

# RECENT FINANCIAL DEREGULATION AND THE INTEREST ELASTICITY OF M1 DEMAND

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*Some analysts contend that the introduction nationwide since 1981 of interest-bearing NOWs and Super NOWs has raised the interest elasticity of M1 demand. This article presents empirical evidence consistent with this view. The demand deposit component of M1 does not exhibit any heightened interest-sensitivity, suggesting it is the OCD component that has lately been more interest-sensitive. Furthermore, it is also shown that the interest elasticity of M1 demand neither changed nor was it very high during the 1970s, a period of substantial financial innovations. This implies that it is the interest rate deregulation, as opposed to financial innovations, that has affected the character of M1 demand.*

## Introduction

It has been suggested that the introduction of interest paying accounts such as NOWs and Super NOWs might have raised the interest elasticity of money demand.<sup>1</sup> Two interrelated reasons have been advanced for this potential rise in interest elasticity. First, M1 now contains assets potentially suitable for savings. It is therefore possible that the public's demand for it is now more sensitive to market yields than in the past when it was closer to a pure transaction aggregate. This is so because the own rate of return on some assets like NOWs is regulated and set below open market rates.<sup>2</sup> Second, NOW accounts pay explicit interest but demand deposits do not. A given change in market interest rates thus causes a larger proportional change in the opportunity cost of holding NOWs than of holding demand

deposits.<sup>3</sup> As a result, changes in market rates might induce larger changes in NOWs than in demand deposits, thereby increasing the interest responsiveness of M1 as a whole as NOWs become a larger fraction of M1.<sup>4</sup>

<sup>3</sup>The interest elasticity of the opportunity cost of holding NOWs can be expressed as  $\Delta(R-R_{now})(R)/(DR)(R-R_{now})$ , where  $R$  is the market interest rate,  $R_{now}$  is the rate offered on NOWs and  $\Delta$  is the first difference operator. If  $R_{now}$  is fixed, then the above expression reduces to  $(R/R_{now})$ . Furthermore, if  $R_{now}$  is less than  $R$ , the expression is greater than one.

<sup>4</sup>To clarify further the second point let us express the aggregate interest elasticity of M1 demand as the weighted average of its component interest elasticities

$$E_{M1,R} = \frac{CC}{M1}(ECC,0_1 \cdot E_{01,R}) + \frac{DD}{M1}(EDD,0_2 \cdot E_{02,R}) + \frac{OCD}{M1}(EOCD,0_3 \cdot E_{03,R}) \quad (a)$$

where the first terms in the parentheses  $ECC,0_1$ ,  $EDD,0_2$ , and  $EOCD,0_3$  are respectively the elasticities of currency, demand deposits, and other checkable deposits with respect to the relevant opportunity cost variables and where the second terms ( $E_{0i,R}$ ;  $i=1,2,3$ ) measure elasticities of these opportunity cost variables with respect to the market rate of interest. The opportunity cost variable for any one component is defined as the difference between the market interest rate and the nominal yield paid on that component.  $E_{M1,R}$  is the aggregate interest elasticity of the M1 demand. The weights in (a) are the respective shares of these components in M1. The component demand elasticities with respect to the opportunity cost variables can in general be different. Moreover, the elasticities of the opportunity cost variables with respect to the market interest rate can also differ from each other.

An important consideration that is relevant in determining the magnitude of the opportunity cost elasticity of a given component in (a) is the behavior of the own rate offered on the component asset. If the interest rate offered on the component asset is either fixed to be zero or strictly proportional to the market interest rate, then the opportunity cost elasticity of that component is unity. But consider now the case in which the explicit interest offered on one component of M1 is regulated and kept below the market interest rate, as was the case for the NOWs component of the other checkable deposits. In this case the interest elasticity of the opportunity cost variable pertaining to that component ( $E_{0i,R}$ ) can be greater than unity. An implication of this is that even if no change occurs in the elasticity of this component with respect to its own opportunity cost variable ( $EOCD,0_3$ ) the aggregate interest elasticity of M1 demand can increase simply because the share of the regulated component in M1 grows over time, other things remaining the same.

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<sup>1</sup>Brayton, Farr, and Porter (1983) and Simpson (1984).

<sup>2</sup>As of January 1986 this regulatory constraint on the interest rate payable on NOW accounts has been removed.

The behavior of interest elasticity of money demand has a bearing *on* how one interprets the recent behavior of MI velocity. MI velocity, instead of rising at its previous trend rate of 3 percent per year, has remained fairly steady in the early 1980s. Moreover, whenever interest rates fell velocity has also declined sharply. Now, if MI demand has recently become more sensitive to the cost of holding money, then the observed behavior of velocity could be predictable. Interest rates, both nominal and real, have trended downward during the last few years. Such fall in rates increases money demand and thus lowers velocity. Increase in money demand could be large if interest elasticity is high. Since money affects income with lags, velocity, conventionally measured by the ratio of income to contemporaneous money, could decline sharply over the short run.

The main objective of this article is to examine whether the interest elasticity of money demand has changed during the last few years. Now that a substantial fraction of the assets included in MI earns an explicit nominal return, it may no longer be appropriate to measure the opportunity cost of holding MI by the market interest rate. A related issue is whether MI demand has also become more sensitive to changes in the opportunity cost variable, defined as the difference between the market interest rate and the own rate of return on MI.

