NBER WORKING PAPER SERIES

MONEY DEMAND PREDICTABILITY

V. Vance Roley

Working Paper No. 1580

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 1985

The research reported here is part of the NBER's research program in Financial Markets and Monetary Economics.

NBER Working Paper #1580
March 1985

Money Demand Predictability

ABSTRACT

The performance of empirical money demand equations over the past decade raises serious questions about money demand predictability. A variety of specifications were presented to explain past episodes of apparent money demand instability, but their success in predicting future money demand is limited in most instances. In particular, the unprecedented decline in the velocity of M1 during 1982 and 1983 was not captured fully by any of the previously-modified conventional specifications. This paper evaluates a variety of the approaches and specifications proposed in previous money demand studies to explain the behavior of the narrowly defined money stock from the mid 1970's through 1983. The empirical results cast doubt on the appropriateness of the conventional money demand specification in both the pre- and post- 1974 periods.

V. Vance Roley
Department of Finance DJ-10
Graduate School of Business Administration
University of Washington
Seattle, WA 98195
(206) 545-7476

Revised
December 1984

MONEY DEMAND PREDICTABILITY

V. Vance Roley*

The considerable amount of research devoted to the demand for money is justified by its fundamental role in the Federal Reserve's formulation and implementation of monetary policy, and the potential impact of monetary policy on both economic activity and inflation.[1/] As a whole, however, the performance of empirical money demand equations over the past decade raises serious questions about its predictability. A vast majority of the specifications presented to explain past episodes of apparent money demand instability achieved only limited success in predicting future money demand.

Empirical research on money demand prior to the mid 1970s, culminating in Goldfeld's (1973) exhaustive study, suggested that the demand for money exhibited a stable relationship with a small set of macroeconomic variables. As noted by Gordon (1984a), however, Goldfeld's empirical relationships were estimated using data generated from the relatively tranquil economic period beginning in the early 1950s and ending in the early 1970s. This period is in sharp contrast to the subsequent period characterized by supply shocks, high and volatile inflation, and large and erratic swings in economic activity. The Federal Reserve also began to formalize the use of the narrowly defined money stock as an intermediate target of monetary policy in the early 1970s. Moreover, the Federal Reserve adopted different monetary control procedures in the October 1979-October 1982 period. Thus, empirical money demand equations from the pre-1974 period might not be expected to describe the latter period with the same precision.

The episode of the "missing money" that occurred in the mid 1970s (e.g., Enzler, Johnson, and Paulus 1976 and Goldfeld 1976) in fact indicated that conventional money demand equations systematically overpredicted actual money balances. As noted by Judd and Scadding (1982), this in turn led to two strands of research on money demand. First, to take into account the financial innovation and deregulation since the early 1970's, a number of researchers modified existing money demand specifications. In particular, money demand equations were selectively modified to reflect commercial banks' authority to issue savings accounts to state and municipal governments in November 1974 and to small businesses in November 1975, the growth of negotiable order of withdrawal (NOW) accounts in New England, accelerated use of cash management practices by businesses along with more intensive use of overnight repurchase agreements (RPs) and overnight Caribbean Eurodollar deposits, and the rapid gains in money market mutual funds (MMMFs). To capture the effects of these institutional events, variables such as interest-rate ratchets (e.g., Goldfeld 1976 and Quick and Paulus 1977), time trends (e.g., Lieberman 1977), brokerage fee proxies (e.g., Porter and Offenbacher 1982), and debits (e.g., Enzler, Johnson, and Paulus 1976 and Goldfeld 1976) have been included as explanatory variables. Some studies additionally included dummy and other shift variables to represent the effects of deregulation and innovation on the narrowly defined money stock (e.g., Hafer and Hein 1982a and Cagan 1983). Other researchers added various financial instruments such as RPs (Garcia and Pak 1979, Wenninger and Sivesand 1979, and Tinsley, Garrett, and Friar

1981), Eurodollar deposits (e.g., Simpson and Porter 1980 and Cagan 1983), and money market mutual funds (e.g., Wenninger, Radecki, and Hammond 1981) either to the existing definition of narrowly defined money or as a determinant of the shift.

Second, the experience during the mid to late 1970s led others to reevaluate conventional money demand specifications. Judd and Scadding (1981) and Carr and Darby (1981) presented empirical models emphasizing the role of money supply shocks. Clower and Howitt (1978), Akerlof (1979), Akerlof and Milbourne (1980), and Santomero and Seater (1981), among others, presented theoretical models as alternatives to conventional transactions approaches. In addition, Laidler (1980), Cooley and LeRoy (1981), Goodfriend (1983), and Gordon (1984a, 1984b) raised important issues concerning the econometric properties of estimated money demand equations, casting serious doubt on the robustness of any past empirical specification.

While many of the above studies presented money demand equations capable of explaining the behavior of the mid to late 1970s, the experience during the early 1980s has once again raised questions about money demand predictability. The unprecedented decline in the velocity of M1 during 1982 and 1983 was not captured fully by any of the previously-modified conventional specifications. Moreover, the apparent "nonshift" in 1981 despite the introduction of nationwide NOWs (e.g., Bennett 1982 and Cagan 1983) was puzzling to many. Studies focusing on the recent period -- including those by Judd and McElhattan (1983), Tatom (1983), Cagan (1983), Hamburger (1983), Hafer (1984), Gordon (1984a), and Simpson (1984) -- have not reached a consensus concerning the underlying factors accounting for the behavior of M1.

The purpose of this paper is to evaluate a variety of the approaches and specifications proposed in previous money demand studies to explain the behavior of the narrowly defined money stock from the mid 1970s through 1983. In the process, fundamental econometric issues relating to both pre- and post-1974 studies as well as issues relating to proposed modifications to conventional money demand specifications are investigated. In an attempt to further isolate the sources of the alleged shifts, the sectoral demands by households and businesses also are examined.

In the first section of this paper, estimation and simulation results from conventional log-levels specifications are summarized. In the second section, the conventional partial-adjustment specification is initially examined using first-differenced data from usual sources. It is then further tested using alternative data sources for the narrowly defined money stock and the short-term interest rate to evaluate the consequences of temporal aggregation. Other specifications, including that proposed by Hamburger (1977), are considered in the third section. In the fourth section, estimation and simulation results of sectoral demands for M1 are presented. The interest elasticity of M1, an important factor in explanations of the 1982-83 experience in studies by Brayton, Farr, and Porter (1983), Cagan (1983), and Hamburger (1983), is examined more closely in the fifth section. In the final section, the implications of the results presented here for both the 1982-83 velocity decline and monetary policy are considered.

1. CONVENTIONAL MONEY DEMAND SPECIFICATIONS

In this section, estimation and simulation results of conventional log-levels money demand specifications are presented. Preceding these results, the model and data are briefly reviewed. The empirical results presented in this section provide benchmarks for comparisons in subsequent sections.

A. Specification and Data

The traditional starting point in most money demand studies, and that taken here, is the Baumol (1952)-Tobin (1956) model of the transactions demand for money. Converting the usual square-root expression into real magnitudes, substituting real GNP for the volume of transactions, and taking natural logarithms yields the familiar expression

$$m_t = \beta_0 + \beta_1 \cdot r_t + \beta_2 \cdot y_t, \tag{1}$$

where m_t is the narrowly defined money stock, M1, deflated by the price level; r_t is the nominal interest rate on the riskless asset; y_t is real GNP (all in natural logarithms); and β_0, β_1, and β_2 are parameters. The parameters are related to the transactions model by the constraints

$$\begin{aligned} \beta_0 &= (1/2)\ln(b) - (1/2)\ln(2), \\ \beta_1 &= -1/2, \\ \beta_2 &= 1/2, \end{aligned} \tag{2}$$

where b is the real brokerage charge in converting the riskless asset into money balances.

The conventional transactions model has been relaxed in a number of ways to reflect other factors not captured because of its inherent simplicity. Appealing to portfolio motives, for example, Hamburger (1977, 1983) included yields on assets such as long-term bonds and equities.[2/] The inclusion of these variables could alternatively be justified in the stochastic version of the transactions model presented by Buiter and Armstrong (1978), with the additional assumption of imperfect asset substitutability.

Again based primarily on portfolio motives, B. Friedman (1978) recently emphasized the possible influence of wealth on money demand.[3/] Laidler (1977, 1980) additionally suggested, based on the results of Cagan (1956) and Goldfeld (1973), among others, that expected inflation is another direct determinant of money demand apart from its indirect effect through nominal interest rates. To better represent the own rate of return on transactions balances, Barro and Santomero (1972) and Klein (1974) also relax the zero own-yield restriction by constructing and using measures of the demand deposit rate. Finally, as noted in the introductory section, a variety of additional variables have been considered in response to the economic events of the 1970s and early 1980s.

Allowing for the possible inclusion of at least some of these additional factors, and following the usual convention that equation (1) represents desired money balances, equation (1) may be rewritten as

$$m_t^* = \beta_0 + \beta_1 \cdot r_t + \beta_2 \cdot y_t + \underline{x}_t \underline{\beta} \qquad (3)$$

where m_t^* denotes desired real money balances, $\underline{x}_t$ is a row vector of other possible explanatory variables, and $\underline{\beta}$ is a column vector of parameters. To further permit the possibility of less-than-immediate adjustment to desired money holdings, the short-run demand for money is typically described by either the real (e.g., Chow 1966 and Goldfeld 1973) or nominal (e.g., Goldfeld 1976) partial adjustment models

$$m_t - m_{t-1} = \theta(m_t^* - m_{t-1}), \qquad (4)$$

$$\ln M_t - \ln M_{t-1} = \theta(\ln M_t^* - \ln M_{t-1}), \qquad (5)$$

where M_t is nominal M1; $\ln M_t^* = m_t + p_t$; p_t is the natural logarithm of the price level; and θ is the partial adjustment parameter. Combining the nominal adjustment model (5) with desired money holdings (3), the short-run demand for money becomes

$$m_t = \theta(\beta_0 + \beta_1 \cdot r_t + \beta_2 \cdot y_t + \underline{x}_t \underline{\beta}) + (1-\theta)m_{t-1} + (1-\theta)(p_{t-1}-p_t). \qquad (6)$$

The real adjustment model only differs from (6) in that the last term -- which approximately equals the negative of actual inflation -- has a coefficient equal to zero. However, if actual inflation serves as a proxy for expected inflation, a term such as $p_{t-1}-p_t$ may nevertheless appear as a statistically significant determinant in the real adjustment model.

Despite the widespread adoption of partial adjustment models to specify money demand, their use has at times been questioned. Feige (1967) claimed that the partial adjustment specification merely reflects individuals' adaptive estimates of permanent income. More recently, Goodfriend (1983) attacked the theoretical rationale used in applying the partial adjustment model to money demand and presented an alternative explanation for the statistical significance of lagged money in money demand regressions. While the initial results reported here employ the partial adjustment specification (6), it is considered in more detail in the next section.

Seasonally-adjusted quarterly data are used to estimate both real and nominal versions of (6), beginning in 1959:Q1 and ending in 1983:Q4. With current definitions of the monetary aggregates, the Federal Reserve's M1 series starts in 1959. M1 data are initially employed as quarterly averages. As mentioned previously, real GNP is taken as the transactions variable, and the price level is represented by the GNP deflator.[4/] To represent the opportunity cost of holding transactions balances, quarterly averages of the 3-month Treasury bill yield and the 6-month commercial paper rate are alternatively used, along with the savings deposit rate.[5/] The total value of equities, as of the end of the quarter, is used as the wealth variable.[6/] While this variable excludes important components of wealth, it most likely reflects a significant portion of the variation in alternative measures of wealth as well as returns on equities.

B. Estimation and Simulation Results

Estimation results for several permutations of the conventional log-levels money demand specification are reported in Table 1. Estimation results are presented for two subsamples. The initial observation in the first subsample reflects the current starting date of the M1 series, taking lagged money values and the serial correlation correction procedure into account. The sample is divided at the end of 1973, prior to the onset of the alleged missing money episode. The second subsample spans the 1974:Q1-1983:Q4 period.

The usual practice of simply adding subsequent years of data to earlier estimation periods is not followed here. Given the different characteristics of the post-1974 economy, as noted previously, pooling pre- and post-1974 data may bias the estimation results for both periods. Moreover, the Federal Reserve's greater commitment to monetary targeting during the 1970s and particularly the change in monetary control procedures from October 1979 to October 1982 would seem to provide classic examples for the potential applicability of the Lucas (1976) critique.[7/]

As is also apparent in the table, a serial correlation correction procedure is used when significant serial correlation is evident. Following Fackler and McMillin (1983), the Hildreth-Lu technique is used to avoid potential problems with the Cochrane-Orcutt procedure.[8/] Other researchers (e.g., Laumas and Spencer 1980 and Hafer and Hein 1982a, 1982b) have used

Hatanaka's (1974) efficient estimator of ρ with only slight differences in the estimation results.

Equations (1.1) through (1.4) use the commercial paper rate as the short-term market interest rate. In equation (1.1), the wealth variable is included along with the change in the logarithm of the price level. Equation (1.2) only differs from (1.1) in that the wealth variable is deleted. Equations (1.3) and (1.4) are similar to (1.1) and (1.2), respectively, except that the price variable is constrained to conform to the nominal adjustment model (6). These same four specifications are repeated in equations (1.5) through (1.8), where the Treasury bill yield replaces the commercial paper rate. Again, both of these yields are calculated as quarterly averages. A comparison of the performances of these yields is included in Table 1 because of the reliance placed on end-of-quarter Treasury bill yield data in subsequent sections, which departs from the traditional use of the commercial paper rate. The greater availability of end-of-quarter Treasury bill yield data from public sources dictated this choice.

The results reported for equations (1.1) through (1.8) exhibit several characteristics. First, when included, the wealth variable is statistically significant at the 5 percent level with the anticipated sign. Second, the estimated elasticities of both the commercial paper rate and the Treasury bill yield are statistically significant, with the former exhibiting slightly larger absolute values. Other estimated coefficients are relatively unaffected by the choice of the short-term interest rate. Third, the estimated coefficient on the price term, in comparison to the coefficient on lagged real money balances, indicates that the nominal adjustment model cannot be rejected at low significance levels. Fourth, the serial correlation correction procedure yields significant estimates of ρ, perhaps indicating misspecification. Finally, despite the autocorrelation correction in addition to the presence of the lagged dependent variable, serial correlation in the estimated equations persists, especially when wealth is excluded. These statistical properties could be symptomatic of either problems with the data (e.g., Goodfriend 1983) or more basic flaws in the specifications.

On the bottom half of Table 1, the same eight specifications are estimated over the 1974:Q1 - 1983:Q4 period. Again, several features of these results are noteworthy. First, the wealth variable is uniformly insignificant in this latter period. Second, the estimated elasticity of the short-term market rate is statistically significant at the 10 percent level in only the most restrictive specifications, (1.12) and (1.16). Third, the results suggest that serial correlation correction is not needed. Fourth, the nominal adjustment model again cannot be rejected at low significance levels, but the speed of adjustment is implausibly slow. Moreover, the significantly larger coefficient estimate on lagged money in the 1974:Q1 - 1983:Q4 period seems contrary to assertions about greater cash management and overall economization on transactions balances during this period.

To further examine the properties of conventional log-levels specifications, selected equations in Table 1 are simulated over the 1974:Q1 - 1983:Q4 and 1982:Q1 - 1983:Q4 periods. Following Hein (1980), post-sample static simulation results are reported. In these simulations, lagged real money balances equal historical values. This methodology is selected mainly for diagnostic reasons. In particular, it is much more straightforward to distinguish between permanent level, increasing, and transitory shifts using this approach. Moreover, dynamic simulation errors are merely combinations of past static simulation errors.

Post-sample static simulation results for the 1974:Q1 - 1983:Q4 period using equations (1.3) and (1.7) -- the nominal adjustment specification with alternative market interest rates -- are reported in the first four columns of Table 2. Simulation errors are reported as both real dollar amounts and percentages. Both of these money demand equations exhibit the downward shift usually found in similar specifications starting in 1975 and continuing throughout the 1970s. In particular, actual real money balances are on average 1.9 and 1.7 percent below predicted levels for equations (1.3) and (1.7), respectively, in the period spanning 1974:Q1 - 1981:Q4. For 1982-83, the simulation results for equations (1.3) and (1.7) continue to reflect a downward shift in comparison to the pre-1974 period, but the mean errors of -2.6 and -2.3 percent, respectively, are smaller in absolute value than those in the preceding two years.9/ These results suggest that concern about the 1982-83 episode may be misdirected. Instead, the relevant puzzle may concern a temporary downward shift in 1980 and 1981, where mean errors averaged -3.3 and -3.0 percent for equations (1.3) and (1.7), respectively.

Simulation results for equations (1.11) and (1.15) -- reestimated over the 1974:Q1 - 1981:Q4 period -- are presented in the last two rows of the table. On average, the prediction errors are positive, but they amount to only $1.6b and $1.7b, respectively, or percentage errors of about 0.7 percent in each case.10/ Furthermore, the largest error -- occurring in 1982:Q4 -- is only about 2½ times the within-sample root-mean-square error. The estimated equations which generated these results may, nevertheless, be criticized on the basis of some of their properties. In addition to those mentioned previously, the only statistically significant coefficient in the nominal-adjustment forecasting equations is on lagged money, and it is not significantly different from unity.

2. FURTHER EXAMINATION OF THE PARTIAL ADJUSTMENT MODEL

The results in the previous section cast doubt on the robustness of conventional money demand equations. As noted, conventional log-levels relationships estimated with data ending before 1974 are consistent with the missing money hypothesis. Using data beginning in 1974, conventional money demand equations exhibit implausibly slow adjustment to desired money balances, and potential determinants apart from lagged money are typically not statistically significant. In this section, the conventional model is further examined along two lines. Estimation with first-differenced data is initially considered. Then, alternative data sources are employed to examine the consequences of temporal aggregation.

