A Review of the Recent Behavior of M2 Demand

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I t is now known that the public's M2 demand experienced a leftward shift in the early 1990s. Since about 1990 M2 growth has been weak relative to what is predicted by standard money demand regressions. It is widely believed that this shift in money demand reflected the public's desire to redirect savings flows from bank deposits to long-term financial assets including bond and stock mutual funds. Recognizing this, policymakers have not paid much attention to M2 in the short-run formulation of monetary policy since July of 1993.[1]

In this article, I review the recent behavior of M2 demand. I then evaluate the hypothesis that the recent shift in M2 demand can be explained if we allow for the effect of the long-term interest rate on money demand. The long-term interest rate supposedly captures household substitutions out of M2 and into long-term financial assets. The evidence here indicates that a standard M2 demand regression augmented to include the bond rate spread can account for most of the "missing M2" since 1990 if the estimation includes the missing

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■ The author wishes to thank Robert Hetzel, Roy Webb, and Alex Wolman for many helpful comments. The views expressed are those of the author and not necessarily those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1] See Greenspan (1993). The issue of the stability of money demand is central in assessing M2's usefulness for formulating policy. If M2 weakens, policymakers have to determine whether this weakness has resulted from a shift in money demand or whether it indicates that the Fed has been supplying an inadequate amount of money to the economy. If it's the latter, weak M2 growth may portend weakness in the economy.

To remind readers, the current definition of M2 includes currency, demand deposits, other checkable deposits, savings deposits, small-denomination time deposits, retail money market mutual funds and overnight repurchase agreements and Eurodollar deposits.

M2 period. Furthermore, changes in the missing M2 are highly correlated with changes in household holdings of bond and stock mutual funds from 1990 to 1994. This evidence lends credence to the view that the steepening of the yield curve in the early 1990s encouraged households to substitute out of M2 and into other financial assets and that part of this missing M2 ended up in bond and stock mutual funds.

However, a few caveats suggest caution in interpreting the twin role of the long-term interest rate and the growth of the mutual fund industry in influencing money demand. One is that the bond rate has no predictive content for M2 demand in the pre-missing M2 period. And during the past two years, 1995 and 1996, actual M2 growth has been in line with that predicted by the money demand regression estimated with and without the bond rate. Hence, the result that the bond rate can account for the missing M2 from 1990 to 1994 is interesting, but it does not necessarily indicate the presence of the systematic influence of the yield curve on M2 demand. The other caveat is that household holdings of bond and stock mutual funds continued to increase in 1995 and 1996, and that increase has not come at the expense of weak M2 growth. In fact, the strong correlation noted above between the missing M2 and household holdings of bond and stock mutual funds disappears when post-'94 observations are included. This result indicates that changes in household holdings of bond and stock mutual funds do not necessarily imply instability in M2 demand.

Taken together, one interpretation of this evidence is that special factors, such as the unusual steepening of the yield curve in the early '90s and the increased availability and liquidity of mutual funds since then, caused the public to redirect part of savings balances from bank deposits to bond and stock mutual funds. Those factors probably have not changed the character of M2 demand beyond causing a one-time permanent shift in the level of M2 balances demanded by the public.[2] The result that the leftward shift in M2 demand ended two years ago should now be of interest to monetary policymakers.

The plan of this article is as follows. Section 1 presents the standard M2 demand regression and reviews the econometric evidence indicating the existence of the missing M2 since 1990. Section 2 presents an explanation of the missing M2 and Section 3 examines the role of the bond rate in explaining the missing M2. Section 4 contains concluding observations.

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[2] Other special factors that have usually been cited are resolution of thrifts by the Resolution Trust Corporation; the credit crunch; the downsizing of consumer balances accomplished by using M2 balances to pay off debt; rising deposit insurance premiums and the imposition of new, high-capital standards for depositories (resulting in a decreasing proportion of intermediation through the traditional banking sector); and so on. But none of these other special factors offers a satisfactory explanation of the missing M2 from 1990 to 1994 as does the steepening of the yield curve. See Duca (1993), Darin and Hetzel (1994), and Feinman (1994) for a further discussion of these special factors.

1. A STANDARD M2 DEMAND EQUATION AND ITS PREDICTIVE FAILURE IN THE EARLY 1990s

An M2 Demand Model

The money demand model that underlies the empirical work here is in error-correction form and is reproduced below (Mehra 1991, 1992):

$$m_t = a_0 + a_1 y_t + a_2(R - RM2)_t + U_t \text{ and} \tag{1}$$

$$\Delta m_t = b_0 + \sum_{s=1}^{n1} b_{1s}\Delta m_{t-s} + \sum_{s=1}^{n2} b_{2s}\Delta y_{t-s}$$
$$+ \sum_{s=0}^{n3} b_{3s}\Delta(R - RM)_{t-s} + \lambda U_{t-1} + \epsilon_t, \tag{2}$$

