money multiplier. Currency-to-deposit innovations account for only 3 percent of the forecast error variance and excess reserve-to-deposit ratios account for only 4.5 percent of the forecast error variance. Innovations in the k- and e-ratios represent the maximum proportion of the forecast error variance that could be attributed to innovations in currency and excess reserves. Clearly, the usefulness of the M2 money multiplier as a signal of shocks to the demand for currency and excess reserves is limited relative to the M1A money multiplier.

Thus, the evidence suggests that the M1A money multiplier carried the strongest signal of shocks to the demand for currency and excess reserves. This evidence is consistent with the notion that the M1A money multiplier is significantly correlated with inflation because it reflects movements in the demand for base money.[9] In this interpretation, the presence of information unique to the broader monetary aggregates does not necessarily repudiate the predictions coming from Sargent and Wallace's model explaining correlations between different money measures and prices. Instead, shocks to the demand for base money would appear capable of explaining the significant relationship between the M1A money multiplier and prices.

5. Summary and Conclusion

This paper examines the relative explanatory power of base money and the money multipliers in an inflation rate setting. The broad question is, Which measure of money is most closely related to prices? This paper's main contribution is in addressing the additional identification problem facing the researcher who finds a significant relationship between the money multiplier and prices; in short, such a finding does not imply that additional categories of indebtedness are correlated with prices. Indeed, both currency and excess reserves--components of base money--affect the money multiplier. This paper examines the quality of the money as a signal of base money demand shocks.

As a first pass, the approach taken here distinguishes between the contribution from base money and the money multiplier in terms of significantly explaining movements in the inflation rate. The regressions are straightforward extensions of those estimated by Fama. Movements in the quantity of base money are significantly correlated with price movements. The evidence further shows that the M1A money multiplier is significantly related to changes in inflation but that the M1 and M2 money multipliers are not.

The next step is to indirectly identify whether the explanatory power in the M1A money multiplier is due to base demand shocks or to demand deposits being a close substitute for base money. I estimate how much of the variation in the money multipliers is due to innovations in currency and excess reserves. Variance decompositions indicate that innovations to currency and excess reserves explain a substantial proportion of the forecast error variance in the M1A money multiplier, indeed accounting for much more of variation than in the M1A money multiplier than in either the M1 or M2 money multipliers. This result suggests that the M1A is a stronger signal of base money demand shocks. As such, the evidence strengthens the case that the money multiplier is significantly related to inflation because is it correlated with innovations to base money demand.

These findings suggest that the predictions coming from Sargent and Wallace's model are not refuted when one finds that there are significant relationships between inflation and the broader monetary aggregates. Shocks to the demand for base money picked up by the money multiplier can quite reasonably account for the statistical relationship between money multipliers and the inflation rate. As such, the evidence lends support to the Sargent and Wallace claim that base money is the money measure most closely related to prices when quantity theory restrictions are present.

Footnotes

In Sargent and Wallace, quantity theory restrictions can take on either of two equivalent forms: the government monopoly in issuing small-denomination currency or a 100 percent reserve requirement.

Sargent (1987) makes a slightly stronger claim (see sec.2, p. 138) about the alternative money measures and their correlations with prices. With strong quantity theory restrictions like the 100 percent reserve requirement condition, one would see smaller fluctuations in outside money by limiting those fluctuations coming from credit markets; that is, the M2 aggregate would be synonymous with base money.

It appears that sometimes the price level is the <u>only</u> thing that the Federal Reserve looks at when setting monetary policy. The assumption that the base money is exogenous to the price level seems reasonable when one considers that price data are released with a lag. In addition, the Fed does not seem to adjust base money supply contemporaneous with movements in the price level. Instead, money supply would respond when a higher inflation rate trend has emerged. This would be modelled as money supply responding to lagged values of the inflation rate, which would not greatly affect the interpretation of these results.

3 There is some question about whether the inflation rate is stationary. The first five values of the autocorrelation function for the percentage-change in the GNP fixed-weight deflator are 1.0, 0.84, 0.79, 0.76, 0.73. Yet, the results from unit-root tests do not reject the null that a unit roots is present. In the subsequent empirical work, I treat the inflation rate as a stationary series.