A. First-Difference Specification

Hafer and Hein (1980), Fackler and McMillin (1983), and Gordon (1984a) all recommend that the conventional money demand specification should at least be considered in first-difference form. Following Granger and Newbold (1974), this practice is desirable as an informal specification test in that the possibility of spurious correlation due to trends is reduced. Plosser and Schwert (1978) recommend this procedure more strongly. They suggest that if an equation is properly specified, its estimated coefficients should be robust over alternative orders of differencing. The presence of a lagged dependent variable, however, potentially complicates the interpretation of estimation results from first-difference specifications. Plosser, Schwert, and White (1982) devised a specification test for this case involving instrumental variables, but as Cooley and LeRoy (1981) noted in a similar context, plausible instruments also are likely to be correlated with the error term in money demand equations. First-differencing is nevertheless applied below to help eliminate trends and possibly autocorrelated error terms.

First difference estimates of the equations in Table 1 are presented in Table 3. For the 1959:Q3-1973:Q4 period, the estimation results reported in equations (3.1) through (3.8) are generally quite similar to those reported for analogous log-levels specifications. Apart from the lower estimated Treasury bill yield elasticity in equations (3.5) through (3.8), the only other noteworthy difference with respect to estimated coefficients is the more rapid adjustment speed. The first-difference specification also appears to have eliminated the autocorrelation problems in Table 1.

In contrast to the results from the earlier subsample, the estimation results obtained after differencing the data in the 1974:Q1-1983:Q4 period differ substantially from those reported in Table 1. The primary conflict occurs with the estimated coefficient on the lagged dependent variable. This coefficient declines from a value of about 0.9 to 0.3. Thus, the results in Table 3 indicate that the speed of adjustment has risen, not declined, in the post-1974 period. A futher consequence is that the nominal adjustment model can be rejected in each case at the 5 percent level of significance. In other words, actual inflation is estimated to have an independent and statistically significant effect on money demand.

The post-sample properties of selected first difference specifications are examined in Table 4. The first four columns report the static simulation errors of equations (3.3) and (3.7) -- which only differ by the definition of the short-term yield -- for the 1974:Q1-1983:Q4 period. In contrast to the results for the log-levels specifications, these equations exhibit only slight negative bias through 1981:Q4, and then small positive bias for the 1982-83 period.[11] These equations also yield greatly reduced root-mean-square errors in comparison to analogous specifications in Table 2. The simulation results for a money demand equation estimated from 1974:Q1 through 1981:Q4 are reported in the last two columns.[12] While the predictive performance of this equation is less accurate than the others in the table, the mean error is nevertheless lower than the within-sample root-mean-square error.[13]

As a whole, the relatively accurate simulation results obtained after differencing suggest that more elaborate specifications may not be needed in order to predict future money demand. Moreover, estimation results for the pre-1974 period yielded stable point estimates for levels and first-difference specifications. However, the plausibility of the estimates may be questioned, particularly concerning partial adjustment. In addition, the estimation results for the 1974-83 sample period are neither sensible nor robust.

B. Consequences of Temporal Aggregation

The data used in the Federal Reserve's policy analysis are constructed as daily averages over months or quarters. For this reason, along with the discrete nature of money withdrawals in the Baumol-Tobin model, temporally aggregated data are used almost exclusively in money demand studies.[14] Despite the seemingly widespread acceptance of this practice, temporal aggregation can lead to biased estimates in many applications (e.g., Zellner and Montmarquette 1971). One prominent example was presented by Working (1960), who demonstrated that data following a random walk, when averaged, will have correlated first differences. Thus, it is at least possible that some of the statistical properties of conventional money demand equations are a consequence of the temporal aggregation of financial data.[15]

To investigate the effects of temporal aggregation, two additional sources of M1 data are considered. One is the M1 data taken from the flow of funds accounts (MFF). These data presumably reflect money balances as of the last day of the quarter.[16] The other source is the Federal Reserve's weekly M1 series, which corresponds to daily-average money balances over a given week. These data are currently available from 1975, and the balances during the last week of the quarter are used here (MW). To avoid potential aggregation problems with other financial data, the 3-month Treasury bill yield on the last day of the quarter replaces the previous averaged yield. Also, as mentioned previously, the wealth variable is already constructed as an end-of-quarter quantity.[17]

The correlations between alternative M1 data -- both in terms of levels and differences -- are reported in Table 5. The flow-of-funds M1 data also are averaged (AMFF) and compared to other measures. On the top half of the table, the correlations between traditional M1, end-of-quarter M1, and averaged end-of-quarter M1 are calculated for the entire 1959-83 sample period. The levels corresponding to these different measures are very highly correlated reflecting a strong time trend. The averaged flow-of-funds data also are highly correlated (0.86) with the traditional data after differencing, while the end-of-quarter data are less highly correlated with both measures.

Similar results are reported for the 1975-83 period, conforming to the current availability of the weekly M1 series. Again, all level measures are highly correlated, and the averaged flow-of-funds data yield the highest correlation (0.72) with the traditional data after differencing. As a whole, the correlations suggest that these alternative measures are broadly consistent.

Estimation results using end-of-quarter, averaged end-of-quarter and last-week-in-the-quarter M1 data are reported in Table 6. The 1959:Q3-1973:Q4 and 1974:Q1-1983:Q4 sample periods are employed as before, as well as the 1975:Q3-1983:Q4 sample period to consider the weekly M1 data series. For each measure of M1, three specifications are estimated. The first corresponds to the most general specification in Table 1, including both wealth and an unrestricted price term. The second applies an autocorrelation correction procedure to the same specification. The lagged dependent variable is dropped in the third specification to compare the partial adjustment model with the serial correlation alternative.

With the exception of the interest-rate elasticities, the results for the pre-1974 sample period using averaged flow-of-funds data -- equations (6.4) - (6.6) -- are similar to those reported in Table 1. The differences are that the estimated Treasury bill yield elasticity is positive and the savings deposit rate is statistically significant.[18/] The nominal adjustment model ($b_6 = b_7$) cannot, however, be rejected, while the real adjustment model ($b_7 = 0$) can be rejected at low significance levels. Moreover, the coefficient on the lagged dependent variable is statistically significant in equations (6.4) and (6.5), and despite its presence in addition to the serial correlation correction procedure in (6.5), substantial serial correlation remains as in Table 1.

Estimation results using end-of-quarter data in the pre-1974 period are presented in equations (6.1) through (6.3). Using these data, the appropriateness of the real versus the nominal partial adjustment model cannot be determined. Moreover, the partial adjustment framework in general may be questioned, as the alternative serial correlation specification (6.3) yields a smaller estimated standard error (0.0061) than either equations (6.1) or (6.2).[19/] All specifications, however, eliminate the significant autocorrelation exhibited in Table 1. Also, similar to equations (6.4) - (6.6), the savings deposit rate has a statistically significant coefficient with the anticipated sign, while the Treasury bill yield is positive and insignificant.

Estimation results for the 1974:Q1-1983:Q4 period are reported in equations (6.7) - (6.12). Using averaged data, equation (6.10) exhibits the larger coefficient on lagged money found in Table 1, but this coefficient diminishes in size once the equation is corrected for serial correlation (6.11). In this latter specification, the nominal adjustment model also can be rejected, in contrast to Table 1. Using end-of-quarter data, the serial correlation specification (6.9) again gives a lower estimated standard error than the partial adjustment specification (6.7), and it also implies that actual inflation influences money demand directly.

In the last six rows of the table, end-of-quarter and last-week-in-the-quarter data are considered over the 1975:Q3-1983:Q4 sample period. In contrast to results from the entire post-1974 sample, estimates of the partial adjustment model using end-of-quarter data (6.13) imply a significantly negative Treasury bill yield elasticity. The serial correlation specification (6.15) also yields a somewhat higher estimated standard error in this case. Using last-week-in-the-quarter data, the estimated standard error of the autocorrelation specification (6.18) again is somewhat higher than that of the partial adjustment alternative (6.16), and the estimated elasticity of the market rate is statistically significant at the 5 percent level in equations (6.16) - (6.17). Because of the similarities to equations (6.13) - (6.15), the properties of equations (6.16) - (6.18) appear to be more of a function of the later starting date of the estimation period than different sources of M1 data.

To further examine the properties of the specifications in Table 6, first difference money demand equations are estimated using alternative M1 data in Table 7. The same three subsamples as before are considered. As a whole, the only equations not rejecting the partial adjustment model -- i.e., exhibiting a statistically significant coefficient on the lagged dependent variable -- use averaged end-of-quarter data (equations 7.2 and 7.4). Combined with the results in Table 6, the evidence suggests that the traditional use of temporally aggregated data is largely responsible for the prominence of the partial adjustment model. That is, temporal aggregation in this case appears to both increase the magnitude of the coefficient on lagged money and the degree of serial correlation in the residuals. Using end-of-quarter data, which reduces the possibility of spurious correlation, the partial adjustment model is not unambiguously better than the alternative involving complete adjustment of money demand within each quarter.

To examine the predictive ability of end-of-quarter money demand equations, post-sample static simulations of both the partial adjustment and serial correlation specifications are presented in Table 8.[20/] In comparison to the results using traditional M1 data in Table 2, the 1974-83 simulations yield substantially larger errors. In addition, both the partial adjustment and serial correlation specifications strongly support the notion that money demand was subject to continued downward shifts through 1981. As before, however, the results indicate that the downward shift diminished in 1982-83, but money demand remains lower than predicted based on pre-1974 data.[21/] Also similar to the results in Table 2, equations estimated from 1974:Q1 through 1981:Q4 predict the 1982-83 period with much greater accuracy. Positive biases are evident, but they amount to less than 1 percent for both the partial adjustment and serial correlation specifications.[22/] The underlying equations used to form these post-sample predictions nevertheless have some questionable characteristics. In particular, interest rates and wealth are not statistically significant in these equations. Furthermore, if the partial adjustment model is the true specification, then the slower speed of adjustment in the post-1973 period must be rationalized. If the partial adjustment model is instead deemed to be untenable, then the alternative complete-adjustment model is plagued by serially correlated residuals, suggesting possible misspecification.

2. OTHER SPECIFICATIONS

In this section, the role of expectations in the demand for money is initially considered. The statistical significance of actual inflation in a number of the previous empirical money demand equations, among other factors, motivates this investigation. Next, the robustness of Hamburger's (1977, 1983) money demand model is examined using the methodology of the previous sections. Hamburger has presented money demand equations capable of relatively accurate predictions in both the 1970s and early 1980s.[23]

A. Expectations and Money Demand

The statistically significant direct impact of actual inflation in a variety of the estimated money demand equations in the previous sections may reflect the sensitivity of the demand for money to expected inflation. One possible justification for this effect is that, in the absence of implicit yields adjusting to market yields, the expected own real rate of return on money balances moves negatively with changes in expected inflation. A vast majority of previous studies implicitly assume that the real own-yield on money balances equals the negative of expected inflation, and then subtract this rate from the other real rates of return entering the money demand equation. This procedure leads to rates of return specified as nominal yields, thereby eliminating the direct effect of inflation. Such a procedure implicitly imposes a zero within-equation adding-up constraint on the coefficients multiplying real rates of return on money and money substitutes. However, in a multi-asset framework with imperfect asset substitutability, and in the absence of perfect certainty about future inflation making all assets risky, such within-equation constraints are in most cases unwarranted (Roley 1983a).

In the first two rows of Table 9, a variable representing expected inflation replaces the previous measure of actual inflation. The specifications most closely correspond to equations (6.1) and (6.7) in Table 6, and end-of-quarter financial data are used in both instances.[24] In comparison to the equations reported previously, the only noticeable difference is the point estimate of the coefficient on expected inflation in the post-1974 sample period. The estimated standard errors of both equations (9.1) and (9.2) are virtually the same as those reported for (6.1) and (6.7).

The role of expectations is expanded in the subsequent two equations reported in Table 9. In these specifications, expectations measures are formed for income as well as the price level. The price term also is respecified to enable a comparison of nominal and real partial adjustment models. The results again are comparable to similar estimated equations reported in Table 6, and neither set can be unambiguously preferred on the basis of these results.

The final four rows consider a random-walk model of money demand (e. g., Sims 1982). The basic notion behind specifications (9.7) and (9.8) is that at the end of a given period, money balances held by economic agents reflect all available information concerning interest rates, income, and the price level. That is, current information is used to predict future real transactions, the price level, and the opportunity cost of holding money balances. On the basis of these forecasts, economic agents determine their current money holdings to finance future real transactions. It also is assumed that adjustment to desired holdings is accomplished at every point in time. At the end of the next period, then, money demand will only differ from that of the previous period due to innovations in its determinants. The alternative hypothesis, represented by equations (9.5) and (9.6), is that current expectations of the determinants of money demand also are useful in predicting future money balances. For the pre-1974 estimation period, the random-walk hypothesis can be rejected at the 5 percent level of significance. In the 1974:Q1-1983:Q4 sample, however, the expectations data as a group do not significantly affect money demand, and the random-walk hypothesis -- involving the additional constraint $b_6 = 1$ -- cannot be rejected at the 5 percent level. The evidence regarding this model must, nevertheless, be regarded as mixed due to the results reported for the earlier subsample. Also, on the basis of the complete set of results in Table 9, variables constructed to represent expectations apparently do not unambiguously improve the characteristics of empirical money demand equations.

B. Hamburger's Model

As mentioned, through several adaptations of the conventional money demand specification, Hamburger (1977, 1983) has been able to estimate equations with somewhat improved post-sample predictive ability over the 1970s and early 1980s. Appealing to portfolio motives, the specification includes the dividend-price yield and a Treasury bond yield. Excluded from the specification is a market yield on a short-term financial asset. The price level is constrained as in the nominal adjustment model, and the long-run income elasticity also is constrained to unity.

Hamburger's (1977) model is empirically examined in Table 10 by considering its robustness with respect to the use of end-of-quarter M1 data and differencing.[25/] On the top half of Table 10, Hamburger's log-levels specification is estimated over both pre- and post-1974 samples, with both traditional M1 and end-of-quarter M1 data. The price level and income constraints also are relaxed in some of the estimated equations. Comparing equation (10.1) and (10.5), which are estimated with temporally aggregated M1, the estimated coefficients are quite similar across the different subsamples. In the earlier estimation period, however, the equation exhibits significantly autocorrelated residuals, and the estimated standard error is about one-half that in the later sample period. While the income constraint can be rejected in the pre-1974 sample (equation 10.2), it cannot be rejected using post-1974 data (equation 10.6). Similar results emerge using end-of-quarter M1 data (equations 10.3, 10.4, 10.7, and 10.8), but in this case the income constraint can be rejected in both estimation periods.

Differencing the specification causes the robustness of Hamburger's model to deteriorate. All constraints can be rejected in both the pre- and post-1974 periods, with the exception of the price constraint using both traditional and end-of-quarter M1 data in the pre-1974 sample. Moreover, the estimated coefficient on lagged money is much smaller than in log-levels specifications, implying more plausible speeds of adjustment in some equations. Using end-of-quarter data, however, causes this estimated coefficient to become insignificantly different from zero when the constraints are relaxed (equations 10.12 and 10.16). As was the case with other specifications, this model does not appear to exhibit the stability necessary for policy analysis.

4. SECTORAL DEMANDS FOR M1 BALANCES

Part of the relatively poor within- and post-sample performances of empirical money demand equations could be due to aggregation across diverse groups of economic agents. Indeed, some of the proposed remedies -- involving interest-rate ratchet variables and more recently explicit own yields on transactions balances -- focus directly on either business or household demand for money. As a consequence, the separate demands for money by these two sectors are examined in this section.

Following Goldfeld (1976), and also to enable comparisons with the results reported previously, flow-of-funds data are used in this investigation. For households, the basic money demand specification is identical to that considered previously in, for example, Table 6. For businesses, the savings deposit rate and the wealth variable are deleted. As before, estimation results for both log-levels and changes in logs specifications are presented.

Estimation results for both the 1959:Q3-1973:Q4 and 1974:Q1-1983:Q4 sample periods are presented in Table 11. Estimated household money demand equations are roughly comparable to those reported in Table 6. The estimated income elasticities in both subsamples are, however, substantially larger than before, as is the estimated coefficient on the lagged dependent variable in the earlier subsample (equations 11.1 and 11.5). Deleting lagged money, it is apparent that the partial adjustment model (11.1 and 11.5) does not yield any major gains in within-sample fit over the alternative serial correlation specification (11.2 and 11.6). As before, either through the implied nominal adjustment model -- imposing $b_6 = b_7$ in equation (11.5) -- or directly in equation (11.6), inflation is estimated to have a significant impact on household money demand in the post-1974 period.[26]

Estimated money demand equations for the business sector exhibit somewhat more peculiar properties. First, as is evident in Table 11, a time trend was included in these specifications. In order to obtain a positive, although statistically insignificant, estimated income elasticity, the addition of a time trend was found to be necessary. Second, in the partial adjustment specifications, the estimated speed of adjustment is implausibly slow in the 1959:Q3-1973:Q4 sample. Finally, in the autocorrelation specification (11.4 and 11.8), inflation is estimated to have an effect similar to that estimated for household money demand in the post-1974 period, but the short-term market interest rate does not exhibit a statistically significant effect in any of the alternative specifications.

To further examine these sectoral demands, the specifications are reestimated after differencing. As indicated on the bottom half of Table 11 (equations 11.9 - 11.12), the estimated equations in at least one major respect change dramatically from those estimated in log-levels form. In particular, not only does the estimated coefficient on lagged money become insignificantly different from zero, but the point estimates are negative in every instance. The impact of inflation on the sectoral demands does, however, appear to be robust in the post-1974 estimation period.

