

Has M2 Demand Become Unstable?

Yash P. Mehra

I. INTRODUCTION

An important issue underlying the current discussion of monetary policy is the interpretation of the recent weakness in the monetary aggregate, M2. Since about 1990, standard money demand regressions have overpredicted M2 growth. The dilemma for policymakers is to determine whether this shortfall in M2 growth has resulted from a shift in money demand or whether it indicates that the Federal Reserve has been supplying an inadequate amount of money to the economy.

A number of analysts contend that the size of the recent shortfall in M2 growth is large and unpredictable. They therefore conclude that the public's M2 demand function has shifted leftward.¹ Those who hold this view believe that M2 is no longer useful as an indicator variable for the thrust of monetary policy.

This paper presents the results of empirical tests of the stability of M2 demand over the period 1990Q1 to 1992Q2. Standard M2 demand regressions typically include a scale variable measured by real GDP and an opportunity cost defined as a short-term nominal rate minus the rate of return on M2 itself (the so-called own rate). The regressions presented here do indeed generate prediction errors in 1990, 1991, and 1992 that cumulate to an overprediction of M2 of about \$144 to \$149 billion (4.2 to 4.3 percent) by the second quarter of 1992. The Dufour test, which is a version of the Chow test, indicates that the prediction errors of this magnitude are not statistically significant. These test results are consistent with the hypothesis that the standard M2 demand regression is stable over the period 1990Q1 to 1992Q2.

Although the prediction errors are not large by the Dufour test, they have been consistently negative.

¹ See, for example, Carlson and Parrott (1991) and Duca (1992), who use the M2 demand model given in Small and Porter (1989) to demonstrate that M2 demand is seriously overpredicted in recent years. The M2 demand regression given in Small and Porter (1989) is based on an error-correction model of nominal M2 demand. The model includes a linear time trend and is estimated under the assumption that nominal M2 and GNP are cointegrated.

This may indicate that some alternative factors not accounted for in standard M2 demand regressions have been depressing M2 growth in recent years. The appendix to this paper examines the role of a yield curve variable, namely, the long-term nominal interest rate minus the own rate on M2. This variable captures substitutions by households out of M2 into long-term financial assets. The empirical work shows that the yield curve variable is significant in a money demand regression that includes post-1989 data, but not pre-1989 data. Such a money demand regression can account for most of the "unexplained" weakness of M2 during the current period. This result is consistent with the hypothesis that M2 demand in recent years has been affected by portfolio substitutions. The hypothesis needs to be confirmed with more out-of-sample data and must therefore be considered tentative. In any event, the size of the current shortfall in M2 that can be attributed to these portfolio substitutions is not so large as to render irrelevant the short-run behavior of M2.

The plan of this article is as follows. Section II presents the error-correction model of M2 demand used here. Section III presents the empirical results. Concluding observations are given in Section IV. The appendix examines whether adding a yield curve variable to a standard money demand regression can account for the recent shortfall in M2 growth.

II. THE MODEL AND THE METHODOLOGY An M2 Demand Model

The error-correction money demand model used here is reproduced below (Mehra, 1991 and 1992).

$$\ln(rM2)_t = a_0 + a_1 \ln(rY)_t + a_2 (R - RM2)_t + U_t \quad (1)$$

$$\begin{aligned} \Delta \ln(rM2)_t = & b_0 + \sum_{s=1}^{n1} b_{1s} \Delta \ln(rM2)_{t-s} \\ & + \sum_{s=0}^{n2} b_{2s} \Delta \ln(rY)_{t-s} \\ & + \sum_{s=0}^{n3} b_{3s} \Delta (R - RM2)_{t-s} \\ & + \lambda U_{t-1} + \epsilon_t, \end{aligned} \quad (2)$$

where $rM2$ is real M2 balances; rY real income; R a short-term nominal interest rate; $RM2$ the own rate on M2; U and ϵ the random disturbance terms. Δ is the first-difference operator and \ln the natural logarithm. 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 GNP and an opportunity cost variable measured as the differential 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 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 balances to changes in income and opportunity cost variables. The parameter λ is the error-correction coefficient. It is assumed that if the variables in (1) are nonstationary, they are cointegrated (Engle and Granger, 1987). Under this assumption, the parameter λ that appears on U_{t-1} in (2) is likely to be non-zero.