where m is real M2 balances; y is real GDP; R is a short-term nominal interest rate; $RM2$ is the own rate on M2; U and ϵ are the random disturbance terms; and Δ is the first-difference operator. All variables are in their natural logs except interest rates. Equation (1) is the long-run equilibrium M2 demand function and is standard in the sense that the public's demand for real M2 balances depends upon a scale variable measured by real GDP and an opportunity cost variable measured as the difference between a short-term nominal rate of interest and the own rate of return on M2. The parameter a_1 measures the long-run income elasticity and a_2 is the long-run opportunity cost parameter. Equation (2) is the short-run money demand equation, which is in a dynamic error-correction form. The parameter b_{is} ($I = 2, 3$) measures short-run responses of real M2 to changes in income and opportunity cost variables. The parameter λ is the error-correction coefficient. It is assumed that if variables in (1) are nonstationary in levels, they are cointegrated (Engle and Granger 1987). The presence of the error-correction mechanism indicates that if actual real money balances are high relative to what the public wishes to hold ($U_{t-1} > 0$), then the public will be reducing its holdings of money balances. Hence the parameter λ that appears on U_{t-1} in (2) is negative.

The long- and short-run money demand equations given above can be estimated jointly. This is shown in (3), which is obtained by solving for U_{t-1} in (1) and substituting in (2) (Mehra 1992):

$$\Delta m_t = d_0 + \sum_{s=1}^{k} b_{1s}\Delta m_{t-s} + \sum_{s=1}^{k} b_{2s}\Delta y_{t-s} + \sum_{s=0}^{n3} b_{3s}\Delta(R - RM2)_{t-s}$$
$$+ d_1 m_{t-1} + d_2 y_{t-1} + d_3(R - RM2)_{t-1} + \epsilon_t, \tag{3}$$

where $d_0 = b_0 - \lambda a_0$; $d_1 = \lambda$; $d_2 = -\lambda a_1$; and $d_3 = -\lambda a_2$. As can be seen, the long-term income elasticity can be recovered from the long-run part of the money demand equation (3), i.e., a_1 is d_2 divided by d_1. If the long-term

income elasticity is unity ($a_1 = 1$ in [1]), then this assumption implies the following restriction on the long-run part of equation (3):

$$d_1 + d_2 = 0. \tag{4}$$

Equation (4) says that coefficients that appear on y_{t-1} and m_{t-1} sum to zero. The short-run part of (3) yields another estimate of the long-term income elasticity, i.e., as $\left(\sum_{s=0}^{n2} b_{2s} \right) / \left(1 - \sum_{s=1}^{n1} b_{1s} \right)$. If the same scale variable appears in the long- and short-run parts of the model, then a convergence condition can be imposed on equation (3) to ensure that one gets the same point-estimate of the long-run scale elasticity. The convergence condition implies another restriction (5) on the short-run part of equation (3):

$$\left(\sum_{s=0}^{n2} b_{2s} \right) / \left(1 - \sum_{s=1}^{n1} b_{1s} \right) = 1. \tag{5}$$

Equivalently, (5) can be expressed as

$$\sum_{s=0}^{n2} b_{2s} + \sum_{s=1}^{n1} b_{1s} = 1.$$

That is, coefficients that appear on Δm_{t-s} and Δy_{t-s} in (3) sum to unity. Equation (3) can be estimated by ordinary least squares or by instrumental variables if income and/or opportunity cost variables are contemporaneously correlated with the disturbance term.

An Estimated Standard M2 Demand Regression: 1960Q4 to 1989Q4

Panel A in Table 1 presents results of estimating the standard money demand regression (3) over the pre-missing M2 period, 1960Q4 to 1989Q4. Regressions are estimated using the new, chain-weighted price and income data.[3,4] I present

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[3] The empirical work here uses the quarterly data over the period 1959Q3 to 1996Q4. Variables that appear in (3) are measured as follows. Real money balances (m) are the log of nominal M2 deflated by the GDP deflator; scale variables are the logs of real GDP and real consumer spending. All income and price data used are chain-weighted. R is the four-to-six-month commercial paper rate; $RM2$ is the weighted average of the explicit rates paid on the components of M2. The bond rate ($R10$) used later is the nominal yield on ten-year Treasury bonds. The data on household holdings of bond and equity mutual funds is from the Board of Governors and is constructed by adding net assets of mutual funds but netting out institutional and IRA/Keogh balances (Collins and Edwards 1994).

[4] Instrumental variables are used to estimate money demand regressions. Instruments used are just lagged values of the right-hand side explanatory variables. Ordinary least squares are not used mainly out of concern for the simultaneity bias. Both procedures yield similar estimates of the long-run parameters, even though estimates of short-run parameters differ. The convergence condition is usually rejected if ordinary least squares are used, but that is not the case with instrumental variables. That result favors instrumental variables. Nevertheless, the Hausman statistic (Hausman 1978) that tests the hypothesis that ordinary least squares estimates of all parameters are identical to those using the instrumental procedure is small, indicating that simultaneity may not be a serious problem.