Though the focus of the present article is on the potential behavior of the interest elasticity in the 1980s, the article also examines the behavior of this elasticity during the 1970s, a period of substantial financial innovation. Some analysts contend that the interest elasticity of MI demand might have been high even before the financial deregulation occurred. If that is correct, the recent strength in MI demand should have been predictable. The article presents some additional evidence on this issue.

The plan of this article is as follows. Section I presents the methodology that underlies the empirical work reported here. Section II presents the empirical results. Section III contains the summary remarks. The article also contains an Appendix that discusses some issues that arise as a result of the form in which money demand regressions have been estimated here.

## I.

### ESTIMATING METHODOLOGY

A money demand regression that includes intercept and slope dummy variables is used to examine

whether financial innovation and deregulation have changed the parameters of the standard money demand function. The estimated money demand regression is

$$\begin{aligned} \Delta \ln(M/P)_t = & a_0 + b(L) \Delta \ln y_t + c(L) \Delta \ln R_t + \\ & d(L) \Delta \ln P_t + a_1 D74 + a_2 D81 + \\ & b(L) D74 * \Delta \ln y_t + c(L) D74 * \\ & \Delta \ln R_t + b(L) D81 * \Delta \ln y_t + \\ & c(L) D81 * \Delta \ln R_t + U_t \end{aligned} \quad (1)$$

where M is nominal money balances (currency plus total checkable deposits), y measures real income, R is the nominal interest rate and P is the price level. D74 and D81 are the dummy variables that equal 1 in the periods 1974:01-1980:12 and 1981:01-1985:03, respectively and zero otherwise. b(L), c(L), and d(L) are polynomials in the lag operator L, defined by  $L^x = X_{t-x}$ . Simply, polynomials in (1) imply that current as well as past values of real income, the interest rate, and the price level influence the demand for real money balances. The real income- and interest rate-interaction variables (like  $D74 * \Delta \ln X$ ) are formed by taking products of the interest rate, real income, and the zero/one dummy variables. The statistical significance and the signs of the estimated coefficients on the interest rate-interaction dummy variables in the regression (1) are used to examine whether the interest rate elasticity has changed over time.

The money demand regression (1) is standard in the sense that real money demand depends only upon real income and a nominal interest rate. However, it differs in several ways from the form in which money demand regressions are usually estimated. First, it is estimated freely by simple distributed lags. It therefore avoids the more popular Koyck-lag specification in which geometric lag shapes are imposed on the distributed-lag coefficients of the independent variables. It does so because the point-estimates of long-term income and interest elasticities could be sensitive to restrictions imposed on the lag shapes. Second, it enters the price level in a distributed lag form. Now standard theoretical models of transaction demand for money typically assume that the price level elasticity of the demand for real money balances is zero. If this assumption is correct, the distributed-lag coefficients on the price level in the money demand regression (1) should sum to zero. However, the standard money demand theory does not say much about the speed with which real money demand

adjusts over time.<sup>6</sup> If changes in the price level affect the demand for money with a lag, the individual distributed-lag coefficients on the price level in (1) would differ from zero.

The price level directly enters the money demand regression (1). The treatment of the price level in (1) thus differs from the one found in standard money demand regressions based on the real-partial adjustment hypothesis. The latter simply assumes that prices affect real money demand without lag and imposes this assumption on the data.<sup>6</sup> Third, the money demand regression here is estimated in the first difference form. The general use of differencing reduces the possibility of spurious regression results.<sup>7</sup> A recent study by Layson and Seaks (1984) concluded that the first-difference version of the money demand specification is statistically preferable to its level form.<sup>8</sup>

The constant term in the money demand regression (1) captures the influence of time trend on the demand for real money balances. Time trend is a proxy variable for technological progress in the financial system and captures, though imperfectly, the influence of changes in the cash management techniques and other financial innovations on money demand.<sup>9</sup> The estimated coefficient on this variable—the constant term in (1)—is generally negative, implying that the demand for real money balances has trended downward over time. This has determined, to some extent, the secular upward trend in M1 velocity.<sup>10</sup> Some analysts contend that the introduction of inter-

est paying NOM's and Super NOWs might have blunted the more aggressive use of cash management by the public. If that is correct, the trend growth rate of M1 velocity could decline. This possibility is investigated by entering also an intercept dummy (D81) in (1). Furthermore, several analysts have already documented that the parameters of the money demand regression had not been stable even over the late 1970s.<sup>11</sup> Additional zero/one dummy variables, defined from 1974 to 1980, are also included to control for the effect of financial innovations on the parameters of the money demand function in the 1970s.<sup>12</sup>

Suppose the inclusion in M1 of interest-bearing assets like NOWs and Super NOWs is responsible for the change in the interest elasticity of money demand. If so, then one should not expect to find any change in the interest elasticity of the old components of M1 such as demand deposits. This implication can be tested by estimating the money demand regression (1) for the demand deposits component of M1.

## II. THE EMPIRICAL RESULTS

The various monthly money demand regressions were estimated from 1961:01 to 1985:03. Table I contains the regressions for M1 demand. Table II

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tracting  $\Delta \ln Y$  from both sides of (i) and using the result that  $\Delta \ln Y$  equals  $\Delta \ln y$  plus  $\Delta \ln P$  we can rewrite (i) as in (ii)

$$\Delta \ln Y - \Delta \ln M = a_0 + (1-a_1) \Delta \ln y + a_2 \Delta \ln R \quad (ii)$$

One can view (ii) as the velocity growth equation consistent with the money demand equation (i). If the long-term income elasticity is unity and if there is no trend in the growth rate of the nominal interest rate, then the trend in the growth rate of M1 velocity is determined by the parameter  $a_0$ . Hence, changes occurring in the intercept of the money demand regression (i) can indicate changes occurring in the underlying trend growth rate of M1 velocity.