Estimating the Money Demand Model: Imposing the Convergence Condition

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).

$$\begin{aligned} \Delta \ln(rM2)_t &= d_0 + \sum_{s=1}^{n1} b_{1s} \Delta \ln(rM2)_{t-s} \\ &+ \sum_{s=0}^{n2} b_{2s} \Delta \ln(rY)_{t-s} \\ &+ \sum_{s=0}^{n3} b_{3s} \Delta (R - RM2)_{t-s} \\ &+ d_1 \ln(rM2)_{t-1} + d_2 \ln(rY)_{t-1} \\ &+ d_3 (R - RM2)_{t-1} + \epsilon_t, \end{aligned} \quad (3)$$

where $d_0 = (b_0 - a_0\lambda)$
 $d_1 = \lambda$
 $d_2 = -\lambda a_1$
 $d_3 = -\lambda a_2.$

As can be seen, the long- and short-run parameters of the money demand model now appear in (3). The key parameters of (1) and (2) that pertain to income and opportunity cost variables can be recovered from (3).

The long-run 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 . The short-run part of (3) yields another estimate of the long-term income elasticity, i.e., $(\sum_{s=0}^{n2} b_{2s}) / (1 - \sum_{s=1}^{n1} b_{1s})$.

If the same scale variable appears in the long- and short-run parts of the model, then a convergence condition can be imposed in equation (3) to ensure that one gets the same point-estimate of the long-run scale elasticity. To explain further, assume that the long-run income elasticity is unity, i.e., $a_1 = 1$ in (1). This assumption implies the following restriction on the long-run part of equation (3).

$$d_1 + d_2 = 0 \quad (4)$$

Equation (4) says that coefficients that appear on $\ln(rY)_{t-1}$ and $\ln(rM2)_{t-1}$ in (3) sum to zero. The convergence condition implies another restriction (5) on the short-run part of equation (3).

$$\left(\sum_{s=0}^{n2} b_{2s} \right) / \left(1 - \sum_{s=1}^{n1} b_{1s} \right) = 1.0 \quad (5)$$

Equivalently, (5) can be expressed as

$$\sum_{s=0}^{n2} b_{2s} + \sum_{s=1}^{n1} b_{1s} = 1.0.$$

That is, coefficients that appear on $\Delta \ln(rM)_{t-s}$ and $\Delta \ln(rY)_{t-s}$ in (3) sum to unity. This study examines whether the test results of stability are sensitive to the convergence condition imposed.

Data and Definition of Variables

The empirical work reported here uses quarterly data over the period 1953Q1 to 1992Q2. The variable $rM2$ is measured as nominal M2 deflated by the implicit GDP price deflator; rY by real GDP; R by the four- to six-month commercial paper rate; and $RM2$ by the weighted average of the explicit rates paid on the components of M2.

Real income appears as a scale variable in both the long- and short-run parts of the money demand regression (3). In contrast, the empirical work reported by Small and Porter (1989) uses consumer spending as the short-run scale variable and GNP as the long-run scale variable. They reason that some components of GNP, such as business fixed investment and changes in inventories, do not generate as much increase in money balances in the short run as does consumer expenditure. Equation (3) is alternatively estimated using real consumer spending as

the short-run scale variable and real GNP as the long-run scale variable. Real consumer expenditure is hereafter denoted as rC .²

III. EMPIRICAL RESULTS

Estimated Standard M2 Demand Regressions

Table 1 presents results of estimating the standard money demand regression (3) over the period

² All the data for the post-1959 period is from the Citibank data base with the exception of RM2. M2 for the pre-1959 period and RM2 are constructed as described in Hetzel (1989). Real GDP for the pre-1959 period are constructed by applying growth rates of real GNP to the real GDP series. Real consumption expenditure for the pre-1959 period are analogously constructed.

1953Q1 to 1989Q4. Regression A in Table 1 gives unrestricted estimates of the money demand regression, whereas regression B gives estimates that satisfy the convergence condition. That is, the regression satisfies the restrictions (4) and (5). The regressions reported in Table 1 use real GDP as the short- and the long-run scale variables, whereas the regressions reported in Table 2 use real consumer expenditure as the short-run scale variable and real GDP as the long-run scale variable.