Table 1 Instrumental Variable Estimates of M2 Demand Regressions: 1960Q4 to 1989Q4

Regression A   M2 Demand without the Bond Rate

$$\Delta m_t = -0.05 + 0.23\ \Delta m_{t-1} + 0.08\ \Delta m_{t-2} + 0.45\ \Delta c_t + 0.24\ \Delta c_{t-1}$$
$$\quad\ (4.3)\quad (2.9)\qquad\quad (1.0)\qquad\quad (4.3)\qquad\quad (3.6)$$

$$-0.002\ \Delta(R - RM2)_t - 0.003\ \Delta(R - RM2)_{t-1} - 0.11\ m_{t-1} + 0.11\ \tilde{y}_{t-1}$$
$$\quad (1.6)\qquad\qquad\qquad (3.7)\qquad\qquad\qquad (4.6)\qquad\quad (4.6)$$

$$-0.002\ (R - RM2)_{t-1} - 0.72\ T_t + 0.03\ D83Q1$$
$$\quad (3.8)\qquad\qquad\qquad (4.2)\qquad (5.5)$$

$CRSQ = 0.78 \quad SER = 0.0047 \quad Q(2) = 1.5 \quad Q(4) = 5.1 \quad Q(29) = 22.6$

$N_c = N_y = 1.0 \quad L_{(R-RM2)} = -0.02$

$F1(2,105) = 0.99$

Regression B   M2 Demand with the Bond Rate

$$\Delta m_t = -0.05 + 0.26\ \Delta m_{t-1} + 0.08\ \Delta m_{t-2} + 0.40\ \Delta c_t + 0.26\ \Delta c_{t-1}$$
$$\quad\ (4.2)\quad (3.5)\qquad\quad (1.1)\qquad\quad (4.2)\qquad\quad (4.0)$$

$$-0.002\ \Delta(R - RM2)_t - 0.004\ \Delta(R - RM2)_{t-1} - 0.11\ m_{t-1} + 0.11\ \tilde{y}_{t-1}$$
$$\quad (1.5)\qquad\qquad\qquad (4.0)\qquad\qquad\qquad (4.4)\qquad\quad (4.4)$$

$$-0.002\ (R - RM2)_{t-1} - 0.63\ T_t + 0.03\ D83Q1 - 0.005\ (R10 - RM2)_{t-1}$$
$$\quad (3.1)\qquad\qquad\qquad (3.3)\qquad (5.2)\qquad\qquad (0.7)$$

$$-0.002\Delta(R10 - RM2)_{t-1}$$
$$\quad (1.5)$$

$CRSQ = 0.79 \quad SER = 0.0045 \quad Q(2) = 1.5 \quad Q(4) = 5.2 \quad Q(29) = 26.9$

$N_c = N_y = 1.0 \quad L_{(R-RM2)} = -0.02 \quad L_{(R10-RM2)} = -0.004$

$F1(2,105) = 0.99 \quad F2(2,105) = 2.24$

Notes: m is real M2 balances; c is real consumer spending; $\tilde{y}$ is $(y_t + y_{t-1})/2$ where y is real GDP; R is the four-to-six-month commercial paper rate; $RM2$ is the own rate on M2; $R10$ is the nominal yield on ten-year U.S. Treasury bonds; $D83Q1$ is a dummy that equals 1 in $83Q1$ and 0 otherwise; Δ is the first difference operator. All variables are in their natural logs, except interest rate variables. $CRSQ$ is the corrected R-squared; SER is the standard error of regression; $Q(k)$ the Ljung-Box Q-statistic based on k number of auto correlations of the residuals. N_y is the long-term income elasticity; N_c is the long-term consumption elasticity; $N_{(R-RM2)}$ is the long-term opportunity cost parameter. $F1$ tests the restriction $N_y = N_c = 1$; $F2$ tests the restriction that the bond rate spread variables are not significant in the regression (the 5 percent critical value is 3.1). Instruments used for estimation are just lagged values of the right-hand side explanatory variables. The reported coefficient on trend is to be divided by 1,000.

the version estimated using real consumer spending as the short-run scale vari-
able and real GDP as the long-run scale variable. The evidence reported in
Mankiw and Summers (1986), Small and Porter (1989), and Mehra (1992)
indicates that in the short run changes in real money balances are correlated
more with changes in consumer spending than with real GDP.[5] The regression,
however, is estimated under the assumption that the long-run scale elasticity
is unity, computed using either the long-run part or the short-run part of (3).
That is, restrictions (4) and (5) are imposed on equation (3). In addition, the
regression includes a deterministic time trend and a dummy for the introduction
of superNows and money market deposit accounts.[6]

   As can be seen, the coefficients that appear on the scale and opportunity
cost variables have theoretically correct signs and are statistically significant.[7]
F1 tests the restrictions that long-run income and consumer spending elastic-
ities are unity. This F-statistic is small, indicating that those restrictions are
consistent with data (see Table 1). The long-run opportunity cost parameter is
-0.02, indicating that a 1 percentage point increase in M2's opportunity cost
$(R - RM2)$ from its current level would reduce equilibrium M2 demand by
about 2 percent. It is also worth noting that the long-run part of the money
demand equation is well estimated. In particular, the estimated error-correction
coefficient is correctly signed and significant, indicating the presence of a co-
integrating M2 relation in the pre-1990 period.

