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THE EFFECTS OF FINANCIAL INNOVATIONS ON THE MEASUREMENT, CONTROL AND EFFICACY OF THE M1 AND M2 AGGREGATES

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During the early part of this decade, several new types of financial assets were authorized by Congress and included in the definitions of various monetary aggregates. The principal new accounts were NOW accounts, which were authorized nationwide in January 1981, and money-market deposit and super-NOW accounts, which became available in December 1982 and January 1983, respectively. Their growth and inclusion in monetary aggregates have given rise to increased uncertainty in explaining movements in the monetary aggregates and to questions concerning their controllability and their relationship to various measures of economic performance.[1/]

The widely accepted view is that these financial innovations have rendered M1 less useful, or even useless, as a monetary policy target.[2/] The related view--that the broader aggregate M2 has been unaffected and still remains a useful aggregate target--is almost as widely shared. While an apparent change in the linkages between M1 and economic performance in the 1980s has buttressed the impression that financial innovations had distorted the M1 measure and impaired its usefulness, little quantitative evidence was produced to assess the credibility or magnitude of such effects.

This paper first describes the financial innovations hypothesis that M1, but not M2, has been significantly affected by the introduction and growth of these new assets. An alternative hypothesis is discussed which has implications that are nearly the opposite of the financial innovations hypothesis. This argument, called the competitive markets hypothesis here, suggests that the demand, desired use and composition of M1 were unaffected by the introduction of so-called interest bearing checking accounts, but that the introduction of money market accounts shifted both the M2 multiplier and its demand or velocity. The article then assesses the validity of the financial innovations hypothesis by examining whether decisions involving the turnover rate for checkable deposits, currency preferences, money multipliers and M1 and M2 demand or velocity have been affected by these innovations, especially in the manner suggested by the financial innovations hypothesis.[3/]

Monetary Aggregates and Financial Innovations

Table 1 shows the components of M1 and M2 in 1988. The M1 measure consists of currency in the hands of the public, demand deposits, other checkable deposits and travelers checks. Other checkable deposits include accounts on which financial institutions can make explicit interest payments. During the 1970s, a few states had authorized interest-paying negotiable order of withdrawal (NOW) accounts. In 1978, checkable accounts with automatic transfer from interest-paying savings accounts (ATS) were authorized by the Federal Reserve System.

Figure 1 shows that the share of other checkable deposits in total checkable deposits (demand and other checkable deposits) rose from about 10 percent in late 1980 to over 25 percent by the end of 1981, the first year that nationwide NOW accounts were authorized. This share continued to rise subsequently, in part due to the introduction of super-NOW accounts (interest-bearing other checkable deposits with unregulated interest rates) in early 1983. By 1988, other checkable deposits had risen to $274.4 billion, nearly half of total checkable deposits and about 35 percent of M1.

M2 is the sum of M1, saving and time deposits at all financial institutions, overnight repurchase agreements and Eurodollars and money market accounts (MM), which includes both money-market mutual funds (MMMF) and money market deposit accounts (MMDA). Money market deposit accounts, which have unregulated interest rates, were authorized at the same time as super-NOW accounts and became available in December 1982. Within the first two quarters of 1983 they had grown to 17 percent of M2 (figure 2). Some of this growth apparently came at the expense of money market mutual fund accounts, since the total share of money market accounts, MMDA and MMDF, rose by less than the 17 percentage points; the share of total money market balances, MM, rose from 10 to about 24 percent of M2 at the time. Since there is little difference between MMDAs and MMMFs, which became available in 1978, they are grouped together here as money market accounts.[5] The share of MM in M2 rose to nearly 25 percent of M2 by 1988 (see table 1 and figure 2).

The Financial Innovations Hypothesis

The financial innovations hypothesis focuses primarily on the effects of these new assets on M1. According to this hypothesis, the introduction of interest-bearing checking accounts made depositors more willing to hold savings balances in their checkable deposit accounts instead of in savings accounts. Thus, the growth of other checkable deposits, especially nationwide NOW accounts in 1981 and super-NOW accounts in 1983 was expected to boost total checkable deposits and M1 and to change the properties of their demands to be more like savings deposits than they had been previously.

According to this hypothesis, the effects on M2 follow from the M1 analysis. In particular, movements of funds from savings to checkable deposits take place between groups of funds within M2, so that such a change was expected to leave M2 unaffected. The total demand for M2 was expected to be unaffected by shifts to other checkable deposits. Similarly, the shift of funds into MMDAs was expected to flow from other components of M2, especially MMMFs; thus, the introduction and expansion of MMDAs were not expected to boost M2.[5/]

Despite this analysis, the surge in the share of MMs in M2 in early 1983 was associated with a sharp rise in M2 growth from a 9.1 percent rise in the four quarters of 1982 to a 16.3 percent annual rate in the first half of 1983. While this result ran counter to the financial innovations hypothesis, it was thought that this effect was transitory. The unexpected surge in M2 was treated as a once-and-for-all surge that carried little implication for future economic performance.[6/]

In the early 1980s, proponents of the financial innovations hypothesis also suggested that these innovations would reduce the interest elasticity of checkable deposits and M1 demand.[7/] Since the rate paid on deposits is expected to change when interest rates change, a given change in interest rates should have a smaller effect on the cost of holding checkable deposits and money and, therefore, a smaller effect on their demand, according to this view. This analysis is questionable, however. In the absence of interest payments on deposits, currency, checkable deposits and M1 have an opportunity cost equal to the rate of interest on alternative assets, i. When there is a competitively determined interest rate paid on checkable deposits it will be proportional to the market rate that banks can earn on assets, i. Thus, the cost of holding interest-bearing deposits remains proportional to the rate of interest.[8/] Similarly, the cost of M1, a weighted average of the costs of its components, remains proportional to the interest rate. Thus, a given percentage change in the interest rate still changes the cost of holding M1 by the same proportion, and, therefore, the interest rate elasticity of money demand is unchanged.[9/]