4 The money multiplier is probably correlated with the interest rate variable. With the interest rate included in the money demand specification, movements in the money multiplier that are not correlated with interest rate developments will reflect changes in agents' demand for base money.

5 See Neumann (1983) for an analytic solution of the M2 money multiplier. When using an adjusted monetary base measure, changes in reserve requirements--the required reserve-to-deposit ratio--do not result in changes in the money multiplier.

6 See Haslag and Hein (1992) for a more detailed description of the methodology used to construct RSI.

7 Hallman et al. derive their inflation rate equation from the equation of exchange. In their derivation, nominal GNP is

separated into its real and price level components using the implicit price deflator. Their analysis proceeds with this measure of the inflation rate.

8 A direct answer to the question is to respecify the inflation rate equation, adding (the growth rate of) demand deposits as an explanatory variable. Changes in demand deposits are highly correlated with changes in consumption, resulting in the standard errors being inflated. The results from this specification indicate that none of the explanatory variables are significantly correlated with changes in the inflation rate.

9 Cox and Rosenblum (1989) show the sizable changes in the composition of M2 and M1 in the 1980s. Most notable was the shift from other checkable deposits to non-M1 funds. Such sharp changes in the composition will alter the currency-to-deposit ratio or excess-reserve-to-deposit ratio without representing increases the demand for either currency or excess reserves and thus, explaining why M1's signalling value fell.

References

Boschen, John F. and Kathleen E. Talbot, (1991), "Monetary Base Growth, Deposit Growth, and Inflation in the Postwar United States," Journal of Business, 64(3), July, p. 313-37.

Cox, W. Michael and Harvey Rosenblum, (1989), "Money and Inflation in a Deregulated Financial Environment: An Overview," Federal Reserve Bank of Dallas Economic Review, May, p.1-20.

Darby, Michael R., Angelo R. Mascaro, and Michael L. Marlow, (1989), "The Empirical Reliability of Monetary Aggregates as Indicators: 1983-1987," Economic Inquiry, 27(4), October, p. 555-85.

Fama, Eugene F. (1982), "Inflation, Output, and Money," Journal of Business, 55(2), p. 201-31.

Hallman, Jeffrey J., Richard D. Porter, and David H. Small, (1991), "Is the Price Level Tied to the M2 Monetary Aggregate in the Long Run?" American Economic Review, 81(4), p. 841-58.

Haslag, Joseph H. and Scott E. Hein, (1992), "Constructing an Alternative Measure of Changes in Reserve Requirement Ratios, unpublished mimeo.

King, Robert G. and Charles I. Plosser, (1984), "Money, Credit, and Prices in a Real Business Cycle," American Economic Review, 74(2), June, 363-80.

Mankiw, N. Gregory and Lawrence H. Summers, (1986), "Money Demand and the Effects of Fiscal Policies, Journal of Money, Credit, and Banking, 18(4), November, p. 415-29.

Neumann, Manfred J.M., (1983), "The Indicator Properties of the St. Louis Monetary Base," Journal of Monetary Economics, 12, p. 595-603.

Sargent, Thomas J., (1987) Dynamic Macroeconomic Theory, Cambridge: Harvard University Press.

------ and Neil Wallace, (1982), "The Real-Bills Doctrine versus the Quantity Theory: A Reconsideration," Journal of Political Economy, 90(6), October, p. 1212-36.

Table 1

Results from Inflation Regressions
(Sample period 1959:2 - 1991:2)

M2:

(a)
$$\pi_t = \underset{(0.001)}{0.002} + \underset{(0.03)}{0.11^*} H_t - \underset{(0.04)}{0.10^*} C_t + \underset{(0.0003)}{0.001^*} R_t$$
$$+ \underset{(0.0002)}{0.0004^*} RSI_t + \underset{(0.03)}{0.02} mm2_t + \underset{(0.05)}{0.76^*} \pi_{t-1}$$