<sup>11</sup> See, for example, Cagan and Schwartz (1975), Goldfeld (1976), Simpson and Porter (1980), Judd and Scadding (1982), and Dotsey (1983).

<sup>12</sup> The sum of coefficients on the interest rate (real income) variable provides an estimate of the long-term interest (income) elasticity over the earlier period 1959-1973. The sum of coefficients on the interest-interaction (income-interaction) dummy variable can then be used to test whether or not the interest rate (the income) coefficient in the relevant subperiod differs from the one in the earlier period 1959-1973. If the sum of coefficients on the interaction variable is statistically significant, it implies that a shift in the long-run value of the regression coefficient has occurred over the relevant subperiod. The sign and size of this sum would then indicate the nature and the magnitude of the presumed shift in the parameter.

<sup>5</sup> Goodfriend (1983) has argued that the lags found in the estimated money demand regressions could arise from the presence of measurement errors in the relevant independent variables.

<sup>6</sup> Spencer (1985) presents empirical evidence that strongly rejects the assumption that the price level affects the demand for real money without lag. See also Gordon (1984).

<sup>7</sup> Granger and Newbold (1974), Plosser and Schwert (1978), and Plosser, Schwert, and White (1982).

<sup>8</sup> A word of caution is in order. While first differencing does guard against spurious regression, it is not well suited to detecting a level shift in the demand for real money balances. For the latter, it might be useful to consider also the level specification.

<sup>9</sup> Lieberman (1977, 1979).

<sup>10</sup> This point can be seen as follows. Ignoring for the moment the dummy variables, the money demand regression estimated here can be expressed as

$$\Delta \ln M - \Delta \ln P = -a_0 + a_1 \Delta \ln y - a_2 \Delta \ln R \quad (9)$$

where  $a_1$  and  $a_2$  measure respectively the long-term income and interest rate elasticities of M1 demand and where  $a_0$  measures the secular rate of decline in the demand for real money balances. One can transform this expression into the velocity growth equation. Sub-

reports the regressions for the transaction deposits component of M1, with and without including other checkable deposits in the transaction deposits. Table III presents simulation results and actual M1 growth from 1981:01 to 1985:03.

### The M1 Demand Regressions

Three money demand regression equations are reported in Table I. Equation (1) includes all the intercept and slope dummy variables. Equation (2) retains only the interest rate dummy variables, because they alone are statistically significant. Equation (3) is similar to equation (2) except that the opportunity cost of holding money is measured as the difference between the market interest rate and the own rate of return on M1.<sup>13,14</sup>

<sup>13</sup> Each money demand regression includes the current and lagged values of changes in the price level. In each, the sum of the estimated distributed-lag coefficients on

These regression results suggest several inferences: First, the interest elasticity of money demand has increased during the last few years. The sum of distributed-lag coefficients on the interest rate-interaction dummy variables is negative and statistically significant (see the t values on D81 \* Δ1nR in equations (1) and (2), Table I). For the period 1981:01-1985:03 these money demand regressions yield an interest elasticity substantially higher than

the price level was not significantly different from zero. Therefore, the coefficients are constrained to sum to zero. This implies that the price level elasticity of demand for real money balances is zero. However, several individual distributed-lag coefficients were significant, suggesting lags in the effect of the price level on money demand. These results are in line with the findings reported in Spencer (1985). See the Appendix to this article for details and further results.

<sup>14</sup> The own rate of return on M1 was approximated by the weighted average of the nominal returns offered on NOWs and Super NOWs, with weights given by their respective shares in M1. See Cagan (1983) and Taylor (1985) for a similar approach.

Table I

### FORMAL TESTS OF A CHANGE IN MONEY DEMAND PARAMETERS, MONTHLY MONEY DEMAND REGRESSIONS; 1961:01-1985:03

#### Equation 1

$$\Delta \ln(M/P) = -.002 + .99 \Delta \ln y - .07 \Delta \ln R - .001 D74 + .10 D74 * \Delta \ln y + .03 D74 * \Delta \ln R + .000 D81 + .38 D81 * \Delta \ln y - .11 D81 * \Delta \ln R$$

(-2.4) (4.3) (-5.0) (-1.3) (.3) (1.4)  
(-.01) (.93) (-3.2)

$$\bar{R}^2 = .49 \quad \text{SER} = .00349 \quad \text{Rho} = 0 \quad \text{DW} = 2.0$$

#### Equation 2

$$\Delta \ln(M/P) = -.002 + .99 \Delta \ln y - .06 \Delta \ln R - .001 D74 + .001 D81 - .08 D81 * \Delta \ln R$$

(-3.0) (7.1) (-6.4) (-1.7) (1.6) (-3.0)

$$\bar{R}^2 = .45 \quad \text{SER} = .00366 \quad \text{Rho} = 0 \quad \text{DW} = 1.93$$

#### Equation 3

$$\Delta \ln(M/P) = -.002 + 1.0 \Delta \ln y - .06 \Delta \ln(R - R_m) - .001 D74 + .001 D81 - .06 D81 * \Delta \ln(R - R_m)$$