Under certain conditions, lifting an effective ban on interest-bearing checkable deposits could raise the interest elasticity of money demand. If an effective ban is lifted, the cost of checkable deposits is lowered for any given level of the interest rate. A given change in the interest rate will change the cost of deposits by a larger percentage amount when the cost of checkable deposits is lower if the rate paid on these deposits is insensitive to a change in market interest rates. If the rate paid on deposits is not sensitive to changes in interest rates in the short run, then a given change in interest rates results in a larger percentage change in the cost of deposits and money and, therefore, a larger change in the quantity demanded of each asset. Whether the interest elasticity of checkable deposit or M1 demand rose (or fell) and, if it did, whether the change is linked to financial innovations is examined below.[10/]

The Competitive-Markets Hypothesis

The effectiveness of the ban on explicit interest payments on checkable deposits has long been disputed.[11/] Until recently, the flexibility and ingenuity of market participants in finding mutually advantageous exchanges that avoid the adverse effects of such a ban were emphasized. For example, a ban on explicit interest payments forces banks to compete by offering implicit interest. One way of paying implicit interest is through the remission of other service charges related to checking accounts, like statement or transaction charges.

For depositors who have larger numbers of deposit and debit transactions per dollar of average balances, the existence of an explicit interest rate on deposits does not imply that there will be an interest payment on these deposits, even if it is legal to make such a payment. Instead, the depositor earns interest, but pays the bank for the excess of charges over the interest payment. For depositors who hold relatively large deposit balances compared with their account activity, service charge remission or other implicit schemes for paying interest may be inefficient ways of paying a competitive rate on deposits. If the competitive-markets view is correct, the advent of deposits that offer explicit interest payments should have second-order effects, at best, on the total demand for total checkable deposits and M1. Thus, it is unlikely to affect relationships like the desired turnover of total checkable deposits, the desired currency ratio or the money multiplier or demand for M1, or to change the response of these choices to changes in interest rates.

On the other hand, innovations like money market accounts genuinely offer new opportunities. The introduction of MMDAs allowed local financial institutions to compete more effectively with more distant money market mutual funds that are not federally insured. Similarly, the earlier introduction of money market mutual funds--highly liquid, safe, assets available in small denominations with competitive market yields--had been a significant innovation that should have influenced how individuals hold wealth and their demand for M2.

Testing the Financial Innovations Hypotheses

The financial innovations hypothesis suggests that total checkable deposits and M1 are both increased by shifts of savings to other checkable deposits, while M2 is unaffected by the size of other checkable deposits or of money market balances. This hypothesis can be tested by examining the extent to which these new assets have influenced the use, composition, total supply, or demand for total checkable deposits, M1 and M2 as predicted.

The turnover rate of deposits, the currency ratio, the money multiplier for M1 and M2 and their demand or velocity are examined below. If total checkable deposits and M1 are boosted by increases in other checkable deposits, then the turnover rate--the ratio of debits on total checkable deposits to total checkable deposits--should be inversely related to the share of other checkable deposits in total checkable deposits (s1). Similarly, the desired ratio of the currency component of M1 to the total checkable deposit component also should be inversely related to s1.

To investigate the effect of other checkable deposits on the M1 multiplier and M1 demand (and on the multiplier and demand for M2), other checkable deposits are measured as ratio to M1 (s11=OCD/M1).[12/] If M1 is increased by a rise in other checkable deposits, then the M1 multiplier should be positively related to s11. This can occur either because the currency ratio falls or because financial institutions' desired ratio of reserves to total checkable deposits declines. Finally, if M1 is increased by other checkable deposits, then the demand for M1, given its other determinants, must be positively related to s11.

The effect of the relative size of other checkable deposits on the interest elasticity of demand is also tested. These two effects--on the size of total checkable deposits and M1, and on the interest sensitivity of their demand composition or patterns of use--constitute the M1-based components of the hypothesis studied below. An absence of any significant effects of the size of other checkable deposits on the M1-related variables examined or their interest elasticity rejects the financial innovations hypothesis and is consistent with the competitive markets view. These effects on the size and interest elasticity of total checkable deposits and M1, and the absence of such effects on M2 make up the financial innovations hypothesis, as tested below. If there are other channels of influence, they are not directly tested here.

Both hypotheses apply to M2 as well, however, and both have implications for the effects or absence of effects of the growth of money market assets. The financial innovations hypotheses suggests that M2 was unaffected by either innovation, while the competitive markets view suggests that the multiplier and demand for M2 are positively related to the money market balances. These hypotheses are tested by assessing the influence of s2, the share of money market balances in M2, on the M2 multiplier and M2 demand.

For each relationship estimated below, a test of the effect of other checkable deposits on the interest elasticity is conducted. The financial innovations hypothesis indicates that the weighted average cost of holding total checkable deposits and M1 and the interest elasticity of various linkages are functions of the relative extent of other checkable deposit holdings. Thus, if β_0, the coefficient on ln i in the log-linear relationships below, is the interest elasticity when s1 is zero, then, with innovations, the interest elasticity becomes $\beta * = \beta_0 + \beta_1$ s1. The interest elasticity following the advent of other checkable deposits is the sum of the β coefficients in the expression: β_0 ln i + β_i (s1 ln i). In a first-difference equation, the appropriate expression is: β_0 Δ ln i + β_1 Δ(s1 lni). Whether the interest elasticity changed is indicated by the significance of β_1.

Financial Innovations and the Deposit Turnover Rate

Other checkable deposits have low turnover, or debits per dollar of deposits, compared with the turnover of demand deposits. For example, in May 1989 the annual rate of debits per dollar of demand deposits at banks outside New York (where demand deposit turnover is nearly seven times larger), was 500.9; turnover on ATS and NOW accounts at commercial banks was only 18.0 times per year, closer to the 3.5 rate on savings deposits at commercial banks.[13/] This similarity between the turnover of ATS and NOW balances and on saving deposits is sometimes taken as evidence supporting the financial innovations hypothesis.

The financial innovations hypothesis suggests that NOW accounts include substantial balances that would have been held in savings or other non-M1 balances prior to the introduction of interest-bearing checking accounts. As a result, the turnover of total checkable deposits should have fallen, and its interest elasticity should have been altered, by mixing these savings balances into total checkable deposits. The competitive markets view suggests, in contrast, that the size of these new checking accounts would have little effect on the size of total checkable deposits or on its properties; only the composition of checkable deposits would shift.