$\bar{R}^2 = 0.76$ S.E.E. = 0.003

(b)
$$\pi_t = \underset{(0.001)}{0.001} + \underset{(0.03)}{0.11^*} H_t - \underset{(0.04)}{0.06} Y_t + \underset{(0.0003)}{0.001^*} R_t$$
$$+ \underset{(0.0002)}{0.0005^*} RSI_t + \underset{(0.03)}{0.005} mm2_t + \underset{(0.05)}{0.78^*} \pi_{t-1}$$

$\bar{R}^2 = 0.76$ S.E.E. = 0.003

(c)
$$\pi_t = \underset{(0.001)}{0.001} + \underset{(0.03)}{0.11^*} H_t + \underset{(0.05)}{0.003} H_{t-1} - \underset{(0.04)}{0.10^*} C_t + \underset{(0.0003)}{0.001^*} R_t$$
$$+ \underset{(0.0004)}{0.0006^*} R_{t-1} + \underset{(0.0002)}{0.0005^*} RSI_t + \underset{(0.035)}{0.05} mm2_t + \underset{(0.05)}{0.75^*} \pi_{t-1}$$

$\bar{R}^2 = 0.77$ S.E.E. = 0.003

Table 1 (Cont.)

Results from Inflation Regressions
(Sample period 1959:2 - 1991:2)

M1:

(a)
$$\pi_t = \underset{(0.001)}{0.002} + \underset{(0.04)}{0.11^*} H_t - \underset{(0.04)}{0.10^*} C_t + \underset{(0.0003)}{0.0009^*} R_t + \underset{(0.0003)}{0.0004} RSI_t + \underset{(0.03)}{0.02} mm1_t + \underset{(0.05)}{0.76^*} \pi_{t-1}$$

$\bar{R}^2 = 0.76$ S.E.E. = 0.003

(b)
$$\pi_t = \underset{(0.001)}{0.001} + \underset{(0.04)}{0.11^*} H_t - \underset{(0.03)}{0.06^*} Y_t + \underset{(0.0003)}{0.001^*} R_t + \underset{(0.0003)}{0.0005} RSI_t + \underset{(0.03)}{0.006} mm1_t + \underset{(0.05)}{0.78^*} \pi_{t-1}$$

$\bar{R}^2 = 0.76$ S.E.E. = 0.003

(c)
$$\pi_t = \underset{(0.001)}{0.001} + \underset{(0.05)}{0.13^*} H_t + \underset{(0.05)}{0.004} H_{t-1} - \underset{(0.04)}{0.10^*} C_t + \underset{(0.0003)}{0.001^*} R_t + \underset{(0.0004)}{0.0006} R_{t-1} + \underset{(0.0003)}{0.0005} RSI_t + \underset{(0.04)}{0.05} mm1_t + \underset{(0.05)}{0.75^*} \pi_{t-1}$$

$\bar{R}^2 = 0.77$ S.E.E. = 0.003

Table 1 (Cont.)

Results from Inflation Regressions
(Sample period 1959:2 - 1991:2)

M1A:

(a)
$$\pi_t = \underset{(0.001)}{0.002} + \underset{(0.04)}{0.12^*} H_t - \underset{(0.05)}{0.12^*} C_t + \underset{(0.0003)}{0.0009^*} R_t + \underset{(0.0004)}{0.0003} RSI_t + \underset{(0.03)}{0.04} mm1a_t + \underset{(0.05)}{0.78^*} \pi_{t-1}$$

$\bar{R}^2 = 0.78$ S.E.E. = 0.003

(b)
$$\pi_t = \underset{(0.001)}{0.001} + \underset{(0.04)}{0.11^*} H_t - \underset{(0.03)}{0.06^*} Y_t + \underset{(0.0003)}{0.0009^*} R_t + \underset{(0.0004)}{0.0002} RSI_t + \underset{(0.03)}{0.02} mm1a_t + \underset{(0.05)}{0.80^*} \pi_{t-1}$$