Evidence on the Missing M2 during the 1990s

Panel A in Table 2 presents the dynamic, out-of-sample predictions of M2
growth from 1990Q1 to 1996Q4. Those predictions are generated using the
standard M2 demand regression given in Table 1. Actual M2 growth and pre-
diction errors (with summary statistics) are also reported. As shown in the

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[5] I prefer to work with this specification because the restrictions that the long-run scale
elasticity computed using either the long-run part or the short-run part is unity are consistent
with the data in this specification. Those restrictions are usually found to be inconsistent with
the data when instead real GDP is used in the short-run part. Nevertheless, the results here are
not sensitive to the use of different scale variables in short- and long-run parts of the money
demand equation. In particular, with real GDP in the short-run part we still have the episode of
the missing M2 from 1990 to 1994 and the result that M2 growth was on track in the years 1995
and 1996.

[6] In the empirical money demand literature, time-trend variables generally proxy for the
effect of ongoing financial innovation on the demand for money. Estimates reported in many
previous studies indicate that the statistical significance of trend variables in money demand
regressions is not robust across different specifications and sample periods. For example, a time
trend when included in the Federal Reserve Board M2 demand model is significant (Small and
Porter 1989; Duca 1995; Koenig 1996), whereas that is not the case in specifications reported in
Hetzel and Mehra (1989) and Mehra (1991, 1992). Different sample periods used in these studies
may account for these different results.

[7] The Ljung-Box Q-statistics presented in Table 1 indicate that serial correlation is not a
problem.

Table 2 Evidence on Missing M2 during the 1990s

Year	Actual M2 Growth	Panel A Regression A				Panel B Regression B			
		Predicted M2 Growth	Error			Predicted M2 Growth	Error		
			Growth	Cumulative			Growth	Cumulative	
				Level (billions)	Percentage			Level (billions)	Percentage
1990Q4	4.0	6.4	−2.3	−71	2.2	6.5	−2.4	−80	2.4
1991Q4	3.0	3.6	−0.5	−91	2.7	3.3	−0.3	−92	2.7
1992Q4	1.8	6.4	−4.5	−257	7.5	5.9	−4.0	−239	6.9
1993Q4	1.4	4.8	−3.4	−392	11.2	5.0	−3.6	−381	10.9
1994Q4	0.6	3.0	−2.4	−489	13.9	2.6	−2.0	−464	13.2
1995Q4	3.8	3.5	0.3	−495	13.6	4.2	−0.4	−500	13.7
1996Q4	4.5	3.9	0.5	−495	13.0	4.0	−0.4	−505	13.3
Mean Error (1990–1996)			−1.78				−1.78		
RMSE			2.52				2.40		

Notes: The predicted values are generated using the regressions reported in Table 1. Regressions are estimated from 1960Q4 to 1989Q4 and dynamically simulated from 1990Q1 to 1996Q4. *RMSE* is the root mean squared error.

table, this money demand regression overpredicts M2 growth from 1990 to 1994. Those prediction errors cumulate to an overprediction in the level of M2 of about \$490 billion, or 14 percent, by the fourth quarter of 1994.[8]

However, since 1995 M2 growth has been in line with that predicted by the money demand regression. The cumulative over prediction in the level of M2 has stabilized and there is no tendency for the level percent error to increase since then (see panel A in Table 2). This evidence indicates that the leftward shift in the public's M2 demand seen early in the 1990s may have ended.

2.   AN EXPLANATION OF THE MISSING M2

Portfolio-Substitution Hypothesis

It is widely held that weak M2 growth observed in the early '90s is due to household substitutions out of bank deposits (in M2) and into long-term financial assets including bond and stock mutual funds.[9] Two developments may have contributed to such portfolio substitution. One is the increased availability and liquidity of bond and stock mutual funds brought about by reductions in transaction costs, improvements in computer technology, and the introduction of check writing on mutual funds. The other is the steepening of the yield curve brought about mainly by a reduction in short-term market interest rates in general and bank deposit rates in particular.[10] It is suggested that the combination of these factors reduced the public's demand for savings in the form of bank deposits, leading them to redirect savings balances into long-term financial assets including bond and stock mutual funds.[11]

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[8] This predictive failure is confirmed by formal tests of stability. The conventional Chow test with the shift date (1978Q4) located near the midpoint of the sample period indicates that the M2 demand regression is unstable from 1960Q4 to 1996Q4. The Dufour test (Dufour 1980), which is a variant of the Chow test, examines stability over the particular interval, 1990Q1 to 1994Q4. This test uses an F-statistic to test the joint-significance of dummy variables introduced for each observation over 1990Q1 to 1994Q4. The results here indicate that the individual coefficients that appear on these shift dummies are generally large and statistically significant. The F-statistic is large and significant at the 10 percent level. (The F-statistic, however, is not significant at the 5 percent level.) Together these results indicate that the M2 demand regression is not stable over this interval.

[9] Darin and Hetzel (1994), Wenninger and Partlan (1992), Feinman and Porter (1992), Collins and Edwards (1994), Orphanides, Reid, and Small (1994), Duca (1995), and Koenig (1996). Wenninger and Partlan (1992) argued that weakness in M2 growth was due to weakness in its small time deposits component.