Moreover, relatively low-turnover depositors would be more likely to move funds from demand deposits to the new accounts, raising the turnover of demand deposits, but leaving the turnover of total checkable deposits unchanged.

The turnover of total checkable deposits did not decline in early 1981, however. Figure 3 shows the natural logarithms of the turnover rate for demand deposits and total checkable deposits (demand, ATS and NOW balances) since 1970. Turnover has a strong upward trend; for example, the turnover rate of demand deposits more than doubled from 1970 to early 1979. The two measures began to deviate in late 1978, when ATS accounts were introduced, reflecting the lower turnover rates for ATS and NOW balances. The upward surge of demand deposit turnover, especially in 1981, suggests that lower turnover deposits were switched from demand deposits to the new accounts. More importantly, the turnover rate for total checkable deposits also rose in 1981, rather than falling as suggested by the financial innovations hypothesis. Overall, the turnover rate for total checkable deposits looks very much like a continuation of the 1970-78 demand deposits turnover series, certainly more so than does the demand deposit turnover series itself.

Deposit turnover measures are velocity measures; as such, they are related to the same factors, such as interest rates and income, that influence the demand for money. Higher interest rates will increase the cost of holding checkable deposits and increase their turnover rates. As income rises, the demand for deposits should rise; the effect of higher income on the deposit turnover rate, however, depends on whether debits rise more or less than the demand for checkable deposits does.

Models of the annualized continuous monthly growth rate of demand deposit turnover, $\dot{DDT}$, and of total checkable deposit turnover, $\dot{CDT}$, were estimated as functions of the annualized continuous rates of increase of the 3-month Treasury bill rate, $\dot{R}$, and of real personal income, $\dot{y}$, for the period January 1979 to January 1989. The starting point was chosen to conform closely to the introduction of ATS accounts in November 1978 and because, with monthly observations, ample degrees of freedom are available.

The financial innovations hypothesis indicates that a rise in s1 should significantly reduce the turnover of total checkable deposits. The competitive markets view indicates that total turnover should not be reduced. Whether a rise in money market balances (s2) affects the turnover rate depends on whether such balances are transaction substitutes for checkable deposits. Current and up to 12 lagged values of annualized percentage point changes in s1 and s2, DS1 and DS2, respectively, were added to the turnover equations, although the allowance for lagged effects beyond one month was uniformly unnecessary for testing the hypotheses.

The estimate for the demand deposit turnover rate that showed the most significant effect of the shift to other checkable deposits is:

$$
(1) \quad \dot{DDT} = \underset{(5.66)}{13.404} - \underset{(-1.32)}{0.041}\,\dot{R}_t + \underset{(3.77)}{0.114}\,\dot{R}_{t-1}
$$

$$
-\underset{(-2.74)}{1.104}\,\dot{y}_{t-1} + \underset{(3.56)}{1.057}\,DS1_t
$$

$\bar{R}^2 = 0.24$ D.W. $= 2.10$ $\hat{\rho}_1 = \underset{(3.09)}{0.279}$ $\hat{\rho}_2 = \underset{(2.92)}{0.264}$

S.E. $= 29.270$

The estimate indicates that interest rates, particularly the lagged value, and past real personal income affect the turnover of demand deposits. The change in the share of other checkable deposits in total checkable deposits is positive and statistically significant, indicating that the financial innovations like ATS, NOW and super-NOW accounts have significantly boosted the turnover of demand deposits.[14/] Movements of demand deposits to these other checkable deposits were from relatively low turnover demand deposits. There is no similar evidence that money market accounts affected the turnover demand deposits, however. The rise in s2 has not significantly affected the turnover rate of demand deposits.

The "best" estimate for total checkable deposit turnover, $\dot{CDT}$, is:

$$\text{(2)}\quad \dot{CDT} = \underset{(4.78)}{11.720} - \underset{(-1.54)}{0.048}\,\dot{R}_t + \underset{(3.79)}{0.114}\,\dot{R}_{t-1}$$

$$-\underset{(-2.48)}{1.003}\,\dot{y}_{t-1} + \underset{(1.62)}{0.489}\,DS1_{t-1}$$

$$\bar{R}^2 = 0.17 \qquad D.W. = 2.00 \qquad \hat{\rho}_1 = \underset{(2.80)}{0.254} \qquad \hat{\rho}_2 = \underset{(2.69)}{0.242}$$

$$S.E. = 28.967$$

Except for the effect of other checkable deposits, equation 2 is quite similar to equation 1. Other checkable deposits have not significantly depressed the turnover of checkable deposits as the financial innovations hypothesis suggests; instead, the most significant effect is positive, but statistically insignificant. The current or other past values of changes in s1 are not as significant as the first lag. The use of the other measure for shifts to other checkable deposits and for shifts of s2 are not as significant either. Equation 2 provides strong evidence against the financial innovations argument that adding interest-bearing other checkable deposits to total checkable deposits and M1 has distorted these measures and lowered turnover or velocity.[15]

If financial innovations changed the interest elasticity of turnover, then the coefficients on the interest rate terms ($\dot{R}_t$, $\dot{R}_{t-1}$) in equations 1 and 2 would be related to sl. To test whether these coefficients have been lowered by the relative size of other checkable deposits in total checkable deposits, the annualized change in the product ($sl_i lnR_i$) for i=t and t-1 are added to each equation. These interaction terms provide no significant explanatory power, however. The F-statistic for the test of whether each coefficient is zero is $F_{2,112} = 1.55$, and $F_{2,112} = 0.90$ for equations 1 and 2, respectively, well below the critical value (5 percent) of 3.08. The sum of the coefficients of the interaction terms in equation 1 is positive, 0.05; this sum is also positive, 0.01, in equation 2. Thus, financial innovations, as defined here, have not had any significant effect on the interest elasticity of deposit turnover velocity.