The unrestricted estimates of the money demand regressions reported in Tables 1 and 2 indicate that the long-run GDP elasticity calculated from the long-run part of the model is unity (see regressions A and C in Tables 1 and 2). This result indicates that it

Table 1

Error-Correction Standard M2 Demand Regressions; 1953Q1 to 1989Q4 Real GDP in the Short- and Long-Run Parts of the Model

Regression A. Estimates without the Convergence Condition

$$\begin{aligned} \Delta \ln(rM2)_t = & -.02 + .31 \Delta \ln(rM2)_{t-1} + .14 \Delta \ln(rM2)_{t-2} + .07 \Delta \ln(rY)_t + .05 \Delta \ln(rY)_{t-1} - .003 \Delta(R - RM2)_t \\ & (1.2) \quad (4.4) \quad (1.9) \quad (1.2) \quad (.9) \quad (4.6) \\ & - .004 \Delta(R - RM2)_{t-1} - .05 \ln(rM2)_{t-1} + .05 \ln(rY)_{t-1} - .002 (R - RM2)_{t-1} - .012 CC1 \\ & (5.1) \quad (2.1) \quad (2.1) \quad (3.3) \quad (2.1) \\ & - .001 CC2 + .020 D83Q1 \\ & (0.0) \quad (3.0) \end{aligned}$$

$$\begin{aligned} CRSQ = .64 \quad SER = .00551 \quad DW = 2.1 \quad Q(36) = 25.4 \\ N_{rY} = 1.0 \quad N_{(R-RM2)} = -.10 \text{ [evaluated at the sample mean]} \end{aligned}$$

Regression B. Estimates with the Convergence Condition

$$\begin{aligned} \Delta \ln(rM2)_t = & -.04 + .43 \Delta \ln(rM2)_{t-1} + .25 \Delta \ln(rM2)_{t-1} + .17 \Delta \ln(rY)_t + .15 \Delta \ln(rY)_{t-1} - .003 \Delta(R - RM2)_t \\ & (3.7) \quad (6.3) \quad (3.5) \quad (3.0) \quad (2.7) \quad (4.6) \\ & - .005 \Delta(R - RM2)_{t-1} - .08 \ln(rM2)_{t-1} + .08 \ln(rY)_{t-1} - .001 (R - RM2)_{t-1} - .01 CC1 \\ & (6.4) \quad (3.6) \quad (3.6) \quad (1.56) \quad (2.2) \\ & + .001 CC2 + .02 D83Q1 \\ & (.2) \quad (3.1) \end{aligned}$$

$$\begin{aligned} CRSQ = .58 \quad SER = .00578 \quad DW = 2.2 \quad Q(36) = 31.7 \\ N_{rY} = 1.0 \quad N_{(R-RM2)} = -.03 \text{ [evaluated at the sample mean]} \end{aligned}$$

Notes: $rM2$ is real M2 balances; rY real GDP; R the four- to six-month commercial paper rate; $RM2$ the own rate on M2; \ln the natural logarithm; and Δ the first-difference operator. $CC1$, $CC2$, and $D83Q1$ are, respectively, one in 1980Q2, 1980Q3 and 1983Q1 and zero otherwise. $CRSQ$ is the corrected R-squared; SER the standard error of regression; DW the Durbin-Watson Statistic; $Q(36)$ the Ljung-Box Q-statistic based on 36 autocorrelations of the residuals. The long-term income elasticity, N_{rY} , is given by the estimated coefficient on $\ln(rY)_{t-1}$ divided by the estimated coefficient on $\ln(rM2)_{t-1}$.