(-3.6) (7.2) (-6.5) (1.8) (1.3) (-2.7)

$$\bar{R}^2 = .448 \quad \text{SER} = .00366 \quad \text{Rho} = 0 \quad \text{DW} = 1.94$$

Notes:  $\ln$  is the natural logarithm,  $\Delta$  is the first difference operator, M is M1, R is the commercial paper rate, y is the real personal income, P is the personal consumption expenditure deflator, and  $R_m$  is the weighted average of the rates paid on NOW and Super NOW accounts with weights given by their relative shares in M1. D74 and D81 are the zero/one dummy variables, taking values 1 respectively in the periods 1974-1980 and 1981-1985 and zero otherwise.  $D * \Delta \ln X$  is formed simply by taking the product of the zero/one dummy variable D and the X variable. The estimated coefficients on the income and interest rate variables are the sum of the coefficients that are estimated with a simple distributed lag and therefore provide estimates of the relevant long-term elasticities.  $\ln y$  includes 8 contemporaneous and lagged terms;  $\ln R$ , 9 such terms. The money demand regressions always included current and three lagged values of the price level, the distributed-lag coefficients on the price level constrained to sum to zero. The regressions were estimated by the Hildreth-Lu estimation procedure. The lag lengths were chosen to maximize adjusted  $R^2$ . SER is the standard error of regression, Rho is the first order serial correlation coefficient, and DW is the Durbin-Watson statistic. Figures in the parentheses are the t values.

that obtained from the earlier part of the sample period.<sup>15</sup> Second, the contention that the public's M1 demand function has recently been more interest-sensitive appears robust when one defines opportunity cost as the difference between the market rate of interest and the own rate of return on M1. There is a marginal reduction in the sum of the estimated distributed-lag coefficients on the interest rate-differential-interaction dummy variables. But this sum is negative and statistically significant (see the t value on D81 \* Δln(R-Rm) in equation 3, Table I). Third, no significant shift appears to have occurred in the income elasticity of money demand. In fact, these money demand regressions provide point estimates of income elasticity which are closer to unity for most of the period studied here. Fourth, except for a leftward shift that occurred in the public's demand for real money balances, these regressions imply that other long-run parameters of the M1 demand function did, not change during the 1970s (see equation (1) in Table I). In particular, it appears that the financial innovations of the 1970s did not raise the interest elasticity of M1 demand during that period.<sup>16</sup> Finally, the constant term

<sup>15</sup> Many previous studies have used two interest rates, typically the commercial paper rate and another rate such as the rate on time deposits. In the regressions above, only the former variable is used. However, adding a time deposit rate-measured here by the Fitzgerald rate-to the above regressions does not alter the conclusion that the interest-sensitivity of the M1 money demand function has increased. For example, estimating the money demand equation that includes the Fitzgerald rate yielded the following regression:

$$\begin{aligned} \Delta \ln(M/P) = & -0.002 + .99 \Delta \ln y - .04 \Delta \ln R - \\ & (-2.4) \quad (5.3) \quad (2.8) \\ & .04 \Delta \ln FITZ - .001 D74 + \\ & (1.8) \quad (-.9) \\ & .0005 D81 - .11 D81 * \Delta \ln R + \\ & (.4) \quad (2.0) \\ & .038 D81 * \Delta \ln FITZ ; \\ & (.7) \end{aligned}$$

$$\text{Sample Period} = 1969:01-1985:03 \quad \bar{R}^2 = .46$$

$$\text{SER} = .0039 \quad \text{Rho} = .1 \quad \text{DW} = 2.0$$

The sum of coefficients on the interaction terms involving the market interest rate (R) is still negative and statistically significant, whereas the same is not true for the other interest rate (FITZ). Since the data on the Fitzgerald rate are available beginning 1968, the estimation period for this money demand regression begins in 1969. The Fitzgerald rate is the measure of the highest effective yield available on time deposits that have usually been subject to Regulation Q. The data on this variable are from the Board's Monthly Money Market Model.

<sup>16</sup> Some analysts have suggested that financial innovations might have affected the interest elasticity of money demand in 1976, not in 1974 as assumed in this article. This view contends that the fundamental changes occurring in transactions technologies in 1974-1975 might have affected money demand behavior in the post-1975 period.

captures the influence of a time trend on the holdings of real money balances and is estimated to be -.002, suggesting a secular decline of about 2.4 percent per annum (-.002X1200) in the holdings of real money balances. The intercept dummy D81 tests for a change in the secular rate of decline in the demand for real money balances. The coefficient on the intercept dummy is .001, which is positive but not statistically significant at the conventional significance levels (see t values in equations 2 and 3 in Table I). Since the constant term in the money demand regression helps determine the trend growth rate of M1 velocity, the low t value on the intercept dummy variable suggests no significant shift in the underlying trend rate of M1 velocity. However, the absolute size of the estimated coefficient on it is relatively large, suggesting considerable caution in the conclusion that no change has occurred in the secular growth rate of M1 velocity.