Financial Innovations and The Currency-Deposit Ratio

The currency ratio is a principal determinant of the money multiplier (the ratio of a monetary aggregate to the adjusted monetary base). Therefore, it is the principal channel through which financial innovations can affect the link between federal reserve actions and the monetary aggregates.[16] The desired ratio of currency to total checkable deposits is the outcome of a portfolio decision based on the relative costs and benefits of holding each means of payment. If total checkable deposits now include a larger component of savings balances than earlier, then financial innovations should have lowered the desired proportion of currency to deposits. In addition, if money market accounts are a substitute for the checkable deposits included in M1, then the introduction and spread of money market holdings will increase the currency ratio.[17]

Figure 4 shows quarterly data on the ratio of the currency and the checkable deposit components of the money stock, M1. There is no decline in this ratio in early 1981 or early 1983 when the financial innovations hypothesis suggests that there were the largest boosts in savings held in other checkable deposits. Nor does the currency ratio rise in early 1983 when there was a large surge in money market accounts.[18]

A modified time series model is used to test the effects of these shifts on the currency ratio. While the growth rate of the currency ratio can be described as a first-order autoregressive time series process, two other factors have had a major impact on the currency ratio over the past 15 years, and these are controlled for in the estimates.[19] The first factor is energy prices; these prices rose sharply in 1973-74 and in 1979-81 and fell sharply in 1986. Energy price increases raise expenditures using currency relatively more than expenditures using checkable deposits, so that the currency ratio rises when energy prices increase.[20] A second factor was the transitory effect of the credit control program in 1980, which temporarily boosted currency demand relative to checkable deposits in the second quarter of the year. Credit limitations increase the use of currency, especially in transactions that would otherwise be facilitated by the use of retail credit.[21] Finally, to examine the interest rate elasticity of the currency ratio, the current and past quarter's 3-month T-bill rates are included; longer lags for the interest rate variables are not statistically significant.

The model of the currency ratio, k, estimated for the period III/1959 to III/1989 is shown in the first column of Table 2. The dependent variable is $\dot{k}_t$, the annualized continuous rate of growth of the currency ratio, and $\dot{p}^e$ is the annualized continuous rate of increase of the relative price of energy resources, measured by the ratio of the producer price index for fuel, power and related products to the implicit price deflator for business sector output. The credit-control variable, D6, equals one in the second quarter of 1980, minus one in the third quarter of 1980, and zero otherwise. The included variables are generally strongly significant.[22/]

Current and lagged (up to four) values of Ds1 or Ds2 were added to the model. The estimate with the most significant effect includes the current quarter change in the share of other checkable deposits in total checkable deposits (Ds1); it is reported in the second column of table 2. The negative coefficient on the change in the other checkable deposit share is not statistically significant.[23/] No other individual financial innovation variable is as significant, nor is any group of current or lagged changes as significant for either innovation. According to these tests, financial innovations have not affected the currency ratio.[24/]

The third column in table 2 examines whether the interest elasticity of the desired currency ratio was affected by financial innovations. The results show a positive but statistically insignificant change in the interest elasticity. Neither interaction term is statistically significant and the test statistic that they are jointly zero, $F_{2,113} = 0.70$, is not significant. Therefore, the hypothesis that financial innovations altered the interest elasticity of currency demand can be rejected.

Financial Innovations and The Money Multiplier

To examine whether financial innovations have affected the money multiplier for M1 or M2, the model specification for the currency ratio is used as a point of departure for each monetary aggregate. If these new assets raise an aggregate like M1 or M2, independently of their other determinants, then the money multiplier, m1 and m2, respectively, should reflect this. In particular, given the other variables affecting the M1 multiplier, a rise in the share of these new deposits in M1 (s11) should raise M1 relative to the monetary base.

Whether the multiplier is affected by the size of other checkable deposits is tested by adding the annualized continuous growth rate of (1-s11), $400\Delta\ln(1\text{-}s11)$, to the right-hand-side of the m1 regression equation. This is equivalent to using DS11 to test whether $s11_t$ affects the m1 multiplier.[25/] In the extreme case for the financial innovations hypothesis where a rise in other checkable deposits is offset one-for-one by reductions in other components of M1, only the remainder of M1 is a function of interest and income, independently of s11. In this case, the coefficient on $400\Delta\ln(1\text{-}s11)$ will be minus one. The addition of this term to both sides will remove the financial innovation term on the right-hand-side and transform the dependent variable into $400\Delta\ln(M1A/Base)$, where M1A equals M1-OCD, or (1-s11)M1.

Since the model includes a lagged dependent variable, the lagged value, $400\ \Delta\ln\ (1\text{-}s11)_{t-1}$, also must be included. Its coefficient is, in principle, equal to the product of the coefficient on the lagged dependent variable and the negative of that on the contemporaneous financial innovations variable. Since the lagged dependent variable has a positive coefficient, the expected sign of the coefficient on $400\ \Delta\ln(1\text{-}s11)_{t-1}$ is positive. To test the effect of the growth of money market balances on M1, the current and lagged (up to four) values of changes in the share of these accounts in M2 were added to the M1 multiplier model; none of these variables is significant, however, either alone or in combination.

The estimated equation used to test whether other checkable deposits have raised the M1 multiplier for the period III/1959 to III/1989 is:

$$(3) \quad \dot{ml}_t = \underset{(-2.95)}{-0.664} \; \underset{(-3.24)}{- \; 0.040} \; \dot{p}^e{}_{t-1} \; \underset{(-0.77)}{- \; 0.005} \; \dot{R}_t$$

$$\underset{(-2.63)}{-0.011} \; \dot{R}_{t-1} \; \underset{(-5.78)}{-9.60} \; D6 \; \underset{(2.75)}{+ \; 0.227} \; ml_{t-1}$$

$$\underset{(-0.08)}{-0.006} \; 400\Delta\ln(1\text{-}sl1)_{t-1}$$

$$\underset{(-2.39)}{-0.193} \; 400\Delta\ln(1\text{-}sl1)_t$$

$\bar{R}^2 = 0.48$ D.W. = 2.02
S.E. = 2.002 h = -0.46

The last coefficient can be used to find an estimate of the fraction (f) of other checkable deposits that affect M1, given the monetary base, interest rates and energy prices, and controlling for the 1980 credit control program. Since the theoretical value of its coefficient is [-f(1-s)/(1-fs)], f equals [0.193/(1-0.807 $sl1)_t$]. At the mean value of sl1, 0.080, the estimated value of f is 20.6 percent. The lagged innovation term is not statistically significant and it has the wrong sign.[26/] The F-statistic for the significance of the last two terms is $F_{2,111} = 4.65$, which is significant at the 5 percent level (critical value = 3.08). The insignificant lagged term, $\Delta\ln(1\text{-}sl1_{t-1})$, could be omitted, but this would impose the constraint that either f or the coefficient on the lagged dependent variable is zero, which contradicts the inclusion of the significant lagged dependent variable and contemporaneous share term.