Table 2

Error-Correction Standard M2 Demand Regressions; 1953Q1 to 1989Q4
Real GDP as the Long-Run Scale Variable and Real
Consumer Expenditure as the Short-Run Scale Variable

Regression C. Estimates without the Convergence Condition

$$\begin{aligned} \Delta \ln(rM2)_t = & -.04 + .30 \Delta \ln(rM2)_{t-1} + .14 \Delta \ln(rM2)_{t-2} + .17 \Delta \ln(rC)_t + .20 \Delta \ln(rC)_{t-1} - .003 \Delta(R - RM2)_t \\ & (1.8) \quad (4.3) \qquad (1.9) \qquad (2.1) \qquad (2.5) \qquad (4.9) \\ & - .004 \Delta(R - RM2)_{t-1} - .06 \ln(rM2)_{t-1} + .06 \ln(rY)_{t-1} - .002 (R - RM2)_{t-1} - .01 CC1 \\ & (5.2) \qquad (2.6) \qquad (2.6) \qquad (3.0) \qquad (1.7) \\ & + .001 CC2 + .02 D83Q1 \\ & (.2) \qquad (3.4) \end{aligned}$$

$$\begin{aligned} CRSQ = .66 \quad SER = .00534 \quad DW = 2.1 \quad Q(36) = 23.6 \\ N_{rY} = 1.0 \quad N_{(R - RM2)} = -.08 \text{ [evaluated at the sample mean]} \end{aligned}$$

Regression D. Estimates with the Convergence Condition

$$\begin{aligned} \Delta \ln(rM2)_t = & -.03 + .33 \Delta \ln(rM2)_{t-1} + .17 \Delta \ln(rM2)_{t-2} + .23 \Delta \ln(rC)_t + .26 \Delta \ln(rC)_{t-1} - .003 \Delta(R - RM2)_t \\ & (3.0) \quad (4.9) \qquad (2.6) \qquad (3.5) \qquad (3.8) \qquad (4.8) \\ & - .004 \Delta(R - RM2)_{t-1} - .06 \ln(rM2)_{t-1} + .06 \ln(rY)_{t-1} - .001 (R - RM2)_{t-1} + .008 CC1 \\ & (5.8) \qquad (3.1) \qquad (3.1) \qquad (2.5) \qquad (1.5) \\ & + .003 CC2 + .02 D83Q1 \\ & (.5) \qquad (3.4) \end{aligned}$$

$$\begin{aligned} CRSQ = .66 \quad SER = .00536 \quad DW = 2.1 \quad Q(36) = 23.6 \\ N_{rY} = N_{rC} = 1.0 \quad N_{(R - RM2)} = -.02 \text{ [evaluated at the sample mean]} \end{aligned}$$

Notes: See notes in Table 1. rC is real consumption expenditure.

is appropriate to impose the convergence condition if real GDP is also the short-run scale variable (see regression B in Table 1). The empirical results reported in Mankiw and Summers (1986) indicate that the long-run real consumption expenditure elasticity is not different from unity. Hence, the convergence condition is imposed even when real consumer expenditure is the short-run scale variable (see regression D in Table 2).

The estimated money demand regressions B and D look reasonable. The coefficients that appear on the scale and opportunity cost variables have theoretically correct signs and are statistically significant. The use of real consumption expenditure in the short-run part of the model does reduce somewhat the standard error of the regression, suggesting real consumption expenditure may be a better short-run scale variable than real GDP.

Evaluating Standard Money Demand Regressions

Is the actual behavior of real M2 balances over 1990Q1 to 1992Q2 consistent with stable M2 demand behavior? This question is investigated by using the Dufour test (Dufour, 1980), which is a variant of the Chow test. It uses an F-statistic to test the joint significance of dummy variables introduced for each observation of the interval for which structural stability is examined. A small F-statistic indicates structural stability.

The results of the Dufour test for the period 1990Q1 to 1992Q2 appear in Table 3. To carry out the test, the regressions in Table 1 and 2 were reestimated over the period 1953Q1 to 1992Q2 with separate shift dummies introduced for each quarter from 1990Q1 to 1992Q2. As can be seen, the

Table 3

**Evidence on Stability in Standard M2 Demand Regressions over 1990Q1 to 1992Q2
Coefficients (t-values) on Dufour Dummies**