## The Transaction Deposits Regressions

Table II reports the regressions testing for shifts in the interest elasticity of the transaction deposits component of M1. Equation 2.1 excludes from transactions deposits other checkable deposits component whereas equations 2.2 and 3.1 retain them. The latter two regressions differ in their measure of the opportunity cost variable. In the money demand regression that excludes other checkable deposits, the shift variables on the interest-elasticity parameter are not statistically significant. When other checkable deposits are included in the transaction deposits, however, the same shift variables on the interest-elasticity parameters turn out to be statistically significant (compare the t values on D81 \* ΔlnR in

If so, then the dummy variable defined as unity over 1974-1980 might fail to detect the change in the interest elasticity of money demand over 1976-1980. One simple way to test the above view is to redefine the dummy variable to be unity over 1976-1980 (DF). The money demand regression- that includes the redefined intercept and slope dummy variables is estimated over 1961-1980. The estimated regression is

$$\begin{aligned} \Delta \ln(M/P) = & -0.003 + 1.1 \Delta \ln Y - .06 \Delta \ln R + \\ & (-6.4) \quad (9.4) \quad (-5.7) \\ & .000 DF - .005 DF * \Delta \ln R \\ & (.12) \quad (-.25) \end{aligned}$$

$$\bar{R}^2 = .51 \quad \text{SER} = .00327 \quad \text{Rho} = 0$$

$$\text{DW} = 2.0$$

As can be seen, the sum of coefficients on the interest rate-interaction dummy variables, though negative, is not different from zero, confirming the earlier finding that the interest elasticity of M1 demand did not increase in the 1970s.

Table II

## DISAGGREGATED MONEY DEMAND REGRESSIONS; 1961:01-1985:03

## Equation 2.1: Demand Deposits

$$\Delta \ln(\text{DD}/P) = -.003 + 1.1 \Delta \ln y - .10 \Delta \ln R - .003 \text{D74} - .005 \text{D81} - .019 \text{D81} * \Delta \ln R$$

(-2.3)
(4.4)
(-4.9)
(-2.3)
(-3.9)
(-4)

$$\bar{R}^2 = .48 \quad \text{SER} = .00536 \quad \text{Rho} = .3 \quad \text{DW} = 1.97$$

(5.4)

## Equation 2.2: Demand Deposits and Other Checkable Deposits

$$\Delta \ln((\text{DD} + \text{OCD})/P) = -.003 + 1.1 \Delta \ln y - .08 \Delta \ln R - .001 \text{D74} + .001 \text{D81} - .10 \text{D81} * \Delta \ln R$$

(-3.7)
(6.3)
(-6.2)
(-2.0)
(1.4)
(-3.0)

$$\bar{R}^2 = .41 \quad \text{SER} = .00465 \quad \text{Rho} = 0.0 \quad \text{DW} = 1.95$$

## Equation 3.1: Demand Deposits and Other Checkable Deposits; Including the Proxy Variable for the Return on Deposits

$$\Delta \ln((\text{DD} + \text{OCD})/P) = -.003 + 1.1 \Delta \ln y - .07 \Delta \ln(R - R_m) - .001 \text{D74} + .001 \text{D81} - .08 \text{D81} * \Delta \ln(R - R_m)$$

(3.7)
(6.3)
(-5.9)
(-2.0)
(1.1)
(-2.6)

$$\bar{R}^2 = .41 \quad \text{SER} = .00465 \quad \text{Rho} = 0.0 \quad \text{DW} = 1.96$$

Notes: DD is demand deposits and OCD is the other checkable deposits. See Notes in Table I for an explanation of the remaining variables.

equations 2.1 and 2.2 in Table II). Redefining the opportunity cost variable to include the own rate of return on money does not alter **the above** result, though there is a marginal reduction in the sum of the coefficients on the interest rate variable (the sum of coefficients on  $\text{D81} * \Delta \ln(R - R_m)$  is now -.08 and has a t value -2.6; see equation 3.1 in Table II). Evidently the inclusion in MI of NOWs and Super NOWs increases interest-sensitivity of the MI demand function

### Explaining the Actual Behavior of MI during the Early 1980s

Suppose the public's MI demand has become more interest sensitive during the 1980s. Would this new money demand regression be consistent with the actual pattern of money growth observed over the period 1981:01-1985:03? The prediction errors that are presented in Table III suggest a cautious yes answer. Two sets of errors that occur in predicting the quarterly levels and growth rates of nominal money balances are presented. One set assumes that the interest elasticity of money demand has not increased during the 1980s. The money demand regression that omits the pertinent dummy variables is estimated over the period 1961:01-1985:03 and

simulated within-sample over the period 1981:01-1985:03; the errors in predicting nominal money **balances are given in Columns AI and AZ, Table III.** The other set of errors is generated under the assumption that the interest elasticity of money demand had increased since 1981. The money demand regression containing the relevant dummy variables is estimated over the entire sample period and the estimated coefficients are used to generate the sample errors (see errors in Columns B1 and B2, Table III). A comparative analysis of the mean and the root mean squared error statistics clearly suggests that the pattern of money growth predicted by this more interest-sensitive money demand regression is not inconsistent with the actual behavior of money growth over the interval 1981:01 to 1985:03.

Redefining the opportunity cost variable to include the own rate of return on MI reduces but does not eliminate the prediction errors over the recent period (see Table IV). It is only under the assumption that MI demand is more sensitive to the interest-rate differential that the prediction errors of the standard money demand regression are reduced further over the period 1981:01-1985:03 (compare the mean and root mean squared error statistics in Tables III and IV).