The significant coefficient on the share of other checkable deposits in the multiplier equation is at odds with the results above for deposit turnover and, more importantly, for the currency ratio. If other checkable deposits boosted total checkable deposits and M1, given the monetary base, the effect should have been anticipated by finding a significant negative effect on the currency ratio, but it was not.

The other principal source of an increase in the multiplier, however, is a decline in the desired ratio of reserves to total checkable deposits.[26/] During the early 1980s, the ratio of total reserves or total reserves adjusted for reserve requirement changes to total checkable deposits fell as the share of other checkable deposits rose. For example, the simple correlations between changes in S11 and changes in the total and the adjusted reserve ratio from I/1978 to III/1989 are -0.38, which is significant at a 99 percent confidence level. Thus, the significant effect of financial innovations on the M1 multiplier arises through reserve behavior, not because of the shifts envisioned by the financial innovations hypothesis.

To test whether the interest elasticity of the M1 multiplier is affected by the relative size of other checkable deposits, the annualized change in the interest elasticity, $400\Delta(sl_t lnR_t)$, is added to equation 3. An insignificant contemporaneous interest rate term ($\dot{R}_t$) and an insignificant term for the shift in the elasticity of the lagged interest rate ($\Delta 400 sl_{t-1} lnR_{t-1}$) are omitted. The estimate is:

$$\text{(4)} \quad \dot{m1}_t = \underset{(-3.86)}{-0.791} \underset{(-2.60)}{-0.031} \dot{p}^e_{t-1} - \underset{(-2.16)}{0.008} \dot{R}_{t-1} + \underset{(2.70)}{0.194} \dot{m}_{t-1}$$

$$\underset{(-6.83)}{-9.951} D6 - \underset{(-0.11)}{0.008} 400\Delta ln(1-sl1)_{t-1}$$

$$\underset{(-4.67)}{-0.479} 400\Delta ln(1-sl1)_t - \underset{(-4.67)}{0.102} 400\Delta(sl_t lnR_t)$$

$\bar{R}^2 = 0.59$ D.W. = 2.19
S.E. = 1.842 h = -1.82

The results indicate that the interest elasticity of the M1 multiplier increased significantly (in absolute value) as the share of other checkable deposits in total checkable deposits rose; the timing of the interest rate effect also changed, becoming stronger in the current quarter.[27] Like the financial innovation result, the shift in the interest elasticity is surprising because both components of the financial innovations hypothesis are rejected for the currency ratio. In each test, however, the significant effect arises through a significantly correlated movement in the reserve ratio.[28] According to equation 4, the effect of a rise in the share of other checkable deposits is to raise the M1 multiplier by an initial 0.479 percent. The permanent effect of each percentage point rise in s11 is to raise M1 by 0.594 percent.

Equation 5 shows the estimate for the M2 multiplier, m2, with the only significant innovation effects for the same period. The estimated M2 multiplier equation for the period III/1959 to III/1989 is:

$$
\begin{aligned}
(5)\quad \dot{m2}_t = \underset{(2.93)}{0.645} - \underset{(-0.03)}{0.000}\, \dot{p}^e{}_{t-1} - \underset{(-3.38)}{0.015}\, \dot{R}_t - \underset{(-0.26)}{0.001}\, \dot{R}_{t-1} \\
+ \underset{(9.15)}{0.635}\, \dot{m2}_{t-1} - \underset{(-2.89)}{4.529}\, D6 + \underset{(4.28)}{0.167} \\
400\Delta \ln(1-s2)_{t-1} - \underset{(-3.88)}{0.147}\, 400\Delta \ln(1-s2)_t
\end{aligned}
$$

$\bar{R}^2 = 0.50$ D.W. $= 2.15$
S.E. $= 2.069$ $h = 0.99$

The effect on the M2 multiplier of the shares of other checkable deposits, money market balances, and their sum in M2 were examined. For the M2 multiplier, lagged energy prices do not have the significant negative effect that they do for the M1 multiplier; the coefficient is not significantly different from zero.[29/] Only money market funds have an important effect on the M2 multiplier. The last term in the estimate indicates that a one percentage point rise in money market balances raises m2, or M2 given the adjusted monetary base, by 0.148 percent. The penultimate term indicates a larger effect equal to 0.263 however, given the coefficient on the lagged dependent variable. These movements in money market funds significantly and positively affect the M2 multiplier.

Unlike the M1 multiplier results, there is no evidence of a shift in the interest elasticity of the M2 multiplier. Neither a current nor a lagged shift in the interest elasticity is significant when added to the M2 multiplier equation in table 3, nor do the other properties of the multiplier estimate change significantly.[30/]

Since the share of other checkable deposits in M2 has no effect on the M2 multiplier, the effect on the M1 multiplier is apparently being offset by changes in other deposits in M2. This is an ironic result because the financial innovations hypothesis predicts the absence of such an effect for M2, but it does so far demand-based reasons that have been rejected here.

Financial Innovations and Money Demand

The evidence for both turnover and the currency ratio reject the implications of the financial innovations hypothesis for the use and composition of M1. These results do not address the more familiar literature on money demand or the velocity problem, however, or the M2 component of the hypothesis. The competitive markets hypothesis and the evidence for the M2 multiplier both suggest that M2 was affected by the growth of money market accounts.