Year/Quarter	Regression A	Regression B	Regression C	Regression D
1990Q1	-.006 (1.1)	-.005 (.9)	-.005 (.9)	-.003 (.7)
1990Q2	-.009 (1.6)	-.008 (1.3)	-.008 (1.4)	-.006 (1.3)
1990Q3	-.008 (1.5)	-.005 (.9)	-.007 (1.3)	-.005 (1.0)
1990Q4	-.009 (1.3)	-.003 (.4)	-.006 (1.0)	-.003 (.6)
1991Q1	-.009 (1.5)	-.003 (.5)	-.005 (.1)	-.001 (.3)
1991Q2	-.005 (.9)	-.005 (.1)	-.003 (.5)	-.003 (.1)
1991Q3	-.012 (2.1)	-.008 (1.4)	-.011 (2.0)	-.009 (1.7)
1991Q4	-.007 (1.1)	-.002 (.4)	-.005 (.9)	-.002 (.4)
1992Q1	-.008 (1.3)	-.003 (.5)	-.007 (1.2)	-.004 (.9)
1992Q2	-.018 (3.0)	-.014 (2.4)	-.017 (3.0)	-.015 (3.0)
FD(10,137)		1.06		1.50
FD(10,135)	1.66		1.45	

Notes: The regression equations A, B, C, and D above correspond, respectively, to regressions reported in Tables 1 and 2. These regressions are reestimated including Dufour dummy variables over the period 1953Q1 to 1992Q2. Dufour dummies are zero-one dummy variables defined for each observation over 1990Q1 to 1992Q2. FD is the F-statistic that tests the null hypothesis that all Dufour dummies are not significant as a group. The degrees of freedom for the F-statistics are in parentheses.

individual coefficients that appear on the shift dummies are generally not statistically significant with the exception of the one for the second quarter of 1992. FD is the F-statistic that tests the null hypothesis that these shift dummies are not significant as a group. These F-statistics are small (the 5 percent critical value is 1.9) and thus indicate that the standard M2 demand regression is stable. The stability result is not sensitive to the short-run scale variable used or to whether the convergence condition is imposed or not. (The conventional Chow test with the shift point located at or before 1990Q1 also indicates that the M2 demand regression is stable.)³

The coefficients that appear on the Dufour dummies measure (static) errors that occur in predicting real M2 balances over the period 1990Q1 to 1992Q2. As can be seen, these prediction errors, though small, are consistently negative, suggesting that the standard money demand regression used here consistently overpredicts real M2 balances over this period. In order to provide a different insight into the magnitude of the prediction error, Table 4 presents static simulations of M2 growth conditional on actual values of scale and opportunity cost variables. The predicted values are generated using

³ Bleaney (1990) notes that when the shift point is close to the end of the data set, the appropriately located Chow test is more powerful than some other general tests for structural change.

the regressions reported in Tables 1 and 2. (The regressions are estimated over 1953Q1 to 1989Q4 and then simulated over 1981Q1 to 1992Q2.) Actual M2 growth and prediction errors (with summary statistics) are also reported.

The results reported in Table 4 suggest two observations. The first is that the imposition of the convergence condition raises substantially the accuracy of M2 forecasts from the standard M2 demand regression. The root mean squared error (RMSE) declines by about 30 percent when the long-run real GDP elasticity is constrained to be unity. (Compare the RMSEs of regressions A with B and C with D in Table 4.) Over the recent period 1990Q1 to 1992Q2, regressions A and C, which ignore the convergence condition, generate prediction errors in 1990, 1991, and 1992 that cumulate to an overprediction of the level of M2 of about \$324 to \$257 billion, or 9.3 to 7.4 percent, by the second quarter of 1992. These results suggest that the public's M2 demand function experienced a large leftward shift. However, regressions B and D, which impose the convergence condition, indicate a much smaller leftward shift. Prediction errors from the latter regressions cumulate to an overprediction of M2 of only \$144 to \$149 billion, or 4.2 to 4.3 percent.

The second observation is that standard M2 demand regressions systematically overpredict real M2