Despite some of the implausible characteristics of the estimated equations in Table 11, selected specifications are simulated for comparison with previous results. In the simulations, the remaining M1 balances not held by households and businesses are treated as exogenous. Thus, the simulation errors reported for aggregate M1 may be downward biased.

The simulation results for household, business, and the implied aggregate M1 balances are reported in Table 12. Both partial adjustment and serial correlation specifications are simulated. In simulations over the 1974:Q1-1983:Q4 period, the static simulation errors suggest that despite the emphasis typically placed on the business sector, household money demand shifted downward in comparison to the pre-1974 period. The errors are, however, only a fraction of those reported for sectorally aggregated M1 in Table 8. The results for business money demand exhibit only small biases, but the underlying specifications include time trends which shift these equations progressively downward over time. The results for total M1 balances predominatly reflect the behavior of household money demand. The results again suggest that the 1982-83 experience may not be as unusual as that in 1980-81, where a further downward shift is evident, some of which was offset in 1982 and 1983.

Post-sample simulations using equations estimated through 1981:Q4 exhibit improved predictive ability on average. In these simulations, reported on the right-hand side of Table 12, only the household money demand equations yield positive mean errors. When combined with business money demand equations, the mean errors are slightly negative over the 1982-83 period. The significant role of inflation in the equations underlying the simulations primarily accounts for this performance.

5. A CLOSER LOOK AT THE INTEREST ELASTICITY OF M1 DEMAND

As noted in the introductory section, the erratic behavior of M1 demand since the early 1970s has frequently been attributed to financial innovation and deregulation. To capture the greater economization on transactions balances supposedly originating primarily in the business sector, a variety of additional variables have been included in conventional money demand equations. Two of these variables -- a simple time trend and an interest-rate ratchet variable -- are briefly examined here. A third variable -- introduced by Cagan (1983) to reflect the own yield on NOW accounts -- also is considered, as it has figured prominently in discussions of the 1982-83 experience. Following the empirical investigation on the roles of these variables, more fundamental issues regarding the identification and bias of estimated interest elasticities are considered.

A. Time Trends, Ratchets, and Own Yields

In examining the demand for money by businesses in the previous section, a linear time trend was found to be necessary to obtain a positive estimated income elasticity, at least among the limited number of alternative explanatory variables considered. This time trend, while not statistically significant in the pre-1974 estimation period, exhibited a statistically significant negative effect on business money demand in the post-1974 sample.

The role of a time trend in explaining total end-of-quarter money demand is considered in the first four rows of Table 13. Both the partial adjustment and serial correlation models are estimated over the pre- and post-1974 samples. As may be expected based on the results reported in Table 7, where first-differenced data were used, a linear time trend is not found to be statistically significant in either estimation period.

In the remaining rows of Table 13, an interest-rate ratchet is included in business and total money demand equations. Following Simpson and Porter (1980) and Cagan (1983), this variable is defined as the previous peak yield on 5-year constant maturity Treasury securities. The previous linear time trend is excluded in all of these specifications.

The estimation results reveal that in only two of the eight specifications is the interest-rate ratchet significant at even the 10 percent level (equations 13.9 and 13.12). In both instances, the estimation results are obtained in the 1974:Q1-1983:Q4 sample period using the partial adjustment specification. In specifications in which the lagged dependent variable is dropped, the inflation variable appears to statistically dominate the interest-rate ratchet. The relevance of this variable therefore depends on the appropriateness of the partial adjustment model. The serial correlation alternative nevertheless yields lower estimated standard errors in both cases (equations 13.10 and 13.12).

The variable presented by Cagan (1983) and also adopted by Hamburger (1983) to improve the predictive performance of money demand equations over the 1983-84 period is considered in the last four rows of Table 13. This variable -- formed by multiplying the fraction of other checkable deposits in M1 by 5.25 percent -- is subtracted from the other rates of return entering the estimated equations. Because this variable presumably reflects the increased sensitivity of households to changes in the rates of return on competing assets, both household and total money demand equations are estimated. Also, estimation results are only presented for the post-1974 sample period since the own-yield variable is either trivially small or equal to zero throughout the pre-1974 period.

In comparison to the results in Table 11, the addition of this own yield gives virtually no improvement over previous results for the household sector (equations 13.13 and 13.14). The estimated Treasury bill yield elasticities do increase slightly in absolute value, but they uniformly remain insignificant at the 5 percent level. With one exception, the results for total money demand also exhibit similar properties to earlier estimates reported in Table 6. The exception involves the partial adjustment specification (equation 13.15), in which the Treasury bill yield elasticity becomes statistically significant at the 5 percent level. On the basis of this one regression, however, it is difficult to argue for the relevance of this variable. Nevertheless, its role in the 1982-83 period is considered explicitly in the concluding section.

B. Identification and Bias

In a very thorough analysis concerning the identification of and simultaneity biases in empirical money demand equations, Cooley and LeRoy (1981) reach very pessimistic conclusions. In particular, they conclude that there is no obvious way to identify money demand equations. As a consequence, they suggest that all previous empirical money demand equations are subject to simultaneity bias, and a coefficient likely to be affected is the interest elasticity of money demand. Laidler (1980) and Gordon (1984b) also examine simultaneity bias in detail, and their results suggest that there is potential for significant bias due to both inappropriate assumptions about causality among economic time series and neglect of Federal Reserve reaction functions.

Following Cooley and LeRoy (1981), the potential simultaneity bias in estimated interest-rate coefficients is considered here by focusing on the Federal Reserve's monetary control procedures. The analysis extends that presented by Cooley and LeRoy in two directions. First, a somewhat more detailed model of financial market equilibrium is presented, focusing explicitly on Federal Reserve policy behavior. Second, because problems concerning biases are frequently ignored due to their unknown magnitudes, percentage biases in estimated interest rate coefficients are calculated under alternative assumptions about the parameters of the model.

The model--based on that presented by Roley and Walsh (1985)--may be represented as [27]

$$m_t = a_0 - a \cdot i_t + u_t \tag{7}$$

$$m_{t+j} = (n + j)g + m^B_{t-n} + (1-\lambda)^j \, [m_{t-1} - (n-1)g - m^B_{t-n}] \tag{8}$$

$$rr_t = nbr_t + b_0 + b(i_t - d_t) + v_t, \tag{9}$$

$$rr_t = k + m_{t-2}, \tag{10}$$

where m_t is the logarithm of real money balances; i_t is the nominal short-term rate; rr_t is the logarithm of required reserves; nbr_t is the logarithm of nonborrowed reserves; d_t is the Federal Reserve's discount rate; a_0, a, λ, g, b_0, b, and k are positive parameters; and u_t and v_t are stochastic error terms. To avoid analytical complications involving temporal aggregation, the model is analyzed in a weekly time frame.

The demand for money in this model is represented by equation (7), where all determinants other than the interest rate are implicitly represented by the constant term, a_0. The error term in the money demand equation is assumed to follow a first-order autoregressive process

$$u_t = \rho \cdot u_{t-1} + e_t \; . \tag{11}$$

Equation (8) represents the Federal Reserve's short-run money stock targets. In the absence of shocks, the money stock target for the jth future period, m_{t+j}, simply equals the long run target $(n+j)g + m^B_{t-n}$, where m^B_{t-n} is the logarithm of the base level of the money stock set n weeks previously, and g is the target long-run growth rate. In the event of a deviation from target in the previous week's money stock, $m_{t-1} - (n-1)g - m^B_{t-n}$, all future short-tun targets are altered to reflect the Federal Reserve's partial accomodation of this shock. The parameter λ reflects the rate at which the deviation of money from its long-run target is offset.

The supply of reserves is represented by equation (9). Under the assumption that excess reserves equal zero, required reserves equal nonborrowed reserves plus the quantity of borrowed reserves as determined by the borrowings function. The borrowings function is in turn represented by a constant amount of frictional borrowing (b_0) and the spread between the short-term interest rate and the discount rate.[28]

Equation (10) represents the demand for reserves under lagged reserve requirements. In this specification, k is the logarithm of the reserve requirement ratio. Under the alternative contemporaneous reserve requirements (CRR) systems imposed prior to late 1968 and after January 1984, some reserve settlement lags are also involved in practice. Under the current CRR system, the lag is essentially two days (e.g. Sellon 1984).

In this simplified model, the Federal Reserve may choose the level of the short-term interest rate or nonborrowed reserves in an attempt to achieve its short-run policy objectives. As implied by LeRoy (1979) and Hetzel (1982), however, the nonborrowed reserves operating procedure can be regarded as being very similar to the money markets conditions procedure in the absence of strict contemporaneous reserve requirements. The main difference is that under the nonborrowed reserves procedure, the short-term rate fluctuates according to the error in the borrowings function, v_t, while under the money markets conditions procedure, the short-term rate is approximately constant throughout the policy period.

To illustrate the biases in estimating the demand for money (7), it is assumed that the money markets conditions procedure is being implemented by the Federal Reserve. In estimating money demand (7), the estimated interest-rate coefficient, $-\hat{a}$, may be represented as

$$-\hat{a} = -a + (\sum_t i_t u_t)/(\sum_t i_t^2). \tag{12}$$

For simplicity, it is assumed that all data are detrended and than $(n + j) g + m^B_{t-n} = \bar{m}$, for all j. It is also assumed that, because of reporting lags, the previous week's money stock is not known by either the public or the Federal Reserve. Under these assumptions, the bias can be represented in terms of the parameters of the model. As an intermediate step, however, it is informative to note that the equilibrium interest rate and its unconditional variance can be represented as

$$i_t = -(1/a)\bar{m} + (1/a)\rho(\rho + \lambda-1)[\sum_{j=0}^{\infty} (1-\lambda)^j \sum_{k=j}^{\infty} \rho^{k-j} e_{t-k-2}], \qquad (13)$$

$$V(i_t) = \frac{\rho^2(\rho + \lambda-1)^2 [1 + (1-\lambda)\rho]}{a^2(1-\rho^2)[1-(1-\lambda)\rho][1-(1-\lambda)^2]} \cdot V(e_t). \qquad (14)$$

Using (13) and (14), and following some tedious derivations, the percentage bias of the negative of the estimated interest-rate coefficient ($\hat{a} > 0$) can be expressed as

$$\frac{\text{plim }(\hat{a}) - (a)}{a} = \frac{-\rho[1-(1-\lambda)^2]}{(\rho + \lambda-1)[1 + (1-\lambda)\rho]} . \qquad (15)$$

First note that this expression implies that single-equation estimation of money demand yields consistent estimates in two cases. First, if the demand for money has uncorrelated errors ($\rho = 0$), the bias (15) equals zero. In this case, i_t and u_t are uncorrelated since past values of the residual do not provide information about future money demand. Second, if the Federal Reserve accommodates all money demand shocks fully ($\lambda = 0$), the interest rate again is uncorrelated with current and past residuals leading to consistent estimates.

Biases are calculated for intermediate cases in Table 14. As is apparent in the table, the magnitude of the bias is extremely sensitive to moderate changes in the parameters. Also, the bias can be either positive or negative, the former occurring when the monetary authority more than accommodates the money demand shock. That is, a positive bias occurs if the effect of the money demand shock deteriorates more rapidly over time, based on the autocorrelation coefficient, than the short-run money path approaches the long-run target.

These results have direct implications for the empirical money demand equations presented previously. In particular, the estimates of conventional money demand equations presented in Table 1 exhibit some biases in the pre-1974 period. If the partial adjustment model is rejected, then all estimation results using either traditional M1 or end-of-quarter M1 data also are biased, and the biases could be large. If the partial adjustment model using end-of-quarter data represents the true model, however, the estimated coefficients are consistent on the basis of this analysis. Unfortunately, in this case the majority of the estimated interest-rate coefficients are not statistically significant, and the estimated partial adjustment parameter exhibits instability over different estimation periods.

C. Other Factors Relating to the Interest Elasticity

Most recent discussions concerning the interest elasticity of money demand have focused on the implications of the greater availability of close money substitutes paying market rates of return as well as the increasingly competitive rates of return that have been and will continue to be paid on transactions balances. As a consequence, it has been suggested that these factors have increased the interest elasticity of money demand. In addition, further increases are hypothesized for the future, at least until the point is reached in which rates of return on transactions balances completely reflect market yields.

These recent analyses, however, seemingly assume that the interest-elasticity is invariant to other factors. An exception is provided by Walsh (1982, 1984), who examines the effects of different monetary policy regimes on the interest elasticity of money demand. In particular, in either Tobin's (1958) model of the speculative demand for money or the stochastic version of the transactions model presented by Buiter and Armstrong (1978), the sensitivity of money demand to interest rates depends on the variance of the market yield. As represented by (14), this variance in turn depends on other factors including the Federal Reserve's short-run policy parameter, λ. Moreover, this expression also is influenced by the Federal Reserve's choice of its monetary control procedure. In particular, a nonborrowed reserves procedure introduces the variance of the error in the borrowings function, v_t, into the variance of the interest rate (14). Given the dramatic rise in the volatility of interest rates in the 1979-82 period (e.g., Roley 1983b), as well as the coincident change in monetary control procedures, these factors may have exerted a greater influence on the interest elasticity of money demand than those related strictly to financial innovation and deregulation. Furthermore, in contrast to these latter factors, an increased variance of the market yield typically reduces the interest-rate coefficient (e.g., Walsh 1982, 1984).

The empirical results presented earlier also do not provide any evidence that the interest rate elasticity of money demand increased when comparing the pre- and post-1974 periods. Estimated Treasury bill yield elasticities in Table 1 for the conventional log-levels specification are uniformly lower in the post-1974 period. Similar results are obtained when this specification is estimated in differenced form in Table 3. Moreover, estimated Treasury bill yield elasticites using end-of-quarter data are typically insignificant in both subsamples, as reported in Tables 6 and 7.

In addition to the possible estimation biases mentioned previously, two other reasons for these results appear to be logical candidates. First, all specifications are estimated either with an inflation variable or with nominal adjustment imposed, which embodies an indirect inflation effect. Given that nominal short-term yields are highly correlated with inflation, these specifications may have led to downward biased estimates of the interest elasticity. To examine this possibility, several equations in Table 6 were reestimated without the inflation term, $p_{t-1}-p_t$. In the 1959-73 sample period, the deletion of the inflation term does not change either the positive sign or the magnitude of the estimated Treasury bill yield elasticity in equation (6.1). In the post-1974 period, however, the estimated elasticity increases in absolute value from 0.0129 to 0.0212 in equation (6.7). In the serial correlation specification, the estimated interest elasticity actually declines in absolute value from 0.0048 to 0.0004 in the latter subsample. Thus, the only potential gain in the size of this estimated elasticity is found for the partial adjustment model in the post-1974 period.

Second, the comparison of equations (6.7) and (6.13) in Table 6 suggests that the estimated interest rate elasticity may increase as more observations are dropped following 1974:Q1. In particular, the estimated elasticity for the 1975:Q3-1983:Q4 subsample is over 80 percent larger than that estimated for the entire post-1974 sample. When progressively later starting dates are used following 1974:Q1, the estimated interest rate elasticity is in fact maximized with a value of 0.0252 for the sample period beginning on 1976:Q2. For starting dates after 1976:Q2, the estimated elasticity declines. When the inflation variable is deleted in the partial adjustment model and this exercise is repeated, the interest rate elasticity takes a maximum value of 0.0324 for the 1975:Q4-1983:Q4 sample period. Similar procedures applied to the serial correlation specification, both with and without the inflation term, failed to achieve any noticeable changes in the estimated elasticity. In sum, while the inflation term in some specifications reduces the statistical significance of the estimated interest-rate elasticity in the post-1974 period, there is no evidence that this elasticity progressively increased in size since the mid 1970s.

6. IMPLICATIONS FOR MONEY DEMAND IN THE 1970s AND 1980s

The empirical results presented in this paper are summarized in this section. Econometric issues raised earlier are first discussed. The results are then summarized in terms of their implications for money demand stability since the early 1970s and the unprecedented decline in M1 velocity in 1982 and 1983.

A. Econometric Issues

As noted earlier, a number of recent studies -- including those by Laidler (1980), Cooley and LeRoy (1981), Goodfriend (1983), and Gordon (1984a, 1984b) -- raise important econometric issues concerning empirical money demand equations. This research focused mainly on the implications of simultaneity bias, measurement errors, and the plausibility of the partial adjustment model. In addition to these issues, the implications of the temporal aggregation of financial data were explored here.

In terms of simultaneity bias, the implications of the Federal Reserve's monetary control procedures were examined. In this case, the potential for simultaneity bias arises if money demand errors are serially correlated, and the Federal Reserve responds to these errors in an attempt to control the money stock. Using specific examples, it was found that the neglect of simultaneity bias leads to biases in estimated coefficients that are potentially large. The magnitude of the biases is highly uncertain, however, as it varies greatly depending on the degree of both serial correlation and monetary control.

Empirical results concerning the partial adjustment model also were rather pessimistic. In particular, it is not clear that the partial adjustment model -- either in real or nominal terms -- should be preferred over specifications simply accounting for serially correlated residuals. The robustness of the partial adjustment model -- at least when estimated over the 1974-83 period -- again may be questioned on the basis of estimation results obtained after differencing the specifications.

Finally, on a positive note, the presence of serially correlated residuals in the conventional partial adjustment model evident in the pre-1974 sample (equations 1.1 through 1.8 in Table 1) appears to be due to the use of temporally aggregated M1 data, and this problem can be corrected (equation 6.1 in Table 6). Moreover, if money demand equations do not exhibit autocorrelation, the estimated equations will be less subject to simultaneity bias. However, the quality of end-of-period data may be questioned, and the partial adjustment model itself may simply reflect either serially correlated residuals or measurement errors.