[10] Many analysts have argued that the decline in the size of taxpayers' subsidy to the depository sector also may have contributed to a reduction in offering rates on bank deposits. It is argued that rising premiums for deposit insurance, higher capital requirements, and more stringent standards for depository borrowing and lending in both wholesale and retail markets may have pressured many banks and thrifts to widen intermediation margins, resulting in lower offering rates on many bank deposits (Feinman and Porter 1992).

[11] It may, however, be noted that bond and stock funds also grew rapidly in the mid '80s, shortly after IRA, 401k, and Keogh regulations were liberalized. Such growth, however, did not

Tests in Previous Studies

The portfolio-substitution hypothesis outlined above has been tested in two different ways. The first one attempts to internalize such substitutions by adding bond and/or stock mutual funds to M2. Duca (1995) adds bond funds to M2 and finds the expanded M2 more explainable from 1990Q3 to 1992Q4. Darin and Hetzel (1994) shift-adjust M2, and Orphanides, Reid, and Small (1994) simply add bond and stock funds to M2. While the resulting monetary aggregates do explain part of the missing M2 or improve the predictive content of M2 in the missing M2 period, they worsen performance in other periods.[12]

The other approach attempts to capture the increased substitution of mutual funds for bank deposits by redefining the opportunity cost of M2 to include the long-term bond rate. This approach assumes that the bond rate is a proxy for the return available on long-term financial assets including bond and stock mutual funds. Hence M2 demand is assumed to be sensitive to both short- and long-term interest rates (Feinman and Porter 1992; Mehra 1992; Koenig 1996). This approach has been relatively more successful in explaining the missing M2 than the other one discussed above.

The main issue here however is whether the character of M2 demand has changed since 1990. In Koenig (1996) long-term interest rates are found to influence M2 demand even before the period of missing money, suggesting that the character of M2 demand did not change and that standard M2 demand regressions estimated without the long-term interest rate are misspecified. In contrast the empirical work in Feinman and Porter (1992) and Mehra (1992) are consistent with the observation that long-term interest rates did not add much towards explaining M2 demand in pre-1990 sample periods. In the next section I examine further the quantitative importance of the long-term interest rate in explaining M2 demand.

3.   THE ROLE OF THE BOND RATE IN M2 DEMAND

Pre-1990 M2 Demand Regression with the Bond Rate

Panel B in Table 1 presents the standard M2 demand regression augmented to include the bond rate spread variable measured as the difference between the nominal yield on ten-year Treasury bonds and the own rate of return on M2.

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destablize M2 demand. The flow-of-funds data discussed in Duca (1994) indicates that the assets that households shifted into bond and equity funds came from direct holdings of bonds and equities rather than from M2 deposits. By contrast more of the inflows into bond and stock funds in the early '90s reflected shifts out of M2 rather than out of direct bond and equity holdings.

[12] For example, Orphanides, Reid, and Small (1994) report that money demand equations that add bond and stock funds to M2 fail Chow tests of stability. Koenig (1996) shows that the bond-fund adjusted M2 demand equation, while it improved the forecast performance from 1990 to 1994, worsened performance in the early sample period. I show later (see footnote 16) that adding bond and stock funds to M2 worsened performance over the last couple of years.

I include both the level and first differences of this spread. The regression is estimated over the pre-missing M2 demand period, 1960Q4 to 1989Q4. It is evident that the coefficient that appears on the level of the bond rate spread variable is small and statistically not different from zero. F2 is the F-statistic that tests the hypothesis that coefficients that appear on both the level and first differences of the bond rate spread variable are zero. This statistic is small, indicating that the bond rate spread did not influence M2 demand in the pre-1990 period (see regression B in Table 1).

Including the bond rate spread in the M2 demand regression estimated using only pre-1990 sample observations does not solve the missing M2 puzzle either. The evidence on this point is indicated by the dynamic out-of-sample simulations of M2 demand given in panel B of Table 2. The augmented M2 demand regression continues to overpredict M2 growth from 1990 to 1994. Those prediction errors cumulate to an overprediction in the level of M2 of about $464 billion, or 13.2 percent by end of 1994. Including the bond rate spread does yield a somewhat lower root mean squared error, but this improvement is very small (compare prediction errors in panels A and B of Table 2).[13]

Full-Sample M2 Demand Regression with the Bond Rate

Table 3 presents M2 demand regressions estimated including post-'90 sample observations. In regression D the bond rate spread enters interacting with a slope dummy that is unity since 1989 and zero otherwise. In that specification the restriction that the bond rate spread did not influence M2 demand in the pre-1990 period is imposed on the regression. I also present the regression C

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[13] In the money demand regression above, long- and short-rate spreads are included in an unrestricted fashion. It is possible to get the result that the bond rate influenced M2 demand even before the missing M2 demand period if the opportunity cost of holding M2 is alternatively measured as a weighted average of long- and short-rates:

$$OC_t = (w * R10_t + (1 - w) * RCP_t) - RM2_t,$$

where OC_t is the opportunity cost; w is the weighting coefficient; and other variables are defined as before. If $w = 0$, then the bond rate is not relevant in influencing M2 demand.