Table 4

Actual and Predicted M2 Growth; Standard M2 Demand Regressions

Year	AG	Regression A		Regression B		Regression C		Regression D	
		PG	E	PG	E	PG	E	PG	E
1981	8.9	8.5	.3	9.7	-.8	8.5	.4	8.6	.2
1982	8.7	7.8	.7	8.4	.3	8.3	.4	8.4	.3
1983	11.5	12.3	-.7	13.5	-1.9	12.4	-.9	12.7	-1.2
1984	7.7	7.3	.3	7.6	.1	7.5	.2	7.4	.3
1985	8.3	8.8	-.5	8.9	-.6	9.1	-.8	9.0	-.7
1986	8.8	7.8	1.0	7.3	1.5	7.9	.9	7.5	1.3
1987	4.2	5.4	-1.2	4.3	-.1	4.7	-.5	4.0	.2
1988	5.1	6.2	-1.1	5.3	-.2	6.2	-1.1	5.7	-.6
1989	4.7	6.1	-1.5	5.1	-.4	5.8	-1.1	5.1	-.4
1990	3.9	7.1	-3.2	6.0	-2.1	6.6	-2.6	5.7	-1.8
1991	2.8	6.1	-3.3	4.2	-1.4	5.2	-2.4	3.9	-1.2
Mean Error			-.8		-.5		-.7		-.3
RMSE			1.61		1.12		1.29		.89
Cumulative Error by 1992Q2									
Level (billions)			-323.5		-144.3		-257.3		-148.9
Percentage			9.3		4.2		7.4		4.3

Notes: AG is actual M2 growth; PG predicted M2 growth; and E the prediction error. The predicted values are generated using the money demand regressions reported in Tables 1 and 2. The money demand regressions are estimated over 1953Q1 to 1989Q4 and simulations begin in 1981. RMSE is the root mean squared error.

demand in recent years. This indicates that some additional factors not accounted for in standard M2 demand regressions may be depressing M2 growth in recent years. The appendix to this paper examines the role of a yield curve variable.

IV. CONCLUDING OBSERVATIONS

Since about 1990, standard money demand regressions have overpredicted M2 growth. The empirical results presented here indicate that the size of these prediction errors is consistent with the presence of a stable M2 demand function over the period 1990Q1 to 1992Q2.

The error-correction money demand regressions estimated without the convergence condition do not predict well the current slowdown in M2 growth. The reason is that in such regressions the coefficients on the short-run scale variables are small in magnitude

and at times even statistically insignificant. Such estimated short-run coefficients do not cumulate to satisfy the long-run constraint that the long-term scale elasticity is unity. As a result, such regressions may indicate that the short-run changes in real M2 balances are not closely related to short-run changes in the scale variable.

However, not all of the recent slowdown in M2 is predicted by standard M2 demand regressions. The expanded M2 demand regressions reported in the appendix indicate that the recent unexplained weakness in M2 may be due to portfolio substitutions triggered by the steepening of the yield curve. Nevertheless, the size of the current shortfall in M2 that is due to these portfolio substitutions is not so large as to render irrelevant the short-run behavior of M2. M2 has been weak primarily because economic activity has been weak.

APPENDIX

This appendix examines whether a yield curve variable added to M2 demand regressions can account for the recent shortfall in M2 growth.

One of the explanations that has been offered for the recent shortfall in M2 growth is that households have substituted out of M2 into long-term financial assets such as bond and equity funds.⁴ These portfolio substitutions were triggered in part by declines in short-term interest rates in general and deposit rates on components of M2 in particular. The steepening of the yield curve encouraged investors to substitute into non-M2 assets.

The slope of the yield curve variable is measured by the long-term bond rate minus the own rate on M2. This variable is used to test whether substitutions by households out of M2 into long-term financial assets can account for the recent money demand prediction error.⁵ The yield curve variable is usually not significant in M2 demand regressions if the estimation period excludes the post-1989 data. This result means that long-term interest rates did not influence M2 demand prior to 1989. Hence, these regressions cannot account for the weakness in M2 over the post-1989 sample period. (These results are not reported.)

The yield curve variable enters significantly in money demand regressions if the estimation period includes the post-1989 data. Table 5 reports regression results when the most recent data are used to estimate the influence of the yield curve variable on money demand. In particular, the yield curve measure is entered in the money demand regression as the product of the long-term cost measure and a zero-one dummy that is unity in 1989Q1 to 1992Q2 and zero otherwise. The regressions are estimated over 1954Q2 to 1992Q2.⁶ The regression F in Table 5 uses real GDP as the scale variable, whereas the regression G uses real consumer spending as the short-run scale variable and real GDP as the long-

run scale variable. Both regressions are estimated under the constraint that the long-run scale elasticity is unity.⁷ As can be seen, the yield curve measure enters with the theoretically correct sign and is statistically significant in both regressions. (The yield curve variable is significant even when it is entered in money demand regressions without the interactive dummy.)