B. Money Demand Shifts in the 1970s and 1980s

The consensus result emerging from the variety of specifications estimated over the 1959-73 sample period is that the demand for M1 balances exhibited at least one shift after 1973. Shifts were suggested by both partial adjustment and serial correlation money demand specifications, using both temporally aggregated and end-of-quarter financial data. Because of the econometric issues raised above, however, these results should be viewed as tentative.

For traditional log-levels specifications estimated over the 1959-73 period, static simulation results reported in Table 2 indicated that money demand shifted as early as 1975:Q1, and perhaps exhibited a further temporary downward shift in 1980 and 1981. The simulation results additionally suggested that part of this temporary shift was reversed in 1982 and 1983. When the conventional specifications were differenced, the persistent level shift in the mid-1970s appeared as a single negative forecast error followed by a series of mean zero errors in Table 4. The results again suggest that money demand shifted downward in 1975:Q1. A further downward shift was apparent in 1981, which was offset in 1982. The results for 1983 failed to indicate any further upward shifts.

Using end-of-quarter financial data, simulation results reported in Table 6 for specifications estimated through 1973 suggest that the money demand shift increased in size throughout 1974, remained relatively stable from 1975 through 1978, and then progressively shifted downward again from 1979 through 1981. A partial reversal of this latter shift was apparent in 1982 and 1983.

Estimation results of these various models also cast doubt on the stability of estimated coefficients in money demand equations estimated over the 1959-73 and 1974-83 periods. Moreover, in the partial adjustment model estimated with either temporally aggregated or end-of-quarter data (Tables 1 and 6), the greatly reduced speed of partial adjustment estimated in the latter period, despite the recent emphasis on cash management and other related factors, suggests implausible behavior. When equations using temporally aggregated data were differenced, the estimated speed of adjustment instead increased in the post-1974 sample (Table 3), as might be expected.

In first-difference specifications using end-of-quarter data, however, the estimated coefficient on lagged real money balances was either significantly negative or not significantly different from zero for both subsamples (Table 7).

A number of the specifications modified to explain the behavior of money demand following 1974 also were examined. As already discussed, the first-difference specification suggested by Hafer and Hein (1980), among others, seems better suited in describing the permanent level shifts witnessed after 1974. Moreover, when traditional data are used, first-differencing probably reduces some of the spurious correlation caused by temporal aggregation and trends.

Following Hamburger (1977) and B. Friedman (1978), a variable reflecting wealth also was included in the estimated equations. The estimated coefficient on this variable was, however, typically insignificant in post-1974 regressions (Tables 1, 3, 6, and 10). The coefficient constraints imposed by Hamburger (1977) also were examined, and the constraint on income elasticity was rejected in virtually all cases (Table 10). Interest-rate ratchet variables and time trends were additionally included in some specifications. Estimated equations including these variables again failed to either restore stability in estimated coefficients across the pre- and post-1974 periods or result in estimated coefficients robust across different specifications (Table 13).

There are a number of potential sources of these results. Again, simultaneity bias and the different monetary policy regimes during the 1974-83 period, especially in comparison to the earlier period, may provide part of the explanation. A related area involving financial innovation and deregulation also may have introduced coefficient instability and apparent shifts. Variables such as time trends and interest-rate ratchets may be poor proxies for these factors. Also in a similar context, the definition of the narrowly defined money stock may be inappropriate. Cagan (1983), for example, achieved greater stability in estimated money demand equations by broadening the current definition of M1.

C. Implications for the 1982-83 Decline in M1 Velocity

Several explanations have been advanced for the unprecedented decline in M1 velocity in 1982 and 1983. Cagan (1983) and Hamburger (1983) explained most of the decline using empirical money demand equations in which the rate of return on NOW accounts was introduced in a manner that increased the interest rate elasticity. The sharp drop in interest rates beginning in mid 1982 then resulted in a pronounced increase in the demand for money. Simpson (1984) also suggested that the interest rate elasticity increased, but that it does not completely explain the 1982-83 experience. Judd and McElhattan (1983) similarly relied on the interest-rate decline in explaining the 1982-83 period, but in their model the interest-rate elasticity was assumed to remain stable. Tatom (1983) deemphasized the roles of interest rates and financial deregulation, and instead focused on the cyclical behavior of the economy. In contrast, Gordon (1984b) suggested that a substantial part of the puzzle is explained by the consequences of financial deregulation, which added deposits with low turnover to M1. Similarly, Hafer (1984) found more historically normal relationships between money and the economy when interest-bearing checkable deposits were excluded from M1.

The simulation results presented for log-levels specifications estimated through 1973, summarized above, suggested that the demand for money experienced an upward shift in 1982-83 in comparison to 1980-81 (Table 2 and 8). As mentioned previously, however, these results also can be interpreted as a transitory downward shift in 1980 and 1981, with money demand returning to more normal post-1974 levels following 1981. Simulation results for first-difference specifications estimated through 1973 reflected similar behavior. In particular, a fairly large upward shift was evident in 1982:Q4, but this shift merely offsets a part of the downward shift in 1981.

Simulation results for money demand equations estimated over the 1974-81 period also suggested an upward shift in 1982-83. Using either temporally aggregated or end-of-quarter data, however, this shift averages less than one percent of the actual money stock (Tables 2 and 6). Nevertheless, as reported in the respective tables, the underlying equations used in the simulations do not conform well to empirical money demand equations typically reported.

The role of the rate of return on NOW accounts was examined in Table 13. For the 1974-83 sample period, this variable did not improve the estimation properties of the demand for money. As constructed, however, this variable is primarily relevant for the last several years of this period. To consider its impact in the 1982-83 period, the residuals from equation (13.15) in Table 13 were compared to those of equation (6.7) in Table 6, which only differs by the addition of the rate of return on NOW accounts in (13.15). These equations also were estimated both with and without the inflation variable. With the inflation term included, the largest percent errors -- occurring in 1983:Q1-Q2 -- were reduced by less than 0.1 percentage points. Without the inflation variable, the largest improvement was 0.2 percentage points in 1983:Q2. Thus, in these specifications, this own-yield variable provided only negligible increases in explanatory power.

Nevertheless, the simulation errors for 1982-83 reported for equations estimated through 1981 are not large by historical standards, especially when compared to errors obtained for the mid 1970s.

The empirical investigation reported here only focused on the current definition of M1. As mentioned, other researchers -- including Cagan (1983), Hafer (1984), and Gordon (1984b) -- have considered both broader and narrower measures of M1 with some success. In particular, it appears that alternative definitions are capable of resolving at least part of the 1982-83 puzzle. Future research on the demand for money may therefore benefit by considering these alternatives, especially given the overall poor performance of empirical money demand equations since the mid 1970s using the current definition of M1.

FOOTNOTES

[*] Associate professor of finance, University of Washington, and research associate, National Bureau of Economic Research. This paper was prepared for the American Enterprise Institute Conference on "Monetary Policy in a Changing Financial Environment" and will be published in the November 1985 supplement of the Journal of Money, Credit and Banking. This research was supported by the National Science Foundation under Grant No. SES-8408603. I am grateful to Phillip Cagan, Craig S. Hakkio, Alan C. Hess, Douglas K. Pearce, and Lawrence H. Summers for helpful comments.

1. Much of this research is summarized in Laidler (1977), Feige and Pearce (1977), and Judd and Scadding (1982).

2. This approach follows a much longer tradition and is stressed, for example, by M. Friedman (1956) and Brainard and Tobin (1968).

3. B. Friedman (1978) also suggests that the significance of the dividend-price ratio in Hamburger's (1977) model is primarily due to its correlation with wealth since dividends are relatively sluggish over time. Hamburger's empirical results also have been critiqued by Hafer and Hein (1979). For a rejoinder, see Hamburger (1983). Another prominent empirical investigation of the role of wealth in money demand is provided by Meltzer (1963).

4. In addition to the empirical equations for total M1 demand reported here, other specifications using real consumption expenditures and the deflator on consumption expenditures were estimated. Per capita specifications also were considered. In all cases, the empirical results did not differ significantly from those reported.

5. All of these data, with the exception of the savings deposit rate, were taken from the Citibank database. The savings deposit rate is from the MPS model database.

6. The source for this variable is the Federal Reserve's flow of funds accounts. Seasonally adjusted levels were formed using B. Friedman's (1977) procedure. Because capital gains account for most of the variance in this series, the seasonally adjusted and unadjusted series are very similar, and the estimation results were virtually unchanged when the unadjusted series was used.

7. There is in fact evidence that the Federal Reserve's change in operating procedures altered the relationship between money and interest rates, at least in the context of weekly money announcements. See, for example, Roley (1983a) and Roley and Walsh (1985).

8. Fackler and McMillin claim that in many instances the iterative Cochrane-Orcutt procedure converges to a local maximum of the likelihood function. To estimate the serial correlation coefficient in this and subsequent tables, 0.02 increments of ρ are considered over the range -1.0 to 1.0.

9. In dynamic simulations starting in 1974:Q1, the cumulative errors in 1981:Q4 are -11.77 and -11.24 percent for equations (1.3) and (1.7), respectively. In 1983:Q4, the cumulative errors are -8.67 and -7.95 percent for these same two equations. In simulations starting in 1982:Q1, the cumulative errors in 1983:Q4 are -7.52 and -6.78 percent for equations (1.3) and (1.7), respectively.

10. In dynamic simulations starting in 1982:Q1, the cumulative errors in 1983:Q4 are 4.25 and 4.23 percent for equations (1.11') and (1.15'), respectively.

11. As might be expected in the presence of permanent level shifts, however, the dynamic simulation errors in terms of levels for equations (3.3) and (3.7) are substantially larger. In particular, in simulations starting in 1974:Q1, the cumulative errors are -13.11 and -12.65 percent in 1981:Q4, respectively, and -8.44 and -7.18 percent in 1983:Q4, respectively. In simulations starting in 1982:Q4, the cumulative errors in 1983:Q4 are 6.76 and 7.45 percent for equations (3.3) and (3.7), respectively.

12. Both equations (3.13) and (3.17) were initially estimated over the 1974:Q1-1981:Q4 subsample. Variables were deleted from the specifications if their estimated coefficients had signs inconsistent with the transactions model (6). As a result, both specifications reduced to equation (3.13'). This methodology is followed for all equations used in subsequent simulations.

13. In a dynamic simulation starting in 1982:Q1, the cumulative error in 1983:Q4 is 12.20 percent for equation (3.13') when transformed into levels.

14. While still using temporally aggregated data, some quarterly studies have not used quarterly averaged data. In the MPS model, for example, average M1 during the last month of the quarter and the first month of the next quarter is used. Laidler (1980) also follows this procedure.

15. Biases due to temporal aggregation also can be interpreted in the measurement error context of Goodfriend (1983).

16. To form seasonally adjusted levels, seasonally adjusted flows were cumulatively subtracted from the reported level for 1983:Q4.

17. The same savings deposit rate as before is used. Movements in this series primarily reflect discrete changes in Regulation Q ceilings, and only minor differences arise when end-of-quarter data are used.

18. End-of-quarter Treasury bill yield data also are averaged in these equations.

19. Formal tests of the partial adjustment model indicate that it cannot be rejected at the 5 percent level of significance. However, this test involves the statistical significance of lagged independent variables, some of which have insignificant estimated coefficients on contemporaneous values. Thus, this test is not likely to be powerful against the alternative hypothesis. For a further discussion of these tests, along with an application to money demand, see Domowitz and Hakkio (1984).

20. As before, variables were deleted if their estimated coefficients had theoretically incorrect signs.

21. In dynamic simulations starting in 1974:Q1, the cumulative errors in 1981:Q4 are -13.58 and -15.46 for equations (6.1') and (6.3'), respectively. In 1983:Q4, the cumulative errors are -11.45 and -11.49 percent for these same two equations. In simulations starting in 1982:Q1, the cumulative errors in 1983:Q4 are -11.45 and -11.49 percent for equations (6.1') and (6.3'), respectively.

22. In dynamic simulations starting in 1982:Q1, the cumulative errors in 1983:Q4 are 1.29 and 4.32 percent for equations (6.7') and (6.9'), respectively.

23. Other money demand models -- including those presented by Carr and Darby (1981) and Judd and Scadding (1981) -- are not considered here for further empirical investigation. Laidler (1980) examines the former model in some detail. In addition to his analysis, it should be noted that the estimated coefficient on the lagged dependent variable is implausibly large in many of their reported regressions. For a detailed analysis of the Federal Reserve Bank of San Francisco model, see Anderson and Rasche (1982).

24. Expectations data are formed from fourth-order autoregressions estimated over the same sample periods as those used to estimate the money demand equation.

25. Hamburger's more recent model only differs from his earlier model in that Cagan's (1983) own-yield variable is included in the recent model. This variable only has the potential for significant effects in the latter part of the sample, and it is considered in the fifth and sixth sections.

26. Replacing real GNP with real consumption expenditures causes the coefficient on the inflation term to become insignificantly different from zero. Despite this difference, both the within- and post-sample errors remain relatively unaffected. See Roley (1985).

27. The model more closely follows the simplified version presented by Roley and Troll (1984). The difference between this model and that presented by Gordon (1984b) relates to the different emphasis on the effects of short-run monetary control. In particular, as described below in the text, equation (8) describes the Federal Reserve's short-run monetary target for a given long-run growth target, g. In contrast, Gordon basically considers g, as well as alternative long-run targets, and not short-run control procedures.

28. Equation (9) actually relates to the logarithms of required and nonborrowed reserves, and a borrowing function specified in terms of the logarithm of one plus the ratio of borrowed and nonborrowed reserves.

REFERENCES

Akerlof, George A. "Irving Fisher on His Head: The Consequences of Constant Target-Threshold Monitoring of Money Holdings." Quarterly Journal of Economics 93(May 1979), 169-87.

Akerlof, George A., and Ross M. Milbourne. "Irving Fisher on His Head II: The Consequences of the Timing of Payments for the Demand for Money." Quarterly Journal of Economics 95(August 1980), 45-57.

Anderson, Richard G., and Robert H. Rasche. "What Do Money Market Models Tell Us about How to Implement Monetary Policy." Journal of Money, Credit and Banking 14(November 1982), 796-828.

Barro, Robert J., and Anthony M. Santomero. "Household Money Holdings and the Demand Deposit Rate." Journal of Money, Credit and Banking 4(May 1972), 397-413.

Baumol, William J. "The Transactions Demand for Cash: An Inventory Theoretic Approach." Quarterly Journal of Economics 66(November 1952), 545-56.

Bennett, Barbara A. "'Shift Adjustments' to the Monetary Aggregates." Federal Reserve Bank of San Francisco, Economic Review (Spring 1982), 6-18.

Brainard, William C., and James Tobin. "Pitfalls in Financial Model Building." American Economic Review 58(May 1968), 99-122.

Brayton, Flint, Terry Farr, and Richard Porter. "Alternative Money Demand Specifications and Recent Growth in M1." Mimeo, Board of Governors of the Federal Reserve System, 1983.

Buiter, Willem H., and Clive A. Armstrong. "A Didactic Note on the Transactions Demand for Money and Behavior Toward Risk." Journal of Money, Credit and Banking 10(November 1978), 529-38.

Cagan, Phillip. "The Monetary Dynamics of Hyperinflation." In Studies in the Quantity Theory of Money, edited by Milton Friedman, pp. 25-117. Chicago: University of Chicago Press, 1956.

____________. "Monetary Policy and Subduing Inflation." Mimeo, American Enterprise Institute, 1983.

Carr, Jack, and Michael R. Darby. "The Role of Money Supply Shocks in the Short-Run Demand for Money." Journal of Monetary Economics 8(September 1981), 183-99.

Chow, Gregory. "On the Long-Run and Short-Run Demand for Money." Journal of Political Economy 74(April 1966), 111-31.

Clower, Robert W., and Peter W. Howitt. "The Transactions Theory of the Demand for Money: A Reconsideration." Journal of Political Economy 86(June 1978), 449-66.

Cooley, Thomas F., and Stephen F. LeRoy. "Identification and Estimation of Money Demand." American Economic Review 71(November 1981), 825-44.

Domowitz, Ian, and Craig S. Hakkio. "Testing for Serial Correlation and Common Factor Dynamics in the Presence of Heteroscedasticity." Mimeo, Federal Reserve Bank of Kansas City, 1984.

Enzler, Jared, Lewis Johnson, and John Paulus. "Some Problems of Money Demand." Brookings Papers on Economic Activity 1(1976), 261-80.

Fackler, James S., and W. Douglas McMillin. "Specification and Stability of the Goldfeld Money Demand Function." Mimeo, 1984.

Feige, Edgar L. "Expectations and Adjustments in the Monetary Sector." American Economic Review 57(May 1967), 462-73.

Feige, Edgar L., and Douglas K. Pearce. "The Substitutability of Money and Near Monies: A Survey of the Time-Series Evidence." Journal of Economic Literature 15(June 1977), 439-69.

Friedman, Bemjamin M. "Financial Flow Variables and the Short-Run Determination of Long-Term Interest Rates." Journal of Political Economy 85(August 1977), 661-89.

________________. "Crowding Out or Crowding In? The Economic Consequences of Financing Government Deficits." Brookings Papers on Economic Activity 3(1978), 593-641.

Friedman, Milton. "The Quantity Theory of Money, A Restatement." In Studies in the Quantity Theory of Money, edited by Milton Friedman, pp. 3-21. Chicago: University of Chicago Press, 1956.