Figure 5 shows the income velocity of M1 and M2 measured by the ratio of nominal gross national product to M1 and M2, respectively. Movements in velocity reflect, inversely, movements in money demand. The velocity of M1 has a strong positive trend until 1981, while M2 velocity does not appear to have a noticeable trend either before or after 1981. This change in the movements of M1 velocity and the absence of such a change for M2 velocity are often cited as evidence that the demand for M1 became less stable in the early 1980s, but that the demand for M2 did not, and as evidence supporting the financial innovations hypothesis.[31/]

Rasche provides a model of the demand for M1 and other monetary aggregates which he argues has been reasonably stable for a long time.[32/] He explains that the shift in M1 velocity behavior is an unexplained "shift in the drift."[33/] That is, the shift in velocity behavior is attributable to a change in the systematic components of velocity that are impounded in the mean of the growth rate specification or in the trend of the level of velocity. This argument rules out shifts in M1 velocity due to changes in the response of velocity to known economic factors that determine it or to changes in the error structure of the random elements that affect velocity. These two sources are typically the bases for claims of increased uncertainty, or of increased instability in a demand function. Rasche also finds evidence that the interest elasticity of M1 demand rose after 1981. With these two exceptions, Rasche's evidence indicates that the demands for M1 and M2 are stable. More importantly, he argues that the timing of financial innovations and their purported effect on M1 demand are inconsistent with the timing of the "shift in the drift" that he finds.

In Rasche's model, money demand, nominal money per dollar of GNP, is hypothesized to depend upon the interest rate (the 3-month Treasury-bill rate), real income and unanticipated inflation. In quarterly estimates, real income is measured by real GNP, x, and unanticipated inflation, $\dot{P}^u$, is measured by the residuals from an MA1 model of changes in the annualized continuous rate of increase of the implicit price deflator for GNP. The income and interest rate effects on money demand occur over three quarters.[34]

An unrestricted version of Rasche's M1 demand equation, estimated for the period II/1953 to III/1989 is:

$$(6)\quad \dot{M1}_t - \dot{GNP}_t = \underset{(-4.37)}{-2.019} - \underset{(-4.45)}{0.040}\,[400/3(\ln R_t - \ln R_{t-3})]$$

$$\underset{(-3.27)}{-0.458}\,\dot{P}^u_t - \underset{(-10.40)}{0.678}\,\dot{x}_t$$

$$+ \underset{(3.79)}{0.401}\,[400/2(\ln x_{t-1} - \ln x_{t-3})]$$

$$+ \underset{(3.15)}{2.366}\,D82_t - \underset{(-5.36)}{0.133}\,D82_t{*}DR13_t$$

$\bar{R}^2 = 0.67$ D.W. $= 1.89$

S.E. $= 2.974$ $\hat{\rho} = \underset{(2.10)}{0.176}$

where GNP is nominal GNP, and $\dot{GNP}$ and $\dot{x}$ are the annualized continuous growth rates of nominal and real GNP, respectively, D82 equals one from I/1982 on and zero earlier, and $DR13_t$ is the interest rate variable that is in the second term on the right.[35/] The significant intercept shift (D82) changes the 2.0 percent trend rate of velocity increase until 1982 into a 0.3 percent trend rate of decline subsequently; the latter is not significantly different from zero, however. The last term in equation 6 tests for the rise in the magnitude of the interest elasticity of money demand found in Rasche (1987); it too is significant.

When the innovations variable, $\Delta\ln(1\text{-}sl1)_t$, is added to equation 6, its coefficient is statistically insignificant, -0.011 (t=-0.16). Adding current and lagged values (up to four) of Ds11 or Ds2 yields similarly insignificant results. Thus, the financial innovations hypothesis is rejected using this version of Rasche's M1 demand. Of course it could be argued that the significance of the last two terms of equation 6 is due to the effects of financial innovations.

A test of whether the rise in the interest elasticity is related to the growth of other checkable deposits rejects this claim, however. This is tested by comparing the effect in equation 6 of D82*DR13 with that of $(sl_t \ln R_t - sl_{t-3} \ln R_{t-3})$ 400/3. The latter term relates the shift in the interest elasticity systematically to the share of other checkable deposits following the financial innovations hypothesis. When this innovations-related shift in the interest elasticity is used in place of the post-1981 shift, its t-statistic is significant, but lower (-2.63 versus -5.36); the equation's standard error is also higher (3.101 versus 2.97). This variable is not significant when both variables are included, however; its t-statistic is -1.07, while that on D82DR13 remains strongly significant (t=-4.41).

Similarly, the hypothesis that $D82_t$ is a proxy variable for the sharp rise in other checkable deposits in the early 1980s is tested by comparing the effect of Δs11 on equation (6) with and without $D82_t$. When this is done, the t-statistic for 400 $\Delta \ln(1\text{-}s11)_t$ is -1.59 when D82 is omitted and -0.87 when D82 is included. The use of these two innovations variables, instead of the 1982 constant and interest rate shifts, also are easily rejected when tested jointly. Thus, financial innovations do not account for the significance of the last two terms in equation 6.

When the basic model of money demand is used for M1A (M1 less other checkable deposits), the results are nearly identical to those in equation 4 with one major exception. The coefficient on 400Δln(1-s11) is 0.908 (t=8.65) and it is not significantly different from one (t=-0.87). This indicates that movements in other checkable deposits are offset one-for-one by movements in M1A. Movements in the share of other checkable deposits do not influence M1 demand, given interest rates and income. Thus, a strong version of the financial innovations hypothesis, the claims, that M1A has a more stable demand than M1, or bears a more stable relationship to the objectives of policy are readily rejected.[36/]

The M2 money demand equation that uses exactly the same set of variables for the same period as the M1 estimate is:

$$(7)\quad \dot{M2}_t - \dot{GNP}_t = \underset{(3.57)}{1.369} - \underset{(-7.89)}{0.056}\ DR13_t - \underset{(-7.13)}{0.726}\ \dot{P}^u_t$$

$$- \underset{(-15.41)}{0.753}\ \dot{x}_t + \underset{(5.17)}{0.429}[400/2(\ln x_{t-1} - \ln x_{t-3})]$$

$$- \underset{(-1.32)}{0.837}\ D82_t - \underset{(-3.47)}{0.069}\ D82_t{*}DR13_t$$

$$\bar{R}^2 = 0.79 \qquad D.W. = 1.91 \qquad \hat{\rho} = \underset{(3.34)}{0.273}$$
$$S.E. = 2.229$$

Unlike the M1 estimate, this estimate suggests that there was no significant shift in the intercept after 1981. Apparently, there was a significant rise in the size of the interest elasticity after 1981, however.