Table 6 evaluates whether the regressions reported in Table 5 can eliminate the prediction error over the period 1990Q1 to 1992Q2. In particular, the regressions reported in Table 5 were simulated over 1981Q1 to 1992Q2. The resulting within-sample forecasts of M2 growth are reported in Table 6. As can be seen, the expanded M2 demand regression explains most of the current shortfall in M2. The cumulative overprediction of M2 is now about \$8 to \$11 billion by the second quarter of 1992. (The cumulative overprediction of M2 is \$84 to \$86 billion or about 2.5 percent when the yield curve variable is added to money demand regressions without the interactive dummy.)

In sum, the yield curve variable captures substitutions by households between M2 and other long-term financial assets. The empirical work shows that this variable is significant in money demand regressions estimated including the post-1989 data. This result implies that M2 demand in recent years has been affected by portfolio substitutions. However, one needs more observations before one can reliably conclude whether this variable is capturing the random variation in money demand or whether it is capturing the recent systematic influence of the long-term rate on money demand.⁸

⁷ The unconstrained estimate of the long-run part of the money demand regression indicates that the long-run GDP elasticity is unity.

⁸ The portfolio substitutions emphasized here are not the only explanation offered for the current weakness in M2. Some have argued that households experienced an adverse shock to their wealth that caused them to desire a smaller amount of debt. They are now reducing their debt by drawing down deposits in M2. Others have suggested that a number of regulatory and economic pressures have reduced the size of the depository system, thereby rechanneling credit flows away from depository institutions and lessening their need to issue monetary liabilities included in M2.

The standard M2 demand regression was alternatively estimated including a lagged value of the level and/or the change in real household net worth. These variables entered with the wrong sign and in general were not significant in the regressions. Similarly, changes in the size of the depository sector were captured by changes in the ratio of deposits in thrift institutions to M2. This variable when included in M2 demand regressions was also not significant.

⁴ Hetzel (1992) provides a thorough review of these alternative explanations. He argues that no single explanation appears to account for the "missing M2" during the recent period.

⁵ Others have followed a different approach. For example, Duca (1992) redefines M2 to include funds held in bond and equity mutual funds and then examines whether money demand regressions estimated using mutual funds adjusted M2 series can account for the "missing M2" in recent years. He concludes that the growth of these mutual funds accounts for only a small part of the "missing M2." Hetzel (1992) arrives at a similar conclusion.

⁶ The sample period begins in 1954Q2 because the data on the ten-year bond rate used here begins in 1953Q4.

Table 5

Expanded M2 Demand Regressions; 1954Q2 to 1992Q2**Regression F. Real GDP in the Short- and Long-Run Parts of the Model**

$$\begin{aligned} \Delta \ln(rM2)_t = & -.04 + .45 \Delta \ln(rM2)_{t-1} + .25 \Delta \ln(rM2)_{t-2} + .15 \Delta \ln(rY)_t + .14 \Delta \ln(rY)_{t-1} - .003 \Delta(R - RM2)_t \\ & (3.5) \quad (6.7) \quad (3.5) \quad (2.7) \quad (2.7) \quad (4.7) \\ & - .005 \Delta(R - RM2)_{t-1} - .07 \ln(rM2)_{t-1} + .07 \ln(rY)_{t-1} - .0001 (R - RM2)_{t-1} - .012 CC1 \\ & (6.5) \quad (3.4) \quad (3.4) \quad (1.4) \quad (2.0) \\ & - .001 CC2 + .02 D83Q1 - .001 (R10 - RM2)_{t-1} * D_{t-1} - .009 \Delta(R10 - RM2)_{t-1} * D_{t-1} \\ & (.1) \quad (3.2) \quad (1.8) \quad (2.3) \end{aligned}$$

$$CRSQ = .64 \quad SER = .00555 \quad DW = 2.1 \quad Q(36) = 33.3$$

Regression G. Real Consumption Expenditure as the Short-Run Scale Variable and Real GDP as the Long-Run Scale Variable