Garcia, Gillian, and Simon Pak. "Some Clues in the Case of the Missing Money." American Economic Review 69(May 1979), 330-4.

Goldfeld, Stephen M. "The Demand for Money Revisited." Brookings Papers on Economic Activity 3(1976), 577-638.

________________. "The Case of the Missing Money." Brookings Papers on Economic Activity 3(1976), 683-730.

Goodfriend, Marvin. "Measurement Error and a Reinterpretation of the Conventional Money Demand Regression." Mimeo, Federal Reserve Bank of Richmond, 1983.

Gordon, Robert J. "The 1981-82 Velocity Decline: A Structural Shift in Income or Money Demand." Mimeo, National Bureau of Economic Research, 1984(a).

________________. "The Short-Run Demand for Money: A Reconsideration." Journal of Money, Credit, and Banking, 16 (November 1984b), 403-34.

Granger, Clive W.J., and Paul Newbold. "Spurious Regressions in Econometrics." Journal of Econometrics 2(July 1974), 111-20.

Hafer, R.W. "The Money-GNP Link: Assessing Alternative Transaction Measures." Federal Reserve Bank of St. Louis, Review 66 (March 1984), 19-27.

Hafer, R.W., and Scott E. Hein. "Evidence on the Temporal Stability of the Demand for Money Relationship in the United States." Federal Reserve Bank of St. Louis, Review 61(December 1979), 3-14.

____________________. "The Dynamics and Estimation of Short-Run Money Demand." Federal Reserve Bank of St. Louis, Review 62(March 1980), 26-35.

____________________. "The Shift in Money Demand: What Really Happened?" Federal Reserve Bank of St. Louis, Review 64(February 1982), 11-16 (a).

____________________. "A Comment on the Stability of the Demand for Money: Evidence from the Post-1973 Period." Review of Economics and Statistics 64(May 1982), 355-7(b).

Hamburger, Michael J. "Behavior of the Money Stock: Is There a Puzzle?" Journal of Monetary Economics 3(July 1977), 265-88.

____________________. "Recent Velocity Behavior, the Demand for Money and Monetary Policy." Conference on Monetary Targeting and Velocity, Federal Reserve Bank of San Francisco, 1983.

Hatanaka, Michio. "An Efficient Two-Step Estimation for the Dynamic Adjustment Model with Autoregressive Errors." Journal of Econometrics 2(September 1974), 199-220.

Hein, Scott E. "Dynamic Forecasting and the Demand for Money." Federal Reserve Bank of St. Louis, Review 62(June/July 1980), 13-23.

Hetzel, Robert L. "The October 1979 Regime of Monetary Control and the Behavior of the Money Supply in 1980." Journal of Money, Credit and Banking 14(May 1982), 234-51.

Judd, John P., and Rose McElhattan. "The Behavior of Money and the Economy in 1982-83." Federal Reserve Bank of San Francisco, Economic Review, (Summer 1983), 46-51.

Judd, John P., and John L. Scadding. "Liability Management, Bank Loans and Deposit 'Market' Disequilibrium." Federal Reserve Bank of San Francisco, Economic Review (Summer 1981), 21-43.

____________________. "The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature." Journal of Economic Literature 20(September 1982), 993-1023.

Klein, Benjamin. "Competitive Interest Payments on Bank Deposits and the Long-Run Demand for Money." American Economic Review 64(December 1974), 931-49.

Laidler, David E.W. The Demand for Money: Theories and Evidence, 2nd ed. New York: Dun-Donnelley, 1977.

________________. "The Demand for Money in the United States--Yet Again." Carnegie-Rochester Conference Series on Public Policy, 12 (1980), 219-71.

Laumas, G.S. and David E. Spencer. "The Stability of the Demand for Money: Evidence from the Post-1973 Period." Reveiw of Economics and Statisics 62(August 1980), 455-9.

Lieberman, Charles. "The Transactions Demand for Money and Technological Change." Review of Economics and Statistics 59(August 1977), 307-17.

LeRoy, Stephen F. "Monetary Control Under Lagged Reserve Accounting." Southern Economic Journal 46(October 1979), 460-70.

Lucas, Robert E. Jr. "Econometric Policy Evaluations: A Critique." Carnegie-Rochester Conference Series on Public Policy, 1(1976), 19-46.

Meltzer, Allan H. "The Demand for Money: The Evidence from the Time Series." Journal of Political Economy 71(June 1963), 219-46.

Plosser, Charles I., and G. William Schwert. "Money, Income, and Sunspots: Measuring Economic Relationships and the Effects of Differencing." Journal of Monetary Economics 4(November 1978), 637-60.

Plosser, Charles I., G. William Schwert, and Halbert White. "Differencing as a Test of Specification." International Economic Review, 23 (October 1982), 535-52.

Porter, Richard D., and Edward K. Offenbacher. "Financial Innovations and the Measurement of the Money Supply." Conference on Financial Innovations, Federal Reserve Bank of St. Louis, 1982.

Quick, Perry D., and John Paulus. "Financial Innovations and the Transactions Demand for Money." Mimeo, Board of Governors of the Federal Reserve System, 1977.

Roley, V. Vance. "Symmetry Restrictions in a System of Financial Asset Demands: Theoretical and Empirical Results." Review of Economics and Statistics 65(February 1983), 124-30(a).

________________. "The Response of Short-Term Interest Rates to Weekly Money Announcements." Journal of Money, Credit and Banking 15(August 1983), 344-54 (b).

__________. "The Demand for Money by Households: An Evaluation of Its Stability." Federal Reserve Bank of Kansas City, *Economic Review*, forthcoming, 1985.

Roley, V. Vance, and Rick Troll. "The Impact of Discount Rate Changes on Market Interest Rates." Federal Reserve Bank of Kansas City, *Economic Review* 69(January 1984), 27-39.

Roley, V. Vance and Carl E. Walsh. "Monetary Policy Regimes, Expected Inflation, and the Response of Interest Rates to Money Announcements." *Quarterly Journal of Economics*, forthcoming, 1985.

Santomero, Anthony M., and John H. Seater. "Partial Adjustment in the Demand for Money: Theory and Empirics." *American Economic Review* 71(September 1981), 566-78.

Sellon, Gordon H., Jr. "The Instruments of Monetary Policy." Federal Reserve Bank of Kansas City, *Economic Review* 69(May 1984), 3-20.

Simpson, Thomas D. "Changes in the Financial System: Implications for Monetary Policy." *Brookings Papers on Economic Activity* 1(1984), 249-65.

Simpson, Thomas D., and Richard D. Porter. "Some Issues Involving the Definition and Interpretation of the Monetary Aggregates." *Federal Reserve Bank of Boston Conference Series*, 23(October 1980), 161-234.

Sims, Christopher A. "Policy Analysis with Econometric Models." *Brookings Papers on Economic Activity* 1(1982), 107-52.

Tatom, John A. "Was the 1982 Velocity Decline Unusual?" Federal Reserve Bank of St. Louis, *Review* (August/September 1983), 5-15.

Tinsley, Peter A., Bonnie Garrett, and Monica E. Friar. "An Exposé of Disguised Deposits." *Journal of Econometrics* 15(January 1981), 117-37.

Tobin, James. "The Interest Elasticity of Transactions Demand for Cash." *Review of Economics and Statistics* 38(August 1956), 241-7.

__________. "Liquidity Preference as Behavior toward Risk." *Review of Economic Studies* 25(February 1958), 65-86.

Walsh, Carl E. "The Effects of Alternative Operating Procedures on Economic and Financial Relationships." In *Monetary Policy Issues in the 1980s*, Federal Reserve Bank of Kansas City, 1982.

__________. "Interest Rate Volatility and Monetary Policy." *Journal of Money, Credit and Banking* 16(May 1984), 133-50.

Wenninger, John, and Charles M. Sivesand. "Defining Money for a Changing Financial System." Federal Reserve Bank of New York, Quarterly Review 4(Spring 1979), 1-8.

Wenninger, John, Lawrence Radecki, and Elizabeth Hammond. "Recent Instability in the Demand for Money." Federal Reserve Bank of New York, Quarterly Review 6(Summer 1981), 1-9.

Working, Holbrook. "Note on the Correlation of First Differences of Averages in a Random Chain." Econometrica 28(October 1960), 916-18.

Zellner, Arnold, and Claude Montmarquette. "A Study of Some Aspects of Temporal Aggregation Problems in Econometric Analysis." Review of Economics and Statistics 53(November 1971), 335-42.

TABLE 1

ESTIMATION RESULTS FOR CONVENTIONAL LEVELS SPECIFICATIONS

$$m_t = b_0 + b_1 \cdot rcp_t + b_2 \cdot rsd_t + b_3 \cdot rtb_t + b_4 \cdot y_t + b_5 \cdot w_t + b_6 \cdot m_{t-1} + b_7 \cdot (p_{t-1} - p_t) + e_t$$

Sample:	Coefficient Estimates†									Summary Statistics‡		
59:Q3-73:Q4	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	ρ	$\bar{R}^2$	SEE	DW
(1.1)	-.6423* (.1615)	-.0124* (.0035)	-.0142 (.0100)	--	.1303* (.0349)	.0231* (.0057)	.6780* (.0916)	.4842* (.1929)	.24** (.13)	.99	.0037	1.70
(1.2)	-.8550* (.1898)	-.0166* (.0043)	-.0187 (.0127)	--	.1738* (.0411)	--	.6503* (.1090)	.5451* (.2084)	.38* (.12)	.99	.0041	1.61
(1.3)	-.7082* (.1540)	-.0115* (.0035)	-.0157 (.0101)	--	.1433* (.0337)	.0225* (.0057)	.6525* (.0906)	$(=b_6)$	.26* (.13)	.99	.0037	1.71
(1.4)	-.8993* (.1788)	-.0161* (.0042)	-.0194 (.0127)	--	.1829* (.0390)	--	.6292* (.1056)	$(=b_6)$	.40* (.12)	.99	.0041	1.64
(1.5)	-.5770* (.1679)	--	-.0084 (.0104)	-.0102* (.0035)	.1166* (.0366)	.0261* (.0057)	.6903* (.0976)	.4995* (.1978)	.26* (.13)	.99	.0038	1.74
(1.6)	-.8138* (.2035)	--	-.0127 (.0139)	-.0123* (.0046)	.1662* (.0442)	--	.6432* (.1192)	.5631* (.2177)	.42* (.12)	.98	.0044	1.58
(1.7)	-.6495* (.1575)	--	-.0104 (.0104)	-.0092* (.0034)	.1312* (.0347)	.0255* (.0058)	.6600* (.0957)	$(=b_6)$	.28* (1.3)	.99	.0038	1.75
(1.8)	-.8407* (.1884)	--	-.0133 (.0137)	-.0119* (.0044)	.1717* (.0413)	--	.6313* (.1138)	$(=b_6)$	.42* (.12)	.98	.0044	1.58
74:Q1-83:Q4												
(1.9)	-.1698 (.1992)	-.0047 (.0073)	-.1179 (.1311)	--	.0585 (.0359)	.0189 (.0150)	.9127* (.0726)	1.125* (.3232)	--	.89	.0086	2.22
(1.10)	-.2671 (.1853)	-.0076 (.0070)	-.0314 (.1127)	--	.0548 (.0361)	--	.9493* (.0671)	1.202* (.3202)	--	.89	.0087	2.15
(1.11)	-.2138 (.1861)	-.0076 (.0058)	-.0863 (.1209)	--	.0571 (.0355)	.0199 (.0148)	.9175* (.0716)	$(=b_6)$	--	.89	.0085	2.30
(1.12)	-.3260** (.1683)	-.0113* (.0051)	.0120 (.0974)	--	.0528 (.0358)	--	.9574* (.0659)	$(=b_6)$	--	.89	.0086	2.24
(1.13)	-.1839 (.2087)	--	-.1210 (.1267)	-.0052 (.0078)	.0614** (.0363)	.0201 (.0145)	.9082* (.0714)	1.116* (.3260)	--	.89	.0086	2.24
(1.14)	-.2760 (.2006)	--	-.0386 (.1136)	-.0073 (.0077)	.0580 (.0367)	--	.9452* (.0671)	1.237* (.3184)	--	.89	.0087	2.15
(1.15)	-.2328 (.1928)	--	-.0932 (.1182)	-.0082 (.0062)	.0616** (.0360)	.0219 (.0141)	.9101* (.0707)	$(=b_6)$	--	.89	.0085	2.33
(1.16)	-.3591* (.1784)	--	.0125 (.0986)	-.0119* (.0058)	.0579 (.0366)	--	.9526* (.0665)	$(=b_6)$	--	.89	.0087	2.26

* Significant at the 5 percent level.

** Significant at the 10 percent level.

† *Numbers in parentheses are standard errors of estimated coefficients.* ρ is the Hildreth-Lu first-order serial correlation cofficient.

‡ $\bar{R}^2$ is multiple correlation coefficient corrected for degrees of freedom, SEE is the standard error of estimate, and DW is the Durbin-Watson statistic. When an equation is corrected for serial correlation, summary statistics correspond to the transformed equation.

m_t = natural logarithm of M1, quarterly average, divided by the GNP deflator.
rcp_t = *natural logarithm of the 6-month commercial paper rate, quarterly average.*
rtb_t = natural logarithm of the 3-month Treasury bill yield, quarterly average.
rsd_t = natural logarithm of the savings deposit rate, quarterly average (MPS model).
y_t = natural logarithm of real GNP, $1972b.
w_t = natural logarithm of the total value of equities (Board of Governors of the Federal Reserve System, Flow of Funds Accounts) divided by the GNP deflator.
p_t = natural logarithm of the GNP deflator, 1972 = 100.
e_t = *random error term.*

TABLE 2

POST-SAMPLE STATIC SIMULATION RESULTS FOR CONVENTIONAL LEVELS SPECIFICATIONS

	Equation (1.3)		Equation (1.7)		Equation (1.11')		Equation (1.15')	
	Error		Error		Error		Error	
Period	$1972b	%	$1972b	%	$1972b	%	$1972b	%
74:Q1	0.89	0.37	1.11	0.46	--	--	--	--
Q2	-0.22	-0.09	-0.45	-0.19	--	--	--	--
Q3	0.88	0.37	0.76	0.33	--	--	--	--
Q4	-0.72	-0.31	-0.48	-0.21	--	--	--	--
75:Q1	-3.56	-1.57	-3.21	-1.41	--	--	--	--
Q2	-2.59	-1.14	-2.14	-0.94	--	--	--	--
Q3	-1.77	-0.78	-1.18	-0.52	--	--	--	--
Q4	-5.11	-2.27	-4.62	-2.05	--	--	--	--
76:Q1	-4.87	-2.15	-4.22	-1.87	--	--	--	--
Q2	-3.87	-1.70	-3.26	-1.43	--	--	--	--
Q3	-5.16	-2.27	-4.53	-1.99	--	--	--	--
Q4	-3.98	-1.75	-3.24	-1.42	--	--	--	--
77:Q1	-3.17	-1.38	-2.29	-0.99	--	--	--	--
Q2	-4.77	-2.06	-4.06	-1.76	--	--	--	--
Q3	-4.31	-1.86	-3.47	-1.50	--	--	--	--
Q4	-3.03	-1.30	-2.32	-1.00	--	--	--	--
78:Q1	-2.77	-1.18	-2.00	-0.85	--	--	--	--
Q2	-3.94	-1.69	-3.27	-1.40	--	--	--	--
Q3	-4.27	-1.83	-3.62	-1.55	--	--	--	--
Q4	-4.36	-1.88	-3.79	-1.63	--	--	--	--
79:Q1	-5.60	-2.43	-4.88	-2.12	--	--	--	--
Q2	-3.69	-1.60	-2.91	-1.26	--	--	--	--
Q3	-3.69	-1.59	-3.16	-1.36	--	--	--	--
Q4	-6.18	-2.68	-5.73	-2.49	--	--	--	--
80:Q1	-4.30	-1.87	-3.66	-1.60	--	--	--	--
Q2	-12.27	-5.55	-11.77	-5.33	--	--	--	--
Q3	-2.24	-0.99	-1.40	-0.62	--	--	--	--
Q4	-5.84	-2.60	-5.47	-2.43	--	--	--	--
81:Q1	-9.28	-4.19	-8.62	-3.89	--	--	--	--
Q2	-6.37	-2.86	-5.73	-2.57	--	--	--	--
Q3	-9.21	-4.19	-8.61	-3.92	--	--	--	--
Q4	-9.11	-4.19	-8.43	-3.88	--	--	--	--
82:Q1	-4.76	-2.16	-4.03	-1.83	2.48	1.12	2.47	1.12
Q2	-9.28	-4.24	-8.66	-3.96	-1.49	-0.68	-1.46	-0.67
Q3	-7.33	-3.33	-6.90	-3.13	0.18	0.08	0.08	0.04
Q4	-3.48	-1.53	-2.73	-1.20	4.72	2.09	4.71	2.08
83:Q1	-4.91	-2.13	-4.18	-1.81	3.50	1.52	3.58	1.55
Q2	-4.90	-2.08	-4.24	-1.80	2.75	1.17	2.83	1.20
Q3	-4.95	-2.07	-4.31	-1.80	1.76	0.74	1.86	0.78
Q4	-6.94	-2.90	-6.26	-2.61	-0.79	-0.33	-0.67	-0.28
ME (74-81) =	-4.33	-1.91	-3.77	-1.67	--	--	--	--
RMSE (74-81) =	5.16	2.30	4.65	2.08	--	--	--	--
ME (82-83) =	-5.82	-2.56	-5.16	-2.27	1.64	0.71	1.67	0.73
RMSE (82-83) =	6.08	2.70	5.47	2.44	2.61	1.19	2.62	1.20

Notes: Equations (1.11') and (1.15') are estimated from 1974:Q1 through 1981:Q4. The estimated equations are:

$$(1.11')\; m_t = \underset{(0.2437)}{-0.1486} - \underset{(0.0063)}{0.0039}\cdot rcp_t - \underset{(0.1560)}{0.1851}\cdot rsd_t + \underset{(0.0354)}{0.0712}\cdot y_t + \underset{(0.0157)}{0.0142}\cdot w_t + \underset{(0.1072)}{0.9096}\cdot(m_{t-1}+p_{t-1}-p_t)$$

$$(1.15')\; m_t = \underset{(0.2571)}{-0.1392} - \underset{(0.0070)}{0.0034}\cdot rtb_t - \underset{(0.1556)}{0.1970}\cdot rsd_t + \underset{(0.0355)}{0.0730}\cdot y_t + \underset{(0.0153)}{0.0156}\cdot w_t + \underset{(0.1051)}{0.9013}\cdot(m_{t-1}+p_{t-1}-p_t)$$

Error = static simulation error and percentage error in terms of real M1 balances ($1972b).
ME (74-81) = static simulation mean error from 1974:Q1 through 1981:Q4.
RMSE (74-81) = static simulation root-mean-square error from 1974:Q1 through 1981:Q4.
ME (82-83) = static simulation mean error from 1982:Q1 through 1983:Q4.
RMSE (82-83) = static simulation root-mean-square error from 1982:Q1 through 1983:Q4.