The money demand regression (3) here also is estimated using this alternative measure. Estimation results using pre-1990 sample observations indicate that the standard error of M2 demand regression is minimized when $w = 0.4$. In that regression the opportunity cost variable is correctly signed and significant, indicating that the long-term interest rate influenced M2 demand even before the missing M2 demand period. This finding is similar to the one reported in Koenig (1996). However, this empirical specification does not solve the missing M2 problem. M2 growth predicted by this regression remains large relative to actual M2 growth from 1990 to 1994. Those prediction errors still cumulate to generate an overprediction in the level of M2 of about $441 billion, or 12.6 percent by end of 1994. The magnitude of this prediction error is somewhat smaller than the one generated by assuming $w = 0$. But the improvement is small. This empirical specification does not solve the missing M2 problem because the increased explanatory power of the bond rate in the M2 demand regression comes at the cost of the short rate.

Table 3 Instrumental Variables Estimates of M2 Demand Regressions: 1960Q4 to 1996Q4

Regression C   M2 Demand with the Bond Rate, but No Slope Dummies

$$\Delta m_t = -0.01 + 0.33\ \Delta m_{t-1} + 0.13\ \Delta m_{t-2} + 0.36\Delta c_t + 0.17\ \Delta c_{t-1}$$
$$\quad\ \ (2.1)\quad (4.8)\qquad\quad (1.9)\qquad\quad (3.9)\qquad\ (2.7)$$

$$-0.001\Delta(R - RM2)_t - 0.005\ \Delta(R - RM2)_{t-1} - 0.03\ m_{t-1} + 0.03\ \tilde{y}_{t-1}$$
$$(0.9)\qquad\qquad\qquad (5.9)\qquad\qquad\qquad (2.4)\qquad\quad (2.4)$$

$$-0.000\ (R - RM2)_{t-1} - 0.000\ (R10 - RM2)_{t-1} - 0.004\ \Delta(R10 - RM2)_{t-1}$$
$$(0.3)\qquad\qquad\qquad (0.1)\qquad\qquad\qquad (3.2)$$

$$-0.51\ T_t + 0.02\ D83Q1$$
$$(3.0)\qquad (5.1)$$

$CRSQ = 0.78\quad SER = 0.0047\quad Q(2) = 2.7\quad Q(4) = 6.6\quad Q(29) = 35.1$

$N_y = N_c = 1\quad N_{(R-RM2)} = -0.005\quad N_{(R10-RM2)} = -0.005$

$F2(2,133) = 5.5^*$

Regression D   M2 Demand with the Bond Rate Interacting with Slope Dummy

$$\Delta m_t = -0.03 + 0.25\ \Delta m_{t-1} + 0.08\ \Delta m_{t-2} + 0.49\ \Delta c_t + 0.18\ \Delta c_{t-1}$$
$$\quad\ \ (3.8)\quad (3.5)\qquad\quad (1.1)\qquad\quad (5.2)\qquad\ (2.8)$$

$$-0.002\ \Delta(R - RM2)_t - 0.003\ \Delta(R - RM2)_{t-1} - 0.07\ m_{t-1} + 0.07\tilde{y}_{t-1}$$
$$(1.5)\qquad\qquad\qquad (4.2)\qquad\qquad\qquad (3.9)\qquad\quad (3.9)$$

$$-0.001(R - RM2)_{t-1} - 0.002\ (D * R10 - RM2)_{t-1} - 0.003\ \Delta(R10 - RM2)_{t-1}$$
$$(2.5)\qquad\qquad\qquad (3.2)\qquad\qquad\qquad\qquad (2.1)$$

$$-0.56\ T_t + 0.02\ D83Q1$$
$$(3.6)\qquad (5.3)$$

$CRSQ = 0.77\quad SER = 0.0046\quad Q(2) = 1.7\quad Q(4) = 6.0\quad Q(36) = 35.3$

$N_y = N_c = 1\quad N_{(R-RM2)} = -0.02\quad N_{(R10-RM2)} = -0.03$

*Significant at the 5 percent level.

Notes: D is a dummy that is 1 from 1989Q1 to 1996Q4 and 0 otherwise. $N_{(R10-RM2)}$ is the long-run bond rate opportunity cost parameter. See also notes in Table 1.

in which no such slope dummy is included. Both differences and the level of the bond rate spread are included in these regressions. As can be seen, the coefficient that appears on the level of the bond rate spread is significant

only in the regression where the spread is included interacting with the slope dummy.[14] Moreover, in that regression other coefficients, including the one that appears on the error-correction variable, have expected signs and are statistically significant. In contrast none of the coefficients that appear on levels of the interest rate spreads are significant in the regression without the slope dummy (compare coefficients in regressions C and D of Table 3).[15] Together this evidence indicates that a significant role for the impact of the long-term interest rate on M2 demand emerges only in the post-1990 period.[16]

Panel D in Table 4 presents the dynamic, within-sample simulations of M2 growth from 1990 to 1996 generated using the regression with the slope dummy. As shown in the table, this regression can account for most of the missing M2 since 1990. The prediction errors now cumulate to an overprediction in the level of M2 of about $41 billion, or 1.2 percent by end of 1994. Since then, the level percent error has displayed no tendency to increase over time. This

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[14] The intuition behind this result is that the least squares regression coefficient measures the average response of M2 demand to the spread variables over the full sample. If for most of the sample period—as is the case here—this response is small or zero, then the estimated regression coefficient that simplify averages such responses over the full sample will be small or zero. But when the slope dummy is included, the estimated regression coefficient receives full weight over part of the sample over which the response is believed to be strong.