$$\begin{aligned} \Delta \ln(rM2)_t = & -.02 + .35 \Delta \ln(rM2)_{t-1} + .17 \Delta \ln(rM2)_{t-2} + .23 \Delta \ln(rC)_t + .24 \Delta \ln(rC)_{t-1} - .001 \Delta(R - RM2)_t \\ & (2.7) \quad (5.4) \quad (2.6) \quad (3.7) \quad (3.7) \quad (5.0) \\ & - .005 \Delta(R - RM2)_{t-1} - .06 \ln(rM2)_{t-1} + .06 \ln(rY)_{t-1} - .001 (R - RM2)_{t-1} - .009 CC1 \\ & (6.1) \quad (2.8) \quad (2.8) \quad (2.3) \quad (1.6) \\ & + .002 CC2 + .02 D83Q1 - .001 (R10 - RM2)_{t-1} * D_{t-1} - .009 \Delta(R10 - RM2)_{t-1} * D_{t-1} \\ & (.5) \quad (3.5) \quad (1.8) \quad (2.4) \end{aligned}$$

$$CRSQ = .69 \quad SER = .00511 \quad DW = 2.1 \quad Q(36) = 24.7$$

Notes: R10 is the ten-year bond rate; D a zero-one dummy that is one over 1989Q1 to 1992Q4 and zero otherwise. All other variables are as defined before.

REFERENCES

- Bleaney, Michael. "Some Comparisons of the Relative Power of Simple Tests for Structural Change in Regression Models," *Journal of Forecasting*, vol. 9 (1990), pp. 437-44.
- Carlson, John B. and Sharon E. Parrott. "The Demand for M2, Opportunity Cost, and Financial Change," Federal Reserve Bank of Cleveland *Economic Review*, vol. 27 (Quarter 2, 1991), pp. 2-11.
- Duca, John V. "The Case of the Missing M2," Federal Reserve Bank of Dallas *Economic Review* (Quarter 2, 1992), pp. 1-24.
- Dufour, Jean-Marie. "Dummy Variables and Predictive Tests for Structural Change," *Economic Letters*, vol. 6 (1980), pp. 241-47.
- Engle, R. F. and C. W. J. Granger. "Cointegration and Error-Correction: Representation, Estimation and Testing," *Econometrica*, vol. 55 (March 1987), pp. 251-76.
- Hetzl, Robert L. "M2 and Monetary Policy," Federal Reserve Bank of Richmond *Economic Review*, vol. 75 (September/October 1989), pp. 14-29.
- . "How Useful is M2 Today?" Federal Reserve Bank of Richmond Memo, September 25, 1992.
- Mankiw, N. Gregory and Lawrence H. Summers. "Money Demand and the Effects of Fiscal Policies," *Journal of Money, Credit and Banking* (November 1986), pp. 415-29.
- Mehra, Yash P. "An Error-Correction Model of U.S. M2 Demand," Federal Reserve Bank of Richmond *Economic Review*, vol. 77 (May/June 1991), pp. 3-12.
- . "The Stability of the M2 Demand Function: Evidence from an Error-Correction Model," *Journal of Money, Credit and Banking*, forthcoming 1993.
- Small, David H. and R. D. Porter. "Understanding the Behavior of M2 and V2," *Federal Reserve Bulletin* (April 1989), pp. 244-54.

Table 6
Actual and Predicted M2 Growth; 1981 to 1991

Year	AG	Regression F		Regression G	
		PG	E	PG	E
1981	8.9	9.7	-.7	8.6	.3
1982	8.7	8.5	.2	8.4	.3
1983	11.5	13.6	-2.0	12.7	-1.2
1984	7.7	7.7	.0	7.3	.3
1985	8.3	8.9	-.6	9.0	-.7
1986	8.8	7.3	1.5	7.5	1.3
1987	4.2	4.3	-.1	4.0	.1
1988	5.1	5.3	-.2	5.7	-.6
1989	4.7	5.5	-.8	5.5	-.8
1990	3.9	4.0	-.1	3.7	.2
1991	2.8	2.2	.6	2.1	.7
<hr/>					
Mean Error			-.20		-.02
RMSE			.86		.66
<hr/>					
Cumulative Error by 1992Q2					
Level (billions)			-8.0		-11.5
Percentage			.2		.3

Notes: The predicted values are generated using regressions F and G reported in Table 5. These regressions are estimated over 1954Q2 to 1992Q2 and simulated over 1981Q1 to 1992Q2.