TABLE 3

ESTIMATION RESULTS FOR CONVENTIONAL FIRST DIFFERENCES SPECIFICATIONS

$$\Delta m_t = b_0 + b_1\cdot\Delta rcp_t + b_2\cdot\Delta rsd_t + b_3\cdot\Delta rtb_t + b_4\cdot\Delta y_t + b_5\cdot\Delta w_t + b_6\cdot\Delta m_{t-1} + b_7\cdot\Delta(p_{t-1}-p_t) + v_t$$

Sample: 59:Q3-73:Q4	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	$\bar{R}^2$	SEE	DW
(3.1)	-.00002 (.00104)	-.0121** (.0065)	-.0073 (.0234)	--	.1401** (.0844)	.0216* (.0085)	.5623* (.1176)	.4949* (.1954)	.44	.0049	2.21
(3.2)	.00002 (.00109)	-.0150* (.0067)	-.0191 (.0241)	--	.1648** (.0882)	--	.5704* (.1237)	.4995* (.2055)	.38	.0051	2.05
(3.3)	-.00005 (.00102)	-.0122* (.0064)	-.0060 (.0229)	--	.1461** (.0819)	.0217* (.0084)	.5499* (.1110)	$(=b_6)$	.45	.0048	2.20
(3.4)	-.00001 (.00108)	-.0150* (.0066)	-.0177 (.0236)	--	.1711* (.0856)	--	.5574* (.1168)	$(=b_6)$	.39	.0051	2.04
(3.5)	-.00005 (.00106)	--	-.0086 (.0239)	-.0070 (.0060)	.1383 (.0861)	.0236* (.0085)	.5504* (.1222)	.4576* (.1976)	.41	.0050	2.17
(3.6)	-.00001 (.00112)	--	-.0223 (.0248)	-.0083 (.0063)	.1652** (.0909)	--	.5528* (.1298)	.4509* (.2098)	.34	.0053	1.93
(3.7)	-.00009 (.00105)	--	-.0069 (.0235)	-.0068 (.0059)	.1463** (.0837)	.0237* (.0085)	.5318* (.1144)	$(=b_6)$	.42	.0049	2.16
(3.8)	-.00005 (.00111)	--	-.0206 (.0244)	-.0081 (.0063)	.1740* (.0883)	--	.5323* (.1216)	$(=b_6)$	.35	.0053	1.92
74:Q1-83:Q4											
(3.9)	-.0022 (.0020)	-.0023 (.0164)	.0144 (.2575)	--	.3129** (.1719)	.0131 (.0231)	.3325** (.1800)	1.156* (.3853)	.27	.0106	2.15
(3.10)	-.0023 (.0020)	-.0077 (.0133)	.0328 (.2529)	--	.3252** (.1688)	--	.3573* (.1728)	1.215* (.3673)	.28	.0105	2.14
(3.11)	-.0019 (.0022)	-.0050 (.0175)	.0311 (.2748)	--	.2986 (.1833)	.0229 (.0243)	.3387** (.1922)	$(=b_6)$	.16	.0114	2.47
(3.12)	-.0020 (.0022)	-.0149 (.0139)	.0654 (.2719)		.3114** (.1817)	--	.3838* (.1858)	$(=b_6)$	.17	.0114	2.45
(3.13)	-.0020 (.0020)	--	-.0146 (.2532)	.0104 (.0159)	.2680 (.1693)	.0213 (.0211)	.2966** (.1780)	1.126* (.3845)	.27	.0106	2.03
(3.14)	-.0020 (.0020)	--	.0045 (.2526)	.0030 (.0142)	.2792** (.1690)	--	.3345** (.1740)	1.243* (.3665)	.27	.0106	2.01
(3.15)	-.0017 (.0021)	--	-.0057 (.2709)	.0100 (.0171)	.2367 (.1807)	.0332 (.0220)	.2957 (.1905)	$(=b_6)$	.17	.0113	2.35
(3.16)	-.0016 (.0022)	--	.0273 (.2750)	-.0022 (.0153)	.2501 (.1837)	--	.3580** (.1894)	$(=b_6)$	.14	.0115	2.33

Note: See the notes in Table 1.

v_t = random error term.

TABLE 4

POST-SAMPLE STATIC SIMULATION RESULTS FOR CONVENTIONAL FIRST DIFFERENCES SPECIFICATIONS

	Equation (3.3)		Equation (3.7)		Equation (3.13')	
	Error		Error		Error	
Period	$1972b	%	$1972b	%	$1972b	%
74:Q1	0.49	0.20	0.73	0.30	--	--
Q2	-1.15	-0.48	-1.68	-0.70	--	--
Q3	0.42	0.18	0.24	0.10	--	--
Q4	-1.86	-0.80	-1.45	-0.63	--	--
75:Q1	-3.52	-1.55	-3.13	-1.38	--	--
Q2	0.00	0.00	0.10	0.44	--	--
Q3	0.75	0.33	0.72	0.32	--	--
Q4	-3.11	-1.38	-3.08	-1.37	--	--
76:Q1	-0.58	-0.26	-0.44	-0.20	--	--
Q2	0.96	0.42	0.91	0.40	--	--
Q3	0.95	-0.42	-0.92	-0.40	--	--
Q4	0.76	0.33	0.88	0.38	--	--
77:Q1	1.18	0.51	1.32	0.57	--	--
Q2	-1.10	-0.48	-1.25	-0.54	--	--
Q3	0.19	0.08	0.13	0.06	--	--
Q4	1.36	0.58	1.17	0.50	--	--
78:Q1	0.78	0.33	0.82	0.35	--	--
Q2	-1.14	-0.49	-1.33	-0.57	--	--
Q3	-0.54	-0.23	-0.70	-0.30	--	--
Q4	-0.30	-0.13	-0.60	-0.26	--	--
79:Q1	-1.39	-0.60	-1.34	-0.58	--	--
Q2	1.40	0.60	1.43	0.62	--	--
Q3	0.42	0.18	0.25	0.11	--	--
Q4	-2.17	-0.94	-2.40	-1.04	--	--
80:Q1	0.88	0.38	0.81	0.35	--	--
Q2	-7.87	-3.56	-7.68	-3.47	--	--
Q3	7.07	3.14	7.12	3.16	--	--
Q4	-1.13	-0.50	-1.62	-0.72	--	--
81:Q1	-3.82	-1.72	-3.73	-1.68	--	--
Q2	1.80	0.81	1.70	0.76	--	--
Q3	-2.45	-1.12	-2.54	-1.16	--	--
Q4	-0.93	-0.43	-0.77	-0.35	--	--
82:Q1	4.16	1.88	4.18	1.89	2.92	1.33
Q2	-3.12	-1.43	-3.05	-1.40	-1.55	-0.71
Q3	0.97	0.44	0.90	0.41	0.83	0.38
Q4	4.33	1.91	4.78	2.11	6.74	2.98
83:Q1	0.36	0.15	0.62	0.27	4.09	1.78
Q2	0.62	0.26	0.64	0.27	1.16	0.49
Q3	0.53	0.22	0.48	0.20	1.43	0.60
Q4	-1.61	-0.67	-1.52	-0.63	-0.73	-0.31
ME (74-81) =	-0.49	-0.22	-0.51	-0.23	--	--
RMSE (74-81) =	2.40	1.09	2.39	1.08	--	--
ME (82-83) =	0.78	0.35	0.88	0.39	1.86	0.82
RMSE (82-83) =	2.50	1.19	2.59	1.23	3.12	1.44

Notes: See the notes in Tables 1 and 2. Equation (3.13') is estimated from 1974:Q1 through 1981:Q4. The estimated equation is:

$$(3.13')\quad \Delta m_t = \underset{(0.0016)}{-0.0061} + \underset{(0.1209)}{0.4968}\cdot\Delta y_t + \underset{(0.2818)}{0.7722}\cdot\Delta(p_{t-1} - p_t)$$

TABLE 5

CORRELATIONS BETWEEN ALTERNATIVE M1 DATA

Variable	Correlation Matrices: 1959:Q3 - 1983:Q4		
M	1.0000		
AMFF	0.9998	1.0000	
MFF	0.9997	0.9999	1.0000
ΔM	1.0000		
ΔAMFF	0.8609	1.0000	
ΔMFF	0.6736	0.7985	1.0000

	Correlation Matrices: 1975:Q2 - 1983:Q4			
M	1.0000			
AMFF	0.9992	1.0000		
MFF	0.9986	0.9994	1.0000	
MW	0.9994	0.9989	0.9992	1.0000
ΔM	1.0000			
ΔAMFF	0.7215	1.0000		
ΔMFF	0.4677	0.6880	1.0000	
ΔMW	0.6227	0.6203	0.8377	1.0000

M = M1, quarterly average.
MFF = M1, end of quarter (Board of Governors of the Federal Reserve System, Flow of Funds Accounts).
AMFF = $(MFF + MFF_{-1})/2$.
MW = M1, last week in quarter.

TABLE 6

ESTIMATION RESULTS FOR LEVELS SPECIFICATIONS USING END OF QUARTER AND AVERAGED DATA

$$m_t = b_0 + b_2 \cdot rsd_t + b_3 \cdot rtb_t + b_4 \cdot y_t + b_5 \cdot w_t + b_6 \cdot m_{t-1} + b_7 \cdot (p_{t-1} - p_t) + e_t$$

Sample:		Coefficient Estimates								Summary Statistics		
59:Q3–73:Q4	LHS	b_0	b_2	b_3	b_4	b_5	b_6	b_7	ρ	$\bar{R}^2$	SEE	DW
(6.1)	mff	-1.104	-.0420*	.0022	.2473*	.0413*	.2729*	.0718	--	.99	.0064	1.93
		(.2270)	(.0148)	(.0054)	(.0502)	(.0092)	(.1377)	(.3382)				
(6.2)	mff	-1.340*	-.0462*	.0024	.3009*	.0458*	.1143	-.0507	.12	.99	.0062	1.96
		(.2306)	(.0152)	(.0057)	(.0506)	(.0095)	(.1378)	(.3223)	(.13)			
(6.3)	mff	-1.507*	-.0528*	.0046	.3396*	.0479*	--	-.0945	.20	.98	.0061	1.89
		(.1181)	(.0130)	(.0054)	(.0209)	(.0089)		(.3120)	(.13)			
(6.4)	amff	-.6359*	-.02328*	.0021	.1383*	.0295*	.6015*	.6761*	--	.99	.0042	1.33
		(.1685)	(.0107)	(.0037)	(.0385)	(.0056)	(.1097)	(.2278)				
(6.5)	amff	-.8702*	-.02852*	.0046	.1933*	.0301*	.4365*	.5916*	.38*	.99	.0038	1.54
		(.1729)	(.0199)	(.0041)	(.0388)	(.0063)	(.1085)	(.1924)	(.12)			
(6.6)	amff	-1.460*	-.0491*	.0123*	.3344*	.0348*	--	.3717**	.52*	.98	.0042	1.34
		(.1088)	(.0137)	(.0046)	(.0192)	(.0073)		(.1963)	(.11)			
74:Q1–83:Q4												
(6.7)	mff	-.1587	-.1873	-.0129	.0913**	.0226	.7645*	.7028**	--	.80	.0112	2.17
		(.2795)	(.1569)	(.0096)	(.0476)	(.0189)	(.0910)	(.4064)				
(6.8)	mff	-.2386	-.1215	-.0145	.0826**	.0181	.8195*	.6623	-.18	.83	.0113	1.97
		(.2714)	(.1475)	(.0102)	(.0428)	(.0184)	(.0839)	(.4055)	(.16)			
(6.9)	mff	-2.014**	-.0664	-.0048	.4027*	.0374**	--	1.138*	.92*	.33	.0111	1.81
		(1.139)	(.2692)	(.0111)	(.1521)	(.0206)		(.3752)	(.06)			
(6.10)	amff	-.0797	-.1295	-.0005	.0497	.0131	.9134*	1.243*	--	.91	.0073	1.29
		(.1839)	(.1024)	(.0062)	(.0312)	(.0124)	(.0637)	(.2726)				
(6.11)	amff	-.2561	.0472	.0064	.0706	.0183	.5754*	1.341*	.90*	.60	.0068	1.54
		(.7132)	(.1627)	(.0068)	(.1058)	(.0127)	(.1331)	(.2471)	(.07)			
(6.12)	amff	-1.788*	.0464	.0067	.3464*	.0199	--	.9577*	.92*	.41	.0083	0.94
		(.8517)	(.2013)	(.0083)	(.1138)	(.0154)		(.2807)	(.06)			
75:Q3–83:Q4												
(6.13)	mff	-.6917**	-.1412	-.0237*	.1599*	.0145	.7603*	.5744	--	.80	.0109	2.16
		(.3944)	(.1760)	(.0119)	(.0630)	(.0237)	(.1022)	(.4323)				
(6.14)	mff	-.7910	-.0946	-.0262*	.1604*	.0111	.7957*	.5104	-.16	.84	.0110	1.95
		(.4021)	(.1653)	(.0120)	(.0669)	(.0216)	(.0982)	(.4258)	(.17)			
(6.15)	mff	-1.972	-.0638	-.0032	.3889**	.0586**	--	1.010*	.92*	.18	.0116	1.78
		(1.659)	(.2881)	(.0129)	(.2203)	(.0341)		(.4412)	(.07)			
(6.16)	mw	-.6693*	-.1311	-.0215*	.1457*	.0220	.7951*	.7427*	--	.78	.0074	2.24
		(.3049)	(.1396)	(.0093)	(.0539)	(.0184)	(.0847)	(.3328)				
(6.17)	mw	-.8879*	-.0951	-.0271*	.1696*	.0191	.8063*	.6366*	-.22	.93	.0083	1.89
		(.3026)	(.1243)	(.0091)	(.0544)	(.0158)	(.0775)	(.3130)	(.17)			
(6.18)	mw	-1.250	-.2538	.0027	.3216**	.0732*	--	.6693**	.90*	.20	.0102	1.45
		(1.420)	(.2501)	(.0114)	(.1913)	(.0301)		(.3899)	(.08)			

Notes: See the notes in Table 1.

LHS = dependent variable in the regression.
mff = natural logarithm of end of quarter M1 (Board of Governor of the Federal Reserve Ssytem, Flow of Funds Accounts) divided by the GNP deflator.
amff = $(mff + mff_{-1})/2$
mw = natural logarithm of last week in the quarter M1 divided by the GNP deflator.

TABLE 7

ESTIMATION RESULTS FOR FIRST DIFFERENCES SPECIFICATIONS USING END OF QUARTER AND AVERAGED DATA

$$m_t = b_0 + b_2\cdot\Delta rsd_t + b_3\cdot\Delta rtb_t + b_4\cdot\Delta y_t + b_5\cdot\Delta w_t + b_6\cdot\Delta m_{t-1} + b_7\,\Delta(p_{t-1}-p_t) + v_t$$

Sample:		Coefficient Estimates							Summary Statistics		
59:Q4-73:Q4	LHS	b_0	b_2	b_3	b_4	b_5	b_6	b_7	$\bar{R}^2$	SEE	DW
(7.1)	Δmff	.0008	-.0681**	.0168**	.2946*	.0362*	-.2391**	-.2156	.21	.0077	1.84
		(.0017)	(.0376)	(.0086)	(.1348)	(.0141)	(.1352)	(.2981)			
(7.2)	Δamff	.0004	-.0371**	.0106*	.1635*	.0247*	.3501*	.5250*	.50	.0045	1.56
		(.0010)	(.0220)	(.0051)	(.0801)	(.0084)	(.1143)	(.1816)			
73:Q1-83:Q4											
(7.3)	Δmff	-.0042**	-.0329	-.0041	.4874*	.0468*	-.0208	1.122*	.32	.0118	1.69
		(.0022)	(.2827)	(.0117)	(.1711)	(.0210)	(.1458)	(.3845)			
(7.4)	Δamff	-.0016	.0950	.0064	.1076	.0227**	.5900*	1.356*	.63	.0069	1.60
		(.0013)	(.1663)	(.0067)	(.1109)	(.0124)	(.1220)	(.2409)			
75:Q3-83:Q4											
(7.5)	Δmff	-.0024	-.0447	-.0003	.3122	.0666*	-.0076	1.012*	.16	.0121	1.84
		(.0027)	(.2938)	(.0134)	(.2098)	(.0325)	(.1653)	(.4428)			
(7.6)	Δmw	-.0006	-.2148	.0017	.1994	.0653*	.1977	.6856**	.18	.0103	2.15
		(.0023)	(.2488)	(.0113)	(.1792)	(.0280)	(.1722)	(.3820)			

Note: See the notes in Table 1, 2, and 6.