Table III

**SIMULATION RESULTS, 1981Q1-1985Q1: PERCENTAGE ERROR IN  
PREDICTING NOMINAL MONEY BALANCES**

Year/Quarter	No Change in the Interest Elasticity of Money Demand; Within-Sample Errors		A Higher Interest Elasticity of Money Demand; Within-Sample Errors	
	AI Quarterly levels	A2 Quarterly Changes	BI Quarterly Levels	B2 Quarterly Changes
1981Q1	.42	1.68	- .33	- 1.34
1981Q2	.98	2.28	- .19	.57
1981Q3	- .01	- 3.90	-1.21	- 4.18
1981Q4	- .41	- 1.72	- 1.91	- 2.87
1982Q1	.17	2.36	- 1.61	1.24
1982Q2	- .07	- .99	- 2.38	-3.19
1982Q3	.17	.98	- 2.20	.75
1982Q4	1.99	7.47	- 1.67	2.24
1983Q1	2.71	2.84	- 2.02	- 1.48
1983Q2	4.35	6.47	- 1.22	3.35
1983Q3	5.80	5.63	.30	6.24
1983Q4	6.07	1.05	.49	.74
1984Q1	5.38	- 2.68	- .03	-2.11
1984Q2	5.50	.46	.11	.57
1984Q3	5.65	.57	.49	1.55
1984Q4	5.46	- .72	.13	- 1.45
1985Q1	6.02	2.17	- .05	- .76
<hr/>				
<b>Mean Error</b>	<b>2.95</b>	<b>1.41</b>	<b>- .78</b>	<b>- .01</b>
<b>RMSE</b>	<b>3.91</b>	<b>3.30</b>	<b>1.27</b>	<b>2.52</b>

Notes: Errors in the columns labeled Quarterly Levels are calculated as the difference between the actual and predicted level, divided by the predicted level of nominal money balances. Errors in the columns labeled Quarterly Changes are calculated as the difference between the actual and predicted quarterly growth rates of nominal money balances. The predicted values used in calculating these errors were generated in two ways. For the errors in columns B1 and B2 the predicted values used are from the money demand regression 2 summarized in Table I. For the errors in columns A1 and A2 the predicted values used are from the money demand regression 2 that was reestimated omitting all the interest rate-interaction dummy variables; this amounts to assuming no change in the interest elasticity of money demand over the 1980s. RMSE is the root mean squared error.

### III.

#### CONCLUDING REMARKS

The evidence presented here suggests that the interest elasticity of the public's M1 demand has increased during the last few years. Furthermore, it is the inclusion in M1 of interest-bearing assets such as NOWs and Super NOWs which accounts for this increase. The demand deposits component of M1 demand does not exhibit any increased interest sensitivity during the same period. Since interest rates,

both nominal and real, have trended downward during the last few years, the strength in M1 demand and the consequent decline in the growth rate of M1 velocity are predictable.

As explained before, one of the reasons for the rise in the interest elasticity of M1 demand is that the own rate on some assets in M1 like NOWs is regulated and kept below the market interest rate. A given change in market rates thus causes a larger proportional change in the opportunity cost of holding NOWs. As a result, changes in market rates might

Table IV

**SIMULATION RESULTS, 1981Q1-1985Q1: PERCENTAGE ERROR IN  
PREDICTING NOMINAL MONEY BALANCES**

Year/Quarter	No Change in the Opportunity Cost Elasticity of Money Demand; Within-Sample Errors		A Higher Opportunity Cost Elasticity of Money Demand; Within-Sample Errors	
	AI	A2	BI	B2
	Quarterly Levels	Quarterly Changes	Quarterly Levels	Quarterly Changes
1981Q1	.39	- 1.60	- .33	- 1.34
1981Q2	.92	2.11	- .20	.53
1981Q3	- .51	- 3.95	- 1.28	- 4.40
1981Q4	- .51	- 1.84	- 1.98	- 3.91
1982Q1	.04	2.26	- 1.62	1.52
1982Q2	- .20	- .97	- 2.33	- 2.94
1982Q3	.04	.98	-2.12	.84
1982Q4	1.74	6.96	- 1.55	2.44
1983Q1	2.25	2.04	- 1.93	- 1.60
1983Q2	3.72	5.83	- 1.23	2.93
1983Q3	5.15	5.59	.22	5.90
1983Q4	5.43	1.07	.38	.63
1984Q1	4.73	- 2.68	- .11	- 1.99
1984Q2	4.88	.58	.07	.71
1984Q3	5.13	.93	.49	1.72
1984Q4	4.93	- .75	.14	- 1.44
1985Q1	5.33	1.57	- .06	- .85
Mean Error	2.60	1.25	- .79	- .01
RMSE	3.47	3.10	1.24	2.49

Notes: Errors in the columns labeled Quarterly Levels are calculated as the difference between the actual and predicted level, divided by the predicted level of nominal money balances. Errors in the columns labeled Quarterly Changes are calculated as the difference between the actual and predicted quarterly growth rates of nominal money balances. The predicted values used in calculating these errors were generated in two ways. For the errors in columns B1 and B2 the predicted values used are from the money demand regression 3 summarized in Table 1. For the errors in columns AI and A2 the predicted values used are from the money demand regression 3 that was reestimated omitting all the interest rate-interaction dummy variables; this amounts to assuming no change in the opportunity cost elasticity of money demand over the 1980s. RMSE is the root mean squared error.

induce larger changes in NOWs. MI would then appear more sensitive to interest rate swings as NOWs become a larger fraction of MI.

But as of January 1986 the regulatory constraint on the rate payable on NOWs has been removed. The rate payable on Super NOWs is already unregulated. One would then expect that the own rates of return on the interest-bearing components of MI would move with market interest rates. If so, the increase observed in the interest elasticity of money demand could fade away.