$\bar{R}^2 = 0.77$ S.E.E. = 0.003

(c)
$$\pi_t = \underset{(0.001)}{0.001} + \underset{(0.05)}{0.13^*} H_t + \underset{(0.05)}{0.012} H_{t-1} - \underset{(0.04)}{0.11^*} C_t + \underset{(0.0003)}{0.0008^*} R_t + \underset{(0.0004)}{0.0008^*} R_{t-1} + \underset{(0.0004)}{0.0004} RSI_t + \underset{(0.04)}{0.08^*} mm1a_t + \underset{(0.05)}{0.79^*} \pi_{t-1}$$

$\bar{R}^2 = 0.77$ S.E.E. = 0.003

Legend: * indicates that the coefficients is significant at the 5% level

Table 2

Forecast Error Variance Decompositions

Variable	Proportion of Forecast Error Variance 5-Step	10-Step	20-Step
M1A:			
k-ratio: Curr	18.3	26.4	40.6
e-ratio: Excess Res	94.1	91.0	85.9
M1:			
k-ratio: Curr	18.7	18.8	16.4
e-ratio: Excess Res	47.7	36.7	31.4
M2:			
k-ratio	2.9	2.1	3.2
e-ratio	0.3	0.3	4.5

RESEARCH PAPERS OF THE RESEARCH DEPARTMENT
FEDERAL RESERVE BANK OF DALLAS

Available, at no charge, from the Research Department
Federal Reserve Bank of Dallas, Station K
Dallas, Texas 75222

9201 Are Deep Recessions Followed by Strong Recoveries? (Mark A. Wynne and Nathan S. Balke)

9202 The Case of the "Missing M2" (John V. Duca)

9203 Immigrant Links to the Home Country: Implications for Trade, Welfare and Factor Rewards (David M. Gould)

9204 Does Aggregate Output Have a Unit Root? (Mark A. Wynne)

9205 Inflation and Its Variability: A Note (Kenneth M. Emery)

9206 Budget Constrained Frontier Measures of Fiscal Equality and Efficiency in Schooling (Shawna Grosskopf, Kathy Hayes, Lori Taylor, William Weber)

9207 The Effects of Credit Availability, Nonbank Competition, and Tax Reform on Bank Consumer Lending (John V. Duca and Bonnie Garrett)

9208 On the Future Erosion of the North American Free Trade Agreement (William C. Gruben)

9209 Threshold Cointegration (Nathan S. Balke and Thomas B. Fomby)

9210 Cointegration and Tests of a Classical Model of Inflation in Argentina, Bolivia, Brazil, Mexico, and Peru (Raúl Anibal Feliz and John H. Welch)

9211 Nominal Feedback Rules for Monetary Policy: Some Comments (Evan F. Koenig)

9212 The Analysis of Fiscal Policy in Neoclassical Models[1] (Mark Wynne)

9213 Measuring the Value of School Quality (Lori Taylor)

9214 Forecasting Turning Points: Is a Two-State Characterization of the Business Cycle Appropriate? (Kenneth M. Emery & Evan F. Koenig)

9215 Energy Security: A Comparison of Protectionist Policies (Mine K. Yücel and Carol Dahl)

9216 An Analysis of the Impact of Two Fiscal Policies on the Behavior of a Dynamic Asset Market (Gregory W. Huffman)

9301 Human Capital Externalities, Trade, and Economic Growth (David Gould and Roy J. Ruffin)

9302 The New Face of Latin America: Financial Flows, Markets, and Institutions in the 1990s (John Welch)

9303 A General Two Sector Model of Endogenous Growth with Human and Physical Capital (Eric Bond, Ping Wang, and Chong K. Yip)

9304 The Political Economy of School Reform (S. Grosskopf, K. Hayes, L. Taylor, and W. Weber)

9305 Money, Output, and Income Velocity (Theodore Palivos and Ping Wang)

9306 Constructing an Alternative Measure of Changes in Reserve Requirement Ratios (Joseph H. Haslag and Scott E. Hein)

9307 Money Demand and Relative Prices During Episodes of Hyperinflation (Ellis W. Tallman and Ping Wang)

9308 On Quantity Theory Restrictions and the Signalling Value of the Money Multiplier (Joseph Haslag)

9309 The Algebra of Price Stability (Nathan S. Balke and Kenneth M. Emery)