TABLE 8

POST-SAMPLE STATIC SIMULATION RESULTS FOR LEVELS SPECIFICATIONS USING END OF QUARTER DATA

	Equation (6.1')		Equation (6.3')		Equation (6.7')		Equation (6.9')	
	Error		Error		Error		Error	
Period	$1972b	%	$1972b	%	$1972b	%	$1972b	%
74:Q1	-2.9	-1.1	-3.0	-1.2	--	--	--	--
Q2	-4.4	-1.8	-5.0	-2.0	--	--	--	--
Q3	-4.0	-1.6	-4.6	-1.9	--	--	--	--
Q4	-5.6	-2.3	-7.3	-3.0	--	--	--	--
75:Q1	-9.6	-4.0	-11.4	-4.8	--	--	--	--
Q2	-3.7	-1.5	-6.5	-2.7	--	--	--	--
Q3	-9.4	-3.9	-11.4	-4.7	--	--	--	--
Q4	-12.0	-5.0	-14.6	-6.2	--	--	--	--
76:Q1	-11.1	-4.6	-14.6	-6.1	--	--	--	--
Q2	-11.0	-4.5	-13.7	-5.7	--	--	--	--
Q3	-13.8	-5.8	-16.5	-6.9	--	--	--	--
Q4	-12.3	-5.1	-15.3	-6.4	--	--	--	--
77:Q1	-9.9	-4.0	-13.1	-5.4	--	--	--	--
Q2	-12.9	-5.3	-16.2	-6.6	--	--	--	--
Q3	-11.3	-4.6	-14.6	-6.0	--	--	--	--
Q4	-11.4	-4.6	-14.4	-5.9	--	--	--	--
78:Q1	-10.9	-4.4	-14.0	-5.7	--	--	--	--
Q2	-12.8	-5.2	-16.7	-6.8	--	--	--	--
Q3	-14.4	-5.8	-18.0	-7.3	--	--	--	--
Q4	-15.0	-6.1	-18.7	-7.6	--	--	--	--
79:Q1	-17.5	-7.2	-21.3	-8.8	--	--	--	--
Q2	-15.3	-6.3	-19.2	-7.8	--	--	--	--
Q3	-15.0	-6.1	-19.0	-7.7	--	--	--	--
Q4	-16.6	-6.8	-20.2	-8.2	--	--	--	--
80:Q1	-18.4	-7.6	-22.2	-9.1	--	--	--	--
Q2	-21.1	-8.8	-24.7	-10.3	--	--	--	--
Q3	-18.2	-7.5	-22.6	-9.3	--	--	--	--
Q4	-28.6	-12.3	-32.8	-14.0	--	--	--	--
81:Q1	-24.0	-10.2	-29.4	-12.4	--	--	--	--
Q2	-26.4	-11.3	-31.1	-13.3	--	--	--	--
Q3	-30.7	-13.4	-35.6	-15.5	--	--	--	--
Q4	-27.2	-11.8	-32.5	-14.1	--	--	--	--
82:Q1	-24.7	-10.7	-29.5	-12.7	-0.7	-0.3	1.3	0.6
Q2	-26.1	-11.3	-31.2	-13.6	-2.2	-1.0	0.3	0.1
Q3	-23.7	-10.2	-29.2	-12.5	-0.3	-0.1	1.1	0.5
Q4	-22.1	-9.3	-27.2	-11.5	1.3	0.5	4.6	1.9
83:Q1	-17.3	-7.1	-22.0	-9.0	6.2	2.5	8.4	3.5
Q2	-15.8	-6.3	-20.4	-8.1	5.3	2.1	2.3	0.9
Q3	-20.8	-8.4	-24.6	-9.9	-1.8	-0.7	-2.7	-1.1
Q4	-21.6	-8.7	-25.6	-10.3	-1.3	-0.5	-0.8	-0.3
ME (74-81) =	-14.3	-6.0	-17.5	-7.3	--	--	--	--
RMSE (74-81) =	16.0	6.7	19.3	8.1	--	--	--	--
ME (82-83) =	-21.5	-9.0	-26.2	-11.0	0.8	0.0	1.8	0.8
RMSE (82-83) =	21.8	9.2	26.5	11.1	3.1	1.0	3.7	1.6

Notes: See the notes in Tables 2 and 6. Restricted versions of equations (6.1) and (6.3) are estimated from 1959:Q3 through 1973:Q3. Restricted versions of equations (6.7) and (6.9) are estimated from 1974:Q1 through 1981:Q4. The estimated equations are:

$$(6.1')\quad mff_t = \underset{(0.2124)}{-1.0746} - \underset{(0.0139)}{0.0405}\cdot rsd_t + \underset{(0.0460)}{0.2402}\cdot y_t + \underset{(0.0083)}{0.0408}\cdot w_t + \underset{(0.1111)}{0.2970}\cdot mff_{t-1}$$

$$(6.3')\quad mff_t = \underset{(0.0851)}{-1.5849} - \underset{(0.0128)}{0.0542}\cdot rsd_t + \underset{(0.0157)}{0.3527}\cdot y_t + \underset{(0.0087)}{0.0466}\cdot w_t + \underset{(0.13)}{0.20}\cdot e_{t-1}$$

$$(6.7')\quad mff_t = \underset{(0.3523)}{-0.1091} - \underset{(0.1839)}{0.2228}\cdot rsd_t - \underset{(0.0112)}{0.0081}\cdot rtb_t + \underset{(0.0481)}{0.0949}\cdot y_t + \underset{(0.0224)}{0.0072}\cdot w_t$$

$$+ \underset{(0.1177)}{0.7704}\, mff_{t-1} + \underset{(0.4897)}{0.8524}\,(p_{t-1}-p_t)$$

$$(6.9')\quad mff_t = \underset{(1.3086)}{-3.2629} - \underset{(0.0115)}{0.0092}\cdot rtd_t + \underset{(0.1749)}{0.5317}\cdot y_t + \underset{(0.0200)}{0.0240}\cdot w_t + \underset{(0.3720)}{1.2876}\cdot(p_{t-1}-p_t)$$

TABLE 9

EXPECTATIONS AND MONEY DEMAND

$$mff_t = b_0 + b_2\cdot rsd_t + b_3\cdot rtb_t + b_4\cdot y_t + b_5\cdot w_t + b_6\cdot mff_{t-1} + b_7\cdot(p^e_{t-1}-p_t) + e_t$$

		Coefficient Estimates												Summary Statistics		
	Sample	b_0	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	$\bar{R}^2$	SEE	DW
(9.1)	59:Q4- 73:Q4	-1.212* (.2629)	-.0411* (.0146)	.0004 (.0054)	.2701* (.0535)	.0439* (.0108)	.2124 (.1376)	-.0715 (.8181)	--	--	--	--	--	.99	.0062	1.92
(9.2)	74:Q1- 83:Q3	-.1511 (.3056)	-.1851 (.1606)	-.0140 (.0097)	.0873** (.0484)	.0234 (.0190)	.7964* (.0963)	-1.227** (.6849)	--	--	--	--	--	.80	.0112	2.29

$$\ln(MFF_t)-p^e_{t+1} = b_0 + b_2\cdot rsd_t + b_3\cdot rtb_t + b_4\cdot y^e_{t+1} + b_5\cdot w_t + b_6\cdot(\ln(MFF_{t-1})-p^e_t) + b_7\cdot(p^e_t-p^e_{t+1}) + e_t$$

	Sample	b_0	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	$\bar{R}^2$	SEE	DW
(9.3)	59:Q4- 73:Q4	-1.038* (.1989)	-.0362* (.0138)	.0024 (.0054)	.2392* (.0452)	.0472* (.0094)	.2383** (.1370)	.1969 (.2498)	--	--	--	--	--	.99	.0062	1.96
(9.4)	74:Q1- 83:Q3	-.2235 (.2662)	-.1820 (.1473)	-.0116 (.0086)	.0971* (.0458)	.0195 (.0187)	.7866* (.0931)	1.029* (.2802)	--	--	--	--	--	.80	.0110	2.16

$$\ln(MFF_t)-p^e_{t+1} = b_0 + b_2\cdot rsd^e_t + b_3\cdot rtb^e_t + b_4\cdot y^e_t + b_5\cdot w_{t-1} + b_6\cdot(\ln(MFF_{t-1})-p^e_t) + b_7\cdot(p^e_t-p_{t-1}) + b_8\cdot rtd^u_t + b_{10}\cdot y^u_t + b_{11}\cdot w^u_t + b_{12}\cdot p^u_t + e_t$$

	Sample	b_0	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	$\bar{R}^2$	SEE	DW
(9.5)	59:Q4- 73:Q4	1.178* (.2906)	-.0366* (.0158)	-.0000 (.0060)	.2640* (.0589)	.0479* (.0141)	.2040 (.1508)	-.8283 (.9417)	-.1005* (.0331)	.0001 (.0057)	.2673* (.1230)	.0349* (.0135)	-.1099 (.3568)	.99	.0062	1.91
(9.6)	74:Q1- 83:Q3	-.6133** (.3322)	.0204 (.1781)	-.0214 (.0143)	.0993* (.0465)	.0037 (.0212)	.8666* (.1005)	.6961 (.7352)	.0997 (.2838)	-.0180 (.0121)	.4613* (.1933)	.0256 (.0229)	-1.730* (.1451)	.83	.0103	2.09

$$\ln(MFF_t)-p^e_{t+1} = b_0 + b_6\cdot(\ln(MFF_{t-1})-p^e_t) + b_8\cdot rsd^u_t + b_9\cdot rtb^u_t + b_{10}\cdot y^u_t + b_{11}\cdot w^u_t + b_{12}\cdot p^u_t + e_t$$

	Sample	b_0	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	$\bar{R}^2$	SEE	DW
(9.7)	59:Q4- 73:Q4	.0014 (.0176)	--	--	--	--	1.001* (.0204)	--	-.0616 (.0418)	-.0006 (.0038)	.2362 (.1443)	.0241 (.0148)	-.3265 (.4059)	.98	.0082	2.32
(9.8)	74:Q1- 83:Q3	.1091** (.0597)	--	--	--	--	.8729* (.0689)	--	.0383 (.2580)	-.0054 (.0105)	.4846* (.1618)	.0382* (.0190)	-1.815* (.3780)	.82	.0105	1.85

Notes: See the notes in Tables 1 and 6. The superscript "e" denotes the expectation formed from an autoregression estimated over the indicated sample period. The superscript "u" denotes the unanticipated component, or residual, from the autoregression.

MFF_t = nominal end of quarter M1.

TABLE 10

ESTIMATION RESULTS FOR HAMBURGER'S SPECIFICATION

$$m_t - y_t = b_0 + b_1 \cdot rd_t + b_2 \cdot rsd_t + b_3 \cdot rl_t + b_4 \cdot (m_{t-1} + (p_{t-1} - p_t) - y_t) + b_5 \cdot (p_{t-1} - p_t) + b_6 \cdot y_t + e_t$$

Sample: 59:Q3- 73:Q4	LHS	b_0	b_1	b_2	b_3	b_4	b_5	b_6	ρ	$\bar{R}^2$	SEE	DW
(10.1)	m	-.0252 (.0276)	-.0308* (.0107)	.0004 (.0135)	-.0173 (.0117)	.9325* (.0335)	--	--	.34* (.12)	.99	.0044	1.67
(10.2)	m	1.303* (.3340)	-.0488* (.0104)	-.0137 (.0125)	.0058 (.0979)	.5758* (.0979)	.0197 (.1977)	-.2691* (.0683)	.34* (.14)	.99	.0039	1.71
(10.3)	mff	-.0747* (.0352)	-.0065 (.0146)	-.0190 (.0176)	-.0345* (.0150)	.8762* (.0455)	--	--	--	.99	.0077	2.31
(10.4)	mff	1.466* (.4099)	-.0299* (.0145)	-.0310** (.0160)	-.0147 (.0162)	.4555* (.1212)	.3237 (.3658)	-.3091* (.0828)	--	.99	.0068	1.78
74:Q1- 83:Q4												
(10.5)	m	-.1545 (.1407)	-.0165 (.0123)	-.0769 (.1238)	-.0288* (.0145)	.9243* (.0384)	--	--	--	.99	.0083	2.30
(10.6)	m	.1518 (.3786)	-.0125 (.0136)	.0557 (.1313)	-.1287** (.0158)	.8824* (.0716)	-.2249 (.2698)	-.0485 (.0652)	--	.99	.0084	2.19
(10.7)	mff	-.1890 (.1871)	.0015 (.0166)	.0881 (.1624)	-.0476* (.0195)	.9050* (.0512)	--	--	--	.98	.0112	2.47
(10.8)	mff	1.027* (.4565)	-.0002 (.0169)	.1485 (.1588)	-.0637* (.0197)	.7005* (.0873)	-.0702 (.3324)	-.2257* (.0799)	--	.99	.0103	2.43

$$\Delta(m_t - y_t) = b_0 + b_1 \cdot \Delta rd_t + b_2 \cdot \Delta rtd_t + b_3 \cdot \Delta rl_t + b_4 \cdot \Delta(m_{t-1} + (p_{t-1} - p_t) - y_t) + b_5 \cdot \Delta(p_{t-1} - p_t) + b_6 \cdot \Delta y_t + v_t$$

59:Q3- 73:Q4												
(10.9)	Δm	-.0015** (.0009)	-.0455* (.0133)	.0096 (.0234)	-.0212 (.0172)	.7554* (.0757)	--	--	--	.66	.0050	2.18
(10.10)	Δm	.0003 (.0010)	-.0550* (.0125)	.0004 (.0219)	-.0036 (.0164)	.4741* (.1088)	-.0271 (.1842)	-.4107* (.1145)	--	.72	.0045	1.94
(10.11)	Δmff	-.0038* (.0016)	-.0324 (.0241)	-.0404 (.0429)	-.0668* (.0317)	.2673* (.1138)	--	--	-	.17	.0091	2.65
(10.12)	Δmff	.0013 (.0016)	-.0634* (.0207)	-.0599* (.0207)	-.0164 (.0275)	-.1387 (.1290)	.0061 (.3079)	-.8611* (.1606)	--	.46	.0074	2.07
74:Q1- 83:Q4												
(10.13)	Δm	-.0019 (.0021)	-.0375 (.0249)	.0008 (.2739)	-.0340 (.0338)	.5534* (.1599)	--	--	--	.28	.0116	2.62
(10.14)	Δm	-.0016 (.0019)	-.0392** (.0231)	.0158 (.2400)	-.0162 (.0305)	.3129** (.1650)	-.7520* (.3231)	-.4086* (.1720)	--	.45	.0101	2.18
(10.15)	Δmff	-.0033 (.0024)	-.0152 (.0286)	-.0967 (.3174)	-.1172* (.0381)	.2511* (.1312)	--	--	--	.26	.0134	2.49
(10.16)	Δmff	-.0032 (.0021)	-.0184 (.0253)	-.0163 (.2629)	-.0918* (.0331)	-.0459 (.1309)	-1.256* (.3682)	-.4879* (.1828)	--	.50	.0110	1.90

Notes: See the notes in Table 1 and 6.

rd = natural logarithm of Standard & Poor's divident-price ratio, quarterly average.

rl = natural logarithm of the 20-year constant maturity Treasury bond yield, quarterly average.