To test the financial innovations hypothesis for M2, the same procedure was followed as for M1.[37/] The results indicate that the contemporaneous effect of a rise in the share of money market balances in M2 is strongly significant, but no other financial innovation variable is. Moreover, when this contemporaneous effect of money market balances is included, neither the intercept shift nor the interest elasticity shift is statistically significant. The estimate, without these insignificant variables, is:[38/]

$$\text{(8)} \quad \dot{M2} - \dot{GNP} = \underset{(3.48)}{1.404} - \underset{(-7.71)}{0.053}\ DR13_t - \underset{(-7.89)}{0.702}\ \dot{P}^u_t$$

$$- \underset{(-17.74)}{0.795}\ \dot{x}_t + \underset{(4.58)}{0.374}[400/2(\ln x_{t-1} - \ln x_{t-3})]$$

$$- \underset{(-5.75)}{0.217}[400\Delta \ln(1-s2_t)]$$

$\overline{R}^2 = 0.82$ D.W. $= 1.80$ $\hat{\rho} = 0.42$ (5.47)

S.E. $= 2.060$

These results indicate that financial innovations have significantly affected the demand for M2.[39] The rise in the share of money market deposits significantly raised the demand for M2. According to the estimate, a 25 percent share of money market deposits in M2 causes M2 demand to be about 6 percentage points larger relative to GNP than it otherwise would be.

Figure 6 shows the growth rate of M2 measured over four-quarter periods since 1978 and an adjusted growth rate that removes the effect of shifts in money market funds from M2 using the estimated effect in equation 8.[40] The money market induced shift in M2 demand affected the measured growth rate most in 1983. In other periods, the pattern of the growth rate has been little affected. The adjusted growth rates ranged from 6.4 to 9.1 percent from 1980 until 1987. The sharp acceleration of M2 growth from 1980 to 1983 and subsequent slowing is eliminated by the adjustment.

The effects on M2 velocity are shown in figure 7. Actual M2 velocity appears to vary about its mean in figure 7. When adjusted for shifts arising from money market accounts, however, M2 velocity has a positive trend, especially since the mid-1970s. This distinction is important for empirical analysis and for policy formulation. Research that ignores the significant shifts in M2 velocity that have been induced by the growth of money market funds is likely to yield biased conclusions.

Conclusion

The financial innovations hypothesis that new monetary instruments have seriously distorted, perhaps permanently, the measurement, control and effectiveness of M1, but not M2, is widely accepted. An older analytical tradition, called the competitive markets view here, suggests that this hypothesis is false. A systematic investigation of the financial innovations hypothesis rejects the hypothesis and also supports the competitive markets hypothesis. The number of theoretical linkages of monetary aggregates or their use to other measures of economic performance is endless, but a few key relationships have been isolated and examined here. These are the turnover rate of checkable deposits, the desired currency-deposit preferences of money holders, the M1 and M2 multiplier, and their velocity or demand.

The analysis indicates that there was a switch of low turnover deposits from demand deposits to these new checkable deposits, so that the average turnover of demand deposits rose. The turnover of total checkable deposits was not affected by these financial innovations, however. This result is counter to the significant decline implied by the financial innovations hypothesis. Similarly, the introduction and growth of other checkable deposits has had no significant effect on the way individuals hold M1--that is, the desired proportion of currency to checkable deposits--or on the velocity of (demand for) M1. While there is evidence of a shift in the drift of M1 velocity and its interest elasticity after 1981, the tests here reject the hypothesis that these shifts were related to the rise in the share of other checkable deposits in M1 in the early 1980s.

The introduction of money market deposit accounts, and earlier of money market mutual funds, did have a significant effect on some of the measures studied. In particular, although the demand for these balances grew expansively, at least until late-1986, this growth has had no effect on the demand for M1, its composition, or the use of checkable deposits. It did shift up the demand for M2 significantly, however. As a result, M2 velocity was depressed by the growth of money market balances, and this provided unwarranted support to the view that M2 velocity is stationary, and that M2 demand is stable. Similarly, the rise in the share of money market balances significantly boosted the M2 multiplier, resulting in greater uncertainty about the control of M2. Movements in the share of money market accounts have accounted for much of the variation of M2 growth over the past ten years or so.

FOOTNOTES

[1] These uncertainties have been a continuing source of concern for the Federal Open Market Committee (FOMC). The concern has focused primarily on M1. See Hafer (1986) and Neutzel (1987) for discussions of uncertainties associated with M1. In 1981, when the authority to offer interest-bearing checkable deposits was extended nationwide, the FOMC announced targets for the old M1-type measure that excluded such new deposits and for an M1-type measure that added these so-called other checkable deposits to the older measure. See Tatom (1982) and Thornton (1982) for an analysis of the 1981 developments and their effects on monetary policy; the latter article discusses the evolution of the current M1 measure following the 1980 redefinitions discussed in Hafer (1980). In 1983, the FOMC refrained from targeting on M1 and indicated a greater reliance on the monetary aggregate M2. See Hafer (1985) for a discussion of the effects of 1983 innovations on policy deliberations.

[2] Some examples are: Hafer (1984), Barnett (1980), Spindt (1983), Morris (1982), Cox and Rosenblum (1989), Darby, Mascaro and Marlow (1987), Friedman (1988), Haraf (1986), Hetzel and Mehra (1989) Judd and Trehan (1987), Judd, Motley and Trehan

(1988), Keeley and Zimmerman (1986), Kopcke (1987), Porter and Offenbacher (1984), Roth (1987), Siegel (1986), Simpson (1984) and Wenninger (1986). In short, this view is widespread. Earlier studies disputing these claims include Cook and Rowe (1985), Gavin (1987), Hein (1982), Jordan (1982) and Tatom (1982, 1983a, 1983b).