I have not reported the slope dummy on the first difference of the bond rate spread because it is not significant in the regression.

[15] In the regression C without the slope dummy, the error-correction coefficient is small in magnitude and only marginally significant. In fact, if restrictions that long-run scale elasticities are unity are not imposed on the regression, then none of the coefficients that appear on levels of variables are significant. Hence in these regressions the hypothesis that there exists a cointegrating M2 demand relation is easily rejected. This finding is similar in spirit to the one in Miyao (1996), where it is shown that once post-'90 sample observations are included in the estimation period, evidence supports no M2 cointegration.

[16] Alternatively, the hypothesis that most of the missing M2 went into bond and stock mutual funds can be tested by broadening the definition of M2 to include such mutual funds. If the hypothesis is correct, then the broadly defined monetary aggregate should be more explainable from 1990 to 1994. This procedure yields similar results. To explain it further, consider the behavior of the monetary aggregate that simply adds bond and stock mutual funds to M2, denoted hereafter as M2+ (Orphanides, Reid, and Small 1994). This aggregate has grown at the following rates (in percent) in recent years: 4.1 in 1990, 6.2 in 1991, 4.6 in 1992, 5.5 in 1993, 0.9 in 1994, 6.3 in 1995, and 7.9 in 1996. For those years M2 growth predicted by the standard M2 demand regression is 6.4, 3.5, 6.4, 4.8, 3.0, 3.5, and 3.9, respectively. The corresponding prediction errors are −2.3, 2.0, −1.7, 0.6, −2.0, 2.9, and 3.9. As can be easily verified, for the period 1990 to 1994 the mean prediction error is −0.57 percentage point and the root mean squared error is 2.0 percentage points. These prediction errors are smaller than those generated using the narrowly defined M2; for the latter the mean error is −1.78 and the root mean squared error is 2.52. Thus M2+ is more explainable over the period 1990 to 1994 than is M2. However, adding bond and stock funds to M2 does not yield a more stable money demand equation. As can be seen, strong growth in M2+ over the period 1995 to 1996 is not easily predicted when conventional money demand parameters are used to characterize M2+ demand. The analysis above, however, is subject to the caveat that the opportunity cost variable in M2+ demand is different from the one that shows up in M2 demand. In particular, the own rate of return on M2+ must include the returns on bond and stock mutual funds.

Table 4 Role of the Bond Rate in Explaining the Missing M2 during the 1990s

Year	Actual M2 Growth	Panel D Regression D Predicted M2 Growth	Error Growth	Cumulative Level	Cumulative Percentage	Missing M2[a] Explained by the Bond Rate	Panel E Cumulative Change since 1989 in Household Holdings of Bond and Stock Mutual Funds[b]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1990	4.0	3.6	0.4	22	0.7	68	2
1991	3.0	0.5	2.5	107	3.2	163	109
1992	1.8	3.4	−1.5	56	1.6	265	212
1993	1.4	3.3	−1.9	11	−0.3	327	370
1994	0.6	1.4	−0.8	−41	1.2	404	386
1995	3.8	3.5	0.3	−31	−0.8	421	505
1996	4.5	4.3	−0.2	−24	−0.7	422	680
Mean (1990–1996)		−0.13					
RMSE		1.41					

[a]in billions

[b]Household holdings are net of institutional and IRA/Keogh assets (Collins and Edwards 1994).

Notes: The predicted values in panel D are the within-sample dynamic simulations generated using M2 demand regression D reported in Table 3.

Column (7) above reports the missing M2 that is predicted by the inclusion of the bond rate in M2 demand regression D. These values are generated by comparing predictions of M2 demand with and without including the bond rate.

evidence indicates that the steepening of the yield curve contributed to weak M2 growth in the early '90s.

The Missing M2 and Bond and Stock Mutual Funds

Figure 1 charts the missing M2 as explained by the bond rate spread since 1990.[17] It also charts the cumulative change (since 1989) in household holdings of bond and stock mutual funds.[18] As can be seen, these two series comove from 1990 to 1994. But this comovement ends in the years 1995 and 1996. Furthermore, in the beginning years (1990, 1991, 1992) of this missing period, the magnitude of the missing M2 somewhat exceeds the cumulative increase in household holdings of bond and stock mutual funds. This data supports the view that weak M2 growth in the early '90s is due to household's substitution out of M2 and into bond and stock mutual funds. But not all of the missing M2 first went into bond and stock funds. A part might have gone into direct holdings of bonds, stocks, and other long-term savings vehicles (Duca 1993; Darin and Hetzel 1994).