Our findings also suggest that the interest elasticity of MI demand did not change during the 1970s, a period of substantial financial innovation. Additional work presented in the Appendix shows that for the period 1961-1980 the interest elasticity is estimated to be below other reports. Taken together, these results further bolster the view that it is partial financial deregulation, as opposed to financial innovation, that has made MI more responsive to market rates during the last few years.

A word of caution is in order. The conclusion that



MI demand has become more interest sensitive must however be considered tentative, The issue of the stability of the interest elasticity of money demand has been examined in the context of the standard money demand regression. The latter treats the demand for real money balances as depending upon a scale variable (measured here by real income) and

an opportunity cost variable (measured either by the market interest rate or by the difference between the market interest rate and the own rate on MI ). No attempt is made to check the robustness of these findings to alternative specifications of the MI demand function. To that extent, the results presented here must be treated with caution.

## APPENDIX

This Appendix examines two additional questions raised by the empirical results presented in the text. First, why do some standard money demand regressions yield very high point estimates of the interest elasticity even for the earlier period 1960 to 1980? Second, should one estimate the money demand regressions under the assumption that the price level has no effect on the demand for real money balances?

### The interest Elasticity of MI Demand: Was It High or Low during the Period 1961-1980?

For the period 1961-1980 the monthly money demand regressions reported here yield the point estimates of the interest rate elasticity close to -.07. They appear quite low when compared with the estimates obtained from some standard money demand regressions. The latter is estimated in level form and includes as an explanatory variable the lagged dependent variable.<sup>17</sup> Are the differences that exist in the point estimates of interest elasticity related to the form in which money demand regressions are estimated? The results presented below suggest this to be the case.

In order to highlight the differences between the standard money demand regression and that estimated in this article, let us first derive the standard versions from the monthly money demand regression (1). Ignoring for the moment the dummy variables, the standard lagged-dependent variable versions of the money demand regression can be derived from the equation (1) by imposing the following restrictions on lag structures.

$$b(L) = b_1 \lambda \sum_{s=0}^{\infty} (1-\lambda)^s \lambda^s = \frac{(b_1 \lambda)}{[1-(1-\lambda)L]} \quad (2a)$$

<sup>17</sup> For example, for almost similar sample periods the interest elasticity is estimated to be -.13 in Judd and Motley (1984) and -.16 in Hafer and Hein (1984).

$$c(L) = c_1 \lambda \sum_{s=1}^{\infty} (1-\lambda)^s \lambda^s = \frac{(c_1 \lambda)}{[1-(1-\lambda)L]} \quad (2b)$$

$$d(L) = 0 \quad (2c)$$

$$d(L) = (\gamma-1) + \gamma \sum_{s=1}^{\infty} (1-\lambda)^s L^s = \frac{[(\gamma-1) + (1-\gamma)L]}{[1-(1-\lambda)L]} \quad (2d)$$

$$a_0 = 0 \quad (2e)$$

Restrictions (2a) and (2b) impose geometrically declining lag structures on income and interest rate variables. Restriction (2c) has two implications:<sup>18</sup> (1) the price level elasticity of the demand for real money balances is zero, i.e., the sum of distributed lag coefficients on the price level is zero; (2) the demand for real money balances adjusts to the price level with no lags, i.e., each of the distributed lag coefficients on the price level is zero. Restriction (2e) amounts to assuming that time trend has no influence on the holdings of real money balances. Substituting (2a), (2b), (2c) and (2e) into (1), ignoring dummy variables, yields the money demand regression (3a).

$$\Delta \ln (M/P) = (b_1 \lambda) / [1-(1-\lambda)L] \Delta \ln y_t + (c_1 \lambda) / [1-(1-\lambda)L] \Delta \ln R_t \quad (3a)$$

Alternatively, (3a) could be expressed as follows:

$$\Delta \ln (M/P) = b_1 \lambda \Delta \ln y_t + c_1 \lambda \Delta \ln R_t + (1-\lambda) \Delta \ln (M/P)_{t-1} \quad (3b)$$

The money demand regression (3b), popularly known as the real-partial adjustment model of money demand, is one of the lagged dependent variable

<sup>18</sup> Mehra (1978) and Spencer (1985).

versions of the standard money demand function. Another version, known as the nominal partial adjustment model of money demand, is obtained if we assume that lags do exist in the adjustment of real money balances to changes in the price level. But we retain the assumptions that the long-run price level elasticity of the demand for real money balances is zero and that the lag shape on the price level variable is geometric. These assumptions imply that  $d(L)$  follows the restriction (2d). Substituting (2a), (2b), (2d) and (2e) into (1) yields the following:

$$\Delta \ln(M/P) = b_1 \lambda \Delta \ln y + c_1 \lambda \Delta \ln R + (1-\lambda) \ln(M_{t-1}/P) \quad (4)$$

The money demand regressions (3b) and (4) and their level versions were estimated over the common sample period 1961-1980. They were also estimated with a time trend. Presented in Table V are the estimates of the interest elasticity of money demand. They show that the estimates of the interest elasticity that are obtained from the level versions of the standard money demand regression are substantially higher than the ones obtained from the relevant first-difference versions. In the level versions the esti-

mates of the interest elasticity are also sensitive to the exclusion of the time trend variable. This suggests that high estimates of the interest elasticity derived from some level versions of the standard money demand regression are not robust and must be treated with considerable caution.