TABLE 11

DEMAND FOR MONEY BY HOUSEHOLDS AND BUSINESSES

$$m_t = b_0 + b_2 \cdot rsd_t + b_3 \cdot rtb_t + b_4 \cdot y_t + b_5 \cdot w_t + b_6 \cdot m_{t-1} + b_7 \cdot (p_{t-1} - p) + b_8 \cdot t + e_t$$

Sample:	Coefficient Estimates										Summary Statistics		
59:Q3-73:Q4	LHS	b_0	b_2	b_3	b_4	b_5	b_6	b_7	b_8	ρ	$\bar{R}^2$	SEE	DW
(11.1)	mh	-2.548* (.7350)	-.1221* (.0498)	-.0197 (.0120)	.4149* (.1220)	-.0070 (.0209)	.5510* (.1283)	.0541 (.8479)	--	--	.97	.0162	1.8
(11.2)	mh	-5.130* (.4014)	-.2271* (.0492)	-.0218 (.0173)	.8298* (.0709)	-.0160 (.0279)	--	-.3248 (.7860)	--	.46* (.12)	.91	.0167	1.8
(11.3)	mb	-1.025 (.9551)	--	-.0033 (.0180)	.1470 (.1481)	--	.8131* (.0974)	.4546 (1.016)	-.0017 (.0014)	--	.78	.0198	1.9
(11.4)	mb	-1.123 (2.087)	--	.0177 (.0215)	.1190 (.3191)	--	--	-.7981 (.7896)	-.0040 (.0032)	.82* (.08)	.07	.0194	1.9
74:Q1-83:Q4													
(11.5)	mh	-.9438* (.4551)	-.2923 (.2181)	-.0135 (.0148)	.2123* (.0888)	.0108 (.0282)	.7579* (.1004)	1.390* (.6331)	--	--	.80	.0175	2.1
(11.6)	mh	-2.721* (1.361)	-.2646 (.4155)	-.0000 (.0188)	.4798* (.2039)	.0328 (.0358)	--	1.563* (.6363)	--	.82* (.09)	.24	.0182	1.7
(11.7)	mb	-.8275 (.9241)	--	.0214 (.0181)	.1089 (.1369)	--	.5292* (.1533)	.6800 (.8898)	-.0037* (.0015)		.90	.0213	1.6
(11.8)	mb	-2.680 (1.683)	--	.0234 (.0192)	.3758 (.2507)	--	--	1.687* (.6720)	-.0087* (.0018)	.68* (.12)	.54	.0192	2.0

$$\Delta m_t = b_0 + b_2 \cdot \Delta rsd_t + b_3 \cdot \Delta rtb_t + b_4 \cdot \Delta y_t + b_5 \cdot \Delta w_t + b_6 \cdot \Delta m_{t-1} + b_7 \cdot \Delta(p_{t-1} - p_t) + v_t$$

Sample:	LHS	b_0	b_2	b_3	b_4	b_5	b_6	b_7	b_8	ρ	$\bar{R}^2$	SEE	DW
59:Q3-73:Q4													
(11.9)	Δmh	.0032 (.0039)	-.0597 (.0872)	.0200 (.0189)	.2678 (.3013)	.0104 (.0325)	-.1128 (.1527)	.1570 (.7094)	--	--	-.06	.0182	1.9
(11.10)	Δmb	-.0061 (.0041)	--	.0075 (.0196)	.2264 (.3268)	--	-.1321 (.1404)	-1.205 (.7895)	--	--	-.01	.0202	1.9
74:Q1-83:Q4													
(11.11)	Δmh	-.0016 (.0036)	-.1365 (.4639)	.0056 (.0191)	.4761** (.2755)	.0433 (.0346)	-.0119 (.1569)	1.538* (.6390)	--	---	.15	.0193	1.7
(11.12)	Δmb	-.0113* (.0038)	--	.0151 (.0196)	.6212* (.3009)	--	-.2179 (.1640)	1.841* (.6313)		--	.21	.0202	1.8

Notes: See the notes in Tables 1 and 6.

mh = natural logarithm of end of quarter household M1 balances (Board of Governors of the Federal Reserve System, Flow of Funds Accounts) divided by the GNP deflator.

mb = natural logarithm of end of quarter nonfinancial corporate business M1 balances (Board of Governors of the Federal Reserve System, Flow of Funds Accounts) divided by the GNP deflator.

t = linear time trend equal to unity in 1959: Q4, and incremented by one in each subsequent quarter.

TABLE 12

POST-SAMPLE STATIC SIMULATION RESULTS FOR HOUSEHOLDS AND BUSINESSES

	(11.1') & (11.3')			(11.2') & (11.4')			(11.5') & (11.7')			(11.6') & (11.8')		
	Errors			Errors			Errors			Errors		
	$1972b		%	$1972b		%	$1972b		%	$1972b		%
Period	mh	mb	mff	mh	mb	mff	mh	mb	mff	mh	mb	mff
74:Q1	1.9	-1.7	0.1	3.0	-1.5	0.6	--	--	--	--	--	--
Q2	-2.6	-1.9	-1.8	-2.2	-1.8	-1.6	--	--	--	--	--	--
Q3	-3.0	-0.2	-1.3	-2.3	-0.1	-0.9	--	--	--	--	--	--
Q4	-0.2	-2.7	-1.2	0.0	-2.6	-0.7	--	--	--	--	--	--
75:Q1	-3.2	-0.8	-1.7	-1.7	-0.7	-1.0	--	--	--	--	--	--
Q2	1.9	3.0	2.0	1.7	2.7	1.8	--	--	--	--	--	--
Q3	-3.3	-1.6	-2.1	-4.0	-2.0	-2.5	--	--	--	--	--	--
Q4	-5.5	-1.1	-2.8	-5.7	-1.3	-3.0	--	--	--	--	--	--
76:Q1	-2.0	0.3	-0.7	-2.8	0.0	-1.2	--	--	--	--	--	--
Q2	-1.3	-0.5	-0.7	-1.0	-0.7	-0.7	--	--	--	--	--	--
Q3	-5.5	-1.6	-2.9	-5.1	-1.7	-2.9	--	--	--	--	--	--
Q4	-3.9	-0.5	-1.8	-3.7	-0.7	-1.8	--	--	--	--	--	--
77:Q1	-1.8	-2.1	-1.6	-2.0	-2.3	-1.8	--	--	--	--	--	--
Q2	-5.1	-0.8	-2.4	-4.9	-0.9	-2.4	--	--	--	--	--	--
Q3	-3.3	-1.5	-1.9	-3.3	-1.6	-2.0	--	--	--	--	--	--
Q4	-4.7	0.0	-1.9	-3.9	0.0	-1.6	--	--	--	--	--	--
78:Q1	-1.0	-2.7	-1.5	-0.7	-2.8	-1.4	--	--	--	--	--	--
Q2	-4.8	-0.7	-2.2	-5.4	-0.8	-2.5	--	--	--	--	--	--
Q3	-6.6	0.4	-2.5	-6.4	0.5	-2.4	--	--	--	--	--	--
Q4	-4.8	-2.1	-2.8	-5.2	-2.1	-3.0	--	--	--	--	--	--
79:Q1	-6.1	-0.9	-2.9	-6.0	-0.8	-2.8	--	--	--	--	--	--
Q2	-3.7	-1.6	-2.2	-3.3	-1.6	-2.0	--	--	--	--	--	--
Q3	-3.3	-1.5	-1.9	-3.0	-1.5	-1.9	--	--	--	--	--	--
Q4	-4.5	0.1	-1.8	-4.4	0.1	-1.8	--	--	--	--	--	--
80:Q1	-5.6	-2.0	-3.1	-6.1	-2.1	-3.4	--	--	--	--	--	--
Q2	-8.8	-1.4	-4.3	-7.7	-1.3	-3.8	--	--	--	--	--	--
Q3	-3.4	1.1	-0.9	-3.4	0.9	-1.0	--	--	--	--	--	--
Q4	-12.7	0.2	-5.4	-13.7	-0.1	-5.9	--	--	--	--	--	--
81:Q1	-7.5	0.6	-2.9	-9.9	0.2	-4.1	--	--	--	--	--	--
Q2	-9.7	-0.5	-4.4	-10.6	-0.8	-4.9	--	--	--	--	--	--
Q3	-11.9	-2.7	-6.3	-13.5	-3.0	-7.2	--	--	--	--	--	--
Q4	-7.3	-3.0	-4.5	-7.7	-3.2	-4.7	--	--	--	--	--	--
82:Q1	-6.0	-1.1	-3.1	-5.8	-1.2	-3.0	0.1	-1.8	-0.7	-0.5	-1.7	-0.9
Q2	-9.1	-1.5	-4.6	-10.0	-1.9	-5.2	-2.4	-2.1	-2.0	-2.0	-1.3	-1.4
Q3	-8.3	-1.3	-4.1	-8.8	-1.6	-4.5	-1.3	-2.3	-1.6	-1.6	-1.8	-1.4
Q4	-4.6	-1.4	-2.5	-4.3	-1.8	-2.6	2.1	-2.6	-0.2	3.3	-1.7	0.7
83:Q1	-0.2	-1.2	-0.5	-0.4	-1.6	-0.8	6.7	-2.4	1.8	7.3	-1.2	2.5
Q2	0.0	-0.6	-0.2	-1.0	-1.1	-0.8	5.1	-2.0	1.3	3.4	-1.4	0.8
Q3	-6.8	-0.5	-2.9	-7.2	-0.9	-3.3	-1.9	-1.5	-1.4	-2.1	-0.8	-1.2
Q4	-7.3	-1.2	-3.4	-7.5	-1.6	-3.7	-1.6	-1.9	-1.4	-1.0	-1.3	-0.9
ME(74-81)=	-4.5	-0.9	-2.3	-4.5	-1.1	-2.3	--	--		--	--	
RMSE(74-81)=	5.6	1.6	2.8	5.9	1.6	2.9	--	--		--	--	
ME(82-83)=	-5.3	-1.1	-2.7	-5.6	-1.5	-3.0	0.8	-2.1	0.0	0.9	-1.4	-0.2
RMSE(82-83)=	6.2	1.2	3.1	6.5	1.5	3.4	3.3	2.1	0.9	3.3	1.4	1.4

Notes: See the notes in Tables 2 and 11. Restricted versions of equations (11.1), (11.2), (11.3) and (11.4) are estimated from 1959:Q3 through 1973:Q4. Restricted versions of equations (11.5), (11.6), (11.7), and (11.8) are estimated from 1974:Q1 through 1981:Q4. The estimated equations are:

$$(11.1')\quad mh_t = \underset{(0.6960)}{-2.4842} - \underset{(0.0486)}{0.1203}\cdot rsd_t \underset{(0.0110)}{-0.0196}\cdot rtb_t + \underset{(0.1143)}{0.4027}\cdot y_t + \underset{(0.1247)}{0.5549}\cdot mh_{t-1}$$

$$(11.2')\quad mh_t = \underset{(0.3614)}{-4.9988} - \underset{(0.0510)}{0.2113}\cdot rsd_t - \underset{(0.0171)}{0.0169}\cdot rtb_t + \underset{(0.0615)}{0.8020}\cdot y_t + \underset{(0.11)}{0.50}\cdot e_{t-1}$$

$$(11.3')\quad mb_t = \underset{(0.7621)}{-0.8492} + \underset{(0.1158)}{0.1187}\cdot y_t + \underset{(0.0862)}{0.7962}\cdot mb_{t-1} - \underset{(0.0012)}{0.0016}\cdot t$$

$$(11.4'\quad mb_t = \underset{(2.032)}{-1.6387} + \underset{(0.3103)}{0.1993}\cdot y_t - \underset{(0.0032)}{0.0042}\cdot t + \underset{(0.08)}{0.82}\cdot e_{t-1}$$

$$(11.5')\quad mh_t = \underset{(0.4251)}{-0.8784} - \underset{(0.2261)}{0.3954}\cdot rsd_t - \underset{(0.0151)}{0.0066}\cdot rtb_t + \underset{(0.0850)}{0.2279}\cdot y_t + \underset{(0.1155)}{0.7481}\ mh_{t-1} + \underset{(0.6521)}{1.5022}\cdot (p_{t-1}-p_t)$$

$$(11.6')\quad mh_t = \underset{(1.5229)}{-2.8474} - \underset{(0.4014)}{0.2228}\cdot rsd_t - \underset{(0.0207)}{0.0096}\cdot rtb_t + \underset{(0.2234)}{0.4995}\cdot y_t + \underset{(0.6293)}{1.8227}\cdot (p_{t-1}-p_t) + \underset{(0.10)}{0.82}\cdot e_{t-1}$$

TABLE 12

(cont.)

$$(11.7')\quad mb_t = \underset{(0.0616)}{-0.1785} + \underset{(0.1725)}{0.3961}\cdot mb_{t-1} + \underset{(0.7487)}{0.8639}\cdot(p_{t-1}-p_t) - \underset{(0.0008)}{0.0023}\cdot t$$

$$(11.8')\quad mb_t = \underset{(1.9130)}{-1.1863} + \underset{(0.2897)}{0.1364}\cdot y_t + \underset{(0.8256)}{1.9279}\cdot(p_{t-1}-p_t) - \underset{(0.0026)}{0.0049}\cdot t + \underset{(0.15)}{0.58}\cdot e_{t-1}$$

TABLE 13

MONEY DEMAND SPECIFICATIONS WITH TIME TRENDS, RATCHET VARIABLES, AND OWN YIELDS

$$m_t = b_0 + b_2 \cdot rsd_t + b_3 \cdot rtb_t + b_4 \cdot y_t + b_5 \cdot w_t + b_6 \cdot m_{t-1} + b_7 \cdot (p_{t-1} - p_t) + b_8 \cdot t + e_t$$

Sample: 59:Q3-73:Q4	LHS	Coefficient Estimates b_0	b_2	b_3	b_4	b_5	b_6	b_7	b_8	ρ	Summary Statistics R^2	SEE	DW
(13.1)	mff	-1.085*	-.0421	.0024	.2445*	.0416*	.2119**	.0729	.00003	--	.99	.0065	1.93
		(.4113)	(.0149)	(.0065)	(.0725)	(.0104)	(.1402)	(.3422)	(.0005)				
(13.2)	mff	-1.479*	-.0527*	.0048	.3353*	.0482*	--	-.0933	.00004	.20	.98	.0062	1.89
		(.4239)	(.0132)	(.0063)	(.0672)	(.0098)		(.3156)	(.0006)	(.13)			
74:Q1-83:Q4													
(13.3)	mff	-.2176	-.1737	-.0131	.0975	.0228	.7627*	.7122**	-.0001	--	.79	.0114	2.16
		(.7188)	(.2207)	(.0101)	(.0848)	(.0193)	(.0945)	(.4259)	(.0009)				
(13.4)	mff	-2.073**	-.0560	-.0062	.4385*	.0397**	--	1.156*	0.0023	.86*	.30	.0112	1.73
		(1.205)	(.2821)	(.0115)	(.1671)	(.0220)		(.3869)	(.0017)	(.08)			
$m_t = b_0 + b_2 \cdot rtd_t + b_3 \cdot rtb_t + b_4 \cdot y_t + b_5 \cdot w_t + b_6 \cdot m_{t-1} + b_7 \cdot (p_{t-1} - p_t) + b_8 \cdot RSP + e_t$													
59:Q3-73:Q4													
(13.5)	mb	-.0818	--	.0022	.0052	--	.8147*	.3206	-.0050	--	.78	.0198	1.95
		(.2815)		(.0164)	(.0480)		(.0970)	(1.027)	(.0036)				
(13.6)	mb	1.003	--	.0207	-.2026	--	--	-.7846	-.0082	.82*	.05	.0196	1.93
		(.8476)		(.0217)	(.1316)			(.7981)	(.0128)	(.08)			
(13.7)	mff	-1.166*	-.0443*	.0010	.2578*	.0377*	.2824*	.0465	-.0010	--	.99	.0064	1.93
		(.2456)	(.0152)	(.0058)	(.0528)	(.0106)	(.1391)	(.3420)	(.0014)				
(13.8)	mff	-1.624*	-.0567*	.0031	.3606*	.0431*	--	-.1248	-.0016	.22**	.98	.0061	1.92
		(.1736)	(.0141)	(.0057)	(.0309)	(.0102)		(.3126)	(.0017)	(.13)			
74:Q1-83:Q4													
(13.9)	mb	1.099**	--	.0362	-.1853**	--	.6076*	.5227	-.0066*	--	.91	.0207	1.88
		(.6365)		(.0199)	(.0972)		(.1194)	(.7141)	(.0023)				
(13.10)	mb	-3.644	--	.0147	.3764	--	--	1.822*	-.0060	.98*	.18	.0205	2.22
		(2.319)		(.0202)	(.3065)			(.6510)	(.0065)	(.03)			
(13.11)	mff	-.2964	-.0292	-.0108	.0785	.0253	.7493*	.7488**	-.0018	--	.80	.0112	2.16
		(.3070)	(.2150)	(.0098)	(.0490)	(.0190)	(.0918)	(.4077)	(.0017)				
(13.12)	mff	-1.657**	-.0457	-.0023	.3633*	.0278	--	1.121*	-.0057*	.86*	.39	.0109	1.83
		(.9661)	(.2656)	(.0111)	(.1344)	(.0210)		(.3742)	(.0029)	(.08)			
74:Q1-83:Q4 $m_t = b_0 + b_2 \cdot rsdm_t + b_3 \cdot rtbm_t + b_4 \cdot y_t + b_5 \cdot w_t + b_6 \cdot m_{t-1} + b_7 \cdot (p_{t-1} - p_t) + e_t$													
(13.13)	mh	-.9210**	.0244	-.0202	.1414*	-.0009	.8045*	1.307**	--		.79	.0179	2.2
		(.5059)	(.0337)	(.0135)	(.0705)	(.0279)	(.0952)	(.6863)					
(13.14)	mh	-3.531*	.0747	-.0039	.5194*	.0300	--	1.669*	.82*		.24	.0182	1.76
		(1.668)	(.1013)	(.0174)	(.2214)	(.0352)		(.6532)	(.09)				
(13.15)	mff	-.3018	.0321	-.0170*	.0587	.0145	.8223*	.7201	--		.79	.0114	2.31
		(.2952)	(.0397)	(.0086)	(.0383)	(.0177)	(.0755)	(.4387)					
(13.16)	mff	-2.309**	.0511	-.0057	.4182*	.0368**	--	1.169*	.92*		.34	.0111	1.8
		(1.223)	(.1241)	(.0106)	(.1588)	(.0205)		(.3827)	(.06)				

Notes: See the notes in Tables 1, 6 and 11.

$R5P$ = peak yield on 5-year constant maturity Treasury securities, in percent.

$rsdm_t = \ln(RSD_t - RM_t)$

$rtbm_t = \ln(RTB_t - RM_t)$

RM_t = proportion of other checkable deposits in either aggregate M1 or household M1 balances, multiplied by 5.25 percent.

TABLE 14

BIAS OF THE ESTIMATED INTEREST ELASTICITY (in percent)

	Policy Parameter, λ						
ρ	0.00	0.01	0.05	0.10	0.30	0.60	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(**)
0.25	0.00	0.54	2.81	5.97	24.11	127.27	-100.00
0.50	0.00	1.36	7.34	16.38	94.44	-350.00	-100.00
0.75	0.00	3.57	21.83	56.72	-501.64	-138.46	-100.00
0.90	0.00	10.52	94.61	(*)	-140.80	-111.18	-100.00
0.95	0.00	24.36	(*)	-184.37	-116.40	-105.14	-100.00
1.00	(**)	-100.00	-100.00	-100.00	-100.00	-100.00	-100.00

*Denominator equals zero in equation (15).

**Both numerator and denominator equal zero in equation (15).