If part of the missing M2 ended up in bond and stock mutual funds, then changes in missing M2 balances should be correlated with changes in household holdings of bond and stock funds. This implication is tested by running the following regression:

$$\Delta BS_t = a_0 + a_1 \Delta BS_{t-1} + a_2 \Delta MM2_t + \epsilon_t,$$

where BS is household holdings of bond and stock funds; $MM2$ is the missing M2; and ϵ_t is the random disturbance term. The series on BS and $MM2$ are reported in Table 4 and charted in Figure 1. Estimation results indicate that from 1991Q1 to 1994Q4 $a_2 \neq 0$, but from 1991Q1 to 1996Q4 $a_2 = 0$.[19] These results are consistent with the hypothesis that part of the missing M2 during the 1990s ended up in bond and stock mutual funds.

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[17] The series on the missing M2 is generated in the following way. The M2 demand regression D, which includes the bond rate interacting with a slope dummy, is estimated from 1960Q4 to 1996Q4. This regression is dynamically simulated from 1990Q1 to 1996Q4, first using actual values of the bond rate spread over the prediction interval and then repeating the simulation with actual values of the bond rate set to zero. The difference in predicted values so generated gives M2 demand explained by the bond rate.

[18] This series is constructed by Collins and Edwards (1994) and is the plus part of the monetary aggregate (M2+) discussed in the previous footnote. As noted before, the plus part is the market value of household holdings of bond and stock mutual funds. The current definition of the conventional M2 aggregate includes currency, demand deposits, other checkable deposits, savings deposits, small time deposits, retail money market mutual funds and overnight RPs, and Eurodollar deposits. Since this definition does not include institutional and IRA/Keogh balances, household holdings of bond and stock funds are also net of such assets. However, unlike M2, those household holdings can increase if bonds and stocks appreciate and thus do not necessarily represent funds out of new savings.

[19] The regressions use quarterly observations on year-over-year changes in BS and $MM2$ and are run from 1991Q1 to 1996Q4.

Figure 1   The Missing M2 and the Cumulative Change in Household Holdings of Bond and Stock Mutual Funds since 1990
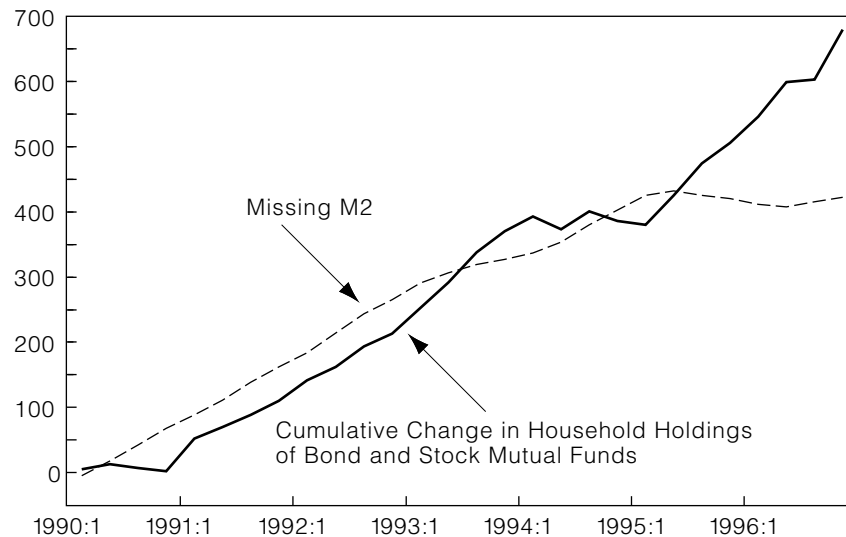
Notes: The missing M2 is the reduction in M2 demand that is due to the bond rate spread. Household holdings are net of institutional and IRA/Keogh assets.

4.   CONCLUDING OBSERVATIONS

It is now known that the public's demand for M2 experienced a leftward shift in the early '90s. It is widely believed that this shift reflected the public's desire to redirect savings balances from bank deposits to long-term financial assets, including bond and stock mutual funds. In this article, I test this popular hypothesis. In particular, I present evidence that a standard M2 demand regression augmented to capture the impact of the long-term interest rate on money demand can account for most of the missing M2 since 1990 and that changes in this missing M2 are highly correlated with changes in household holdings of bond and stock mutual funds in the early 1990s.

The evidence here, however, also indicates that the long-term interest rate has no predictive content for M2 demand in the pre-missing M2 period. That result suggests caution in assigning a causal role to the independent influence of the long-term rate on M2 demand found in the missing M2 period. Furthermore, household holdings of bond and stock mutual funds continued to increase in the years 1995 and 1996, but that increase has not accompanied any weakness

in M2. Hence increases in household holdings of bond and stock mutual funds may not necessarily signal instability in M2 demand.

One interpretation of the recent behavior of M2 demand is that some special factors caused a leftward shift in the public's M2 demand. The evidence here is consistent with the view that those special factors included the combination of the unusual steepening of the yield curve and the increased availability, liquidity, and public awareness of bond and stock mutual funds. The evidence so far is that those special factors have not changed fundamentally the character of M2 demand beyond causing a one-time permanent shift in the level of M2 balances demanded by the public. Hence the result that the leftward shift in M2 demand ended two years ago should now be of interest to monetary policymakers.

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