### Testing the Price Level Elasticity Assumption

As stated before, the simple theoretical models of the transaction demand for money imply that the price level elasticity of the demand for real money balances is zero. In estimating the money demand regressions this restriction on the price level elasticity has been imposed on the data, i.e., the coefficients on the price level are constrained to sum to zero.

Does relaxing the constraint on the price level elasticity alter any of the conclusions about the interest elasticity of M1 demand? Table VI reports the regressions pertinent to answer that question. Equation 6.1 is the money demand regression that includes all the relevant intercept and slope dummy variables but is estimated without imposing the constraint that the coefficients on the price level sum to zero. Equation 6.2 is similar to Equation 6.1 except

Table V

### INTEREST ELASTICITIES OF THE STANDARD MONTHLY MONEY DEMAND EQUATIONS, 1961-1980

Level Form	Long-Run Elasticity		
	Time Trend Excluded	Time Trend Included	
Real-Partial Adjustment Equation	- .23	- .09	
Nominal-Partial Adjustment Equation	-.21	-.08	
<b>First Difference Form</b>			
Real-Partial Adjustment Equation	- .03	- .02	
Nominal-Partial Adjustment Equation	- .03	-.04	

Notes: The estimates of the long-run interest elasticity are from the following money demand regressions.

Level Form

$$\ln(M/P) = a + b \ln y + c \ln R + d \ln(M/P)_{-1} + g D74 + h TT$$

$$\ln(M/P) = \tilde{a} + \tilde{b} \ln y + \tilde{c} \ln R + \tilde{d} \ln(M_{-1}/P) + \tilde{g} D74 + \tilde{h} TT$$

First Difference Form

$$\Delta \ln(M/P) = b \Delta \ln y + c \Delta \ln R + d \Delta \ln(M/P)_{-1} + e D74 + \text{constant}$$

$$\Delta \ln(M/P) = \tilde{b} \Delta \ln y + \tilde{c} \Delta \ln R + \tilde{d} \Delta \ln(M_{-1}/P) + \tilde{e} D74 + \text{constant}$$

The regressions are estimated by the Hildreth-Lu estimation procedure. TT is time trend. For an explanation of the variables see the Notes in Table 1.

Table VI

**FORMAL TESTS OF A CHANGE IN MONEY DEMAND PARAMETERS ESTIMATED  
WITHOUT IMPOSING THE PRICE LEVEL ELASTICITY CONSTRAINT  
ON THE DATA; 1961:01-1985:03**

## Equation 6.1

$$\begin{aligned} \Delta \ln(M/P) = & - .001 + .93 \Delta \ln y - .06 \Delta \ln R - .000 D74 + .04 D74 * \Delta \ln y + .023 D74 * \Delta \ln R + \\ & (-1.3) \quad (4.1) \quad (-4.4) \quad (-.38) \quad (.15) \quad (1.5) \\ & .000 D81 + .31 D81 * \Delta \ln y - .11 D81 * \ln R - .74 \Delta \ln P_t + .28 \Delta \ln P_{t-1} + \\ & (.29) \quad (.76) \quad (-3.1) \quad (-6.8) \quad (2.5) \\ & .24 \Delta \ln P_{t-2} + .06 \Delta \ln P_{t-3} \\ & (2.1) \quad (.52) \end{aligned}$$

$$\bar{R}^2 = .49 \quad SER = .00332 \quad Rho = .1 \quad DW = 1.92 \\ (-1.5)$$

$$\text{Sum of Coefficients on the Price level} = -.20 \\ (-1.2)$$

## Equation 6.2

$$\begin{aligned} \Delta \ln(M/P) = & - .001 + .93 \Delta \ln y - .06 \Delta \ln(R - R_m) - .000 D74 + .04 D74 * \Delta \ln y + \\ & (-1.3) \quad (4.1) \quad (-4.4) \quad (-.40) \quad (.15) \\ & .027 D74 * \Delta \ln(R - R_m) + .000 D81 + .32 D81 * \Delta \ln y - .09 D81 * \Delta \ln(R - R_m) - \\ & (1.5) \quad (.09) \quad (.78) \quad (-2.8) \\ & .76 \Delta \ln P_t + .23 \Delta \ln P_{t-1} + .26 \Delta \ln P_{t-2} + .07 \Delta \ln P_{t-3} \\ & (-7.2) \quad (2.2) \quad (2.4) \quad (.62) \end{aligned}$$

$$\bar{R}^2 = .49 \quad SER = .00349 \quad Rho = 0.0 \quad DW = 2.1$$

$$\text{Sum of Coefficients on the Price Level} = -.20 \\ (-1.2)$$

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Notes: All variables are as defined before. For the price level variable the individual coefficients are reported. See Notes in Table I for other details.

that it uses the alternative measure of the opportunity cost variable. The sum of coefficients on the income-interaction dummy variables is generally insignificant as before, but the sum of coefficients on the interest rate-interaction dummy variables though insignificant over 1974-1980 is not so over 1981:01-1985:03 (see t values on these variables in Table VI). As regards the price level constraint the sum of coefficients on the price level is -.20 with a t value -1.2, suggesting that this sum is statistically not different from zero. However, the individual coefficients on the

price level are statistically different from zero (see Table VI). These results suggest that the theoretical restriction on the price level elasticity is in conformity with the data and that relaxing this constraint does not alter any of the conclusions about the interest elasticity of M1 demand. The results also show that the demand for real money balances adjusts to the price level with lags, suggesting that the real partial adjustment version of the standard money demand regression is inconsistent with the data.

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