3/ Numerous other financial innovations have occurred over the past several decades. This article focuses on the introduction of the principal new types of monetary assets that are included in the monetary aggregates. Moreover, the analysis is limited to the effects of these innovations on M1 and M2; it ignores the effects on broader monetary aggregates or on differently weighted aggregates, like the divisia or turnover-weighted aggregates. These other measures are discussed by Barnett (1980) and Spindt (1983).

4/ Some analysts point to the similarities between super-NOW accounts and money market accounts; the latter offer the limited checking services and unregulated interest rates. They suggest that money market balances are close substitutes for M1. See Cox and Rosenblum (1989) and Motley (1988), for example.

5/ See Thornton (1983). In late 1982, the FOMC anticipated that maturing all-savers certificates and the impending introduction of MMDAs would temporarily boost M1 and, to a lesser extent, M2. The FOMC decided in October 1982 to set no short-run objective for M1, but to place greater weight on M2. There was no indication that M2 would rise relative to M1, especially by as much as it did.

[6] For example, the FOMC's initial target range for M2 announced in February 1983 called for M2 growth in the 7 to 10 percent range from the February-March average to the fourth quarter of 1983. This range was viewed as comparable to the 1982 range of 6 to 9 percent, allowing for some further boost to M2 due to new MMDAs. Hafer (1985) discusses these developments and their effects on the FOMC deliberations in detail.

[7] Rasche (1988b) cites several studies that make this argument.

[8] If ρ equals the marginal and average reserve ratio on checkable deposits, and r_d, the rate paid on deposits, equals $(1-\rho)i$, then the cost of M1 is i/m, where m is the money multiplier measured as the ratio of M1 to the source base, currency plus reserves. See the Appendix for a derivation of this expression.

[9] Let the interest elasticity of money demand be written as E (M,i). It can be thought of as the product of $E(M, P_m)$ and $E(P_m, i)$, where P_m is the price of holding money. When the last component is one, the interest elasticity, E(M,i), equals $E(M,P_m)$, the elasticity of money demand with respect to the price of holding money. Since the latter elasticity

is unaffected by financial innovations, the interest elasticity of money demand will only change if the elasticity $E(P_m, i)$ does. So long as P_m is proportional to i, this elasticity is one and will not change. If the elasticity of money demand with respect to its cost is not a constant, as typically assumed in the literature, but, instead, rises along with the price of holding money along a linear demand curve then a financial innovation that lowers the price of deposits will lower the elasticity of demand. This functional form issue is not, however, the relevant concern in the literature on the changing elasticity of demand.

10/ Rasche (1987), (1988a), and (1988b) has provided evidence for a rise in the interest elasticity of M1 demand, but he does not link this to financial innovations. Friedman (1988), Moore, Porter and Small (1988), Carlson (1989), and Poole (1988) also have pointed to the rise in the interest elasticity of M1 demand, although for different reasons. The first three studies suggest that this effect arose from financial innovations, while Poole suggests that this larger elasticity is not a recent development; instead, he argues that only its recognition is recent.

11/ This view of regulation and bank markets has a long theoretical and empirical tradition. It has been developed in such works as Barro and Santomero (1972), Cox (1966), Kareken (1967), Benjamin Klein (1970, 1974), Michael Klein (1974), Tatom (1971), Saving (1971), (1977), and (1979), Santomero (1974), Startz (1979), and Frodin and Startz (1982).

12/ In these instances, the issue is whether other checkable deposits affect M1 instead of total checkable deposits, so s11 is a more natural measure and its effect is more easily interpreted. No results below are affected by this choice, however.

13/ These data are available in the Federal Reserve statistical release, G.6, Debits and Deposit Turnover at Commercial Banks. Debits on ATS and NOW, like demand deposits, typically are third party payments; debits for savings, on the other hand, typically are in-bank withdrawals. Moreover, turnover is substantially larger for business accounts than for individuals and only the latter can legally hold NOW and ATS accounts.

14/ The current and other past values of s1 are not as significant as the first lag. The current value of s1 is the only other significant. When both the current and lagged value are included, neither is statistically significant; in each case, the standard error is lower with the current value than with the lagged value and when S1 is used instead of S11.

[15] The overall and adjusted turnover rates excluding demand deposits in New York were also examined. Their growth rates are white noise and are independent of interest rates or real personal income. They are also not significantly correlated with the current or, in the case of s2, lagged values of the changes in the financial innovation shares. The turnover rate of demand deposits outside New York is positively correlated with the one-month lag of the share of other checkable deposits; the correlation coefficient for the period March 1970 to January 1989 is 0.16, which is significant at a 1.3 percent level. For the period January 1979 to January 1989, the correlation coefficient is 0.17, which is only significant at a 5.7 percent level. The adjusted turnover rate is not significantly related at this or any lag. For the one-month lag, its correlation coefficient is 0.07 over the longer period, and 0.08 over the shorter period. Of course, both of these insignificant but positive correlations are contrary to the significant negative relation posited by the financial innovations hypothesis.

[16] The adjusted monetary base is described in Gilbert (1980) and (1987). A recent analysis of the behavior of the multiplier and its determinants is in Burger (1988).

[17] The effect of nationwide NOW accounts on the currency ratio is tested in Tatom (1982). A model of the demand for currency and demand deposits is used to test whether other checkable deposits lowered desired currency holdings relative to total checkable deposits. The tests reject the financial innovations hypothesis. Rasche and Johannes (1987) show that the 1981 shift to NOW accounts did include a shift of savings to these accounts equal to about the 27.5 percent of such funds in the first four months of 1981. This was the proportion suggested by the staff of the Board of Governors of the Federal Reserve System, but their estimates were for a continuing effect and they applied for all of 1981. Rasche and Johannes argue that this shift significantly but temporarily reduced the currency ratio and raised the money multiplier. They find no evidence beyond that time (or before the first four months of 1981) for a permanent effect on the currency ratio or other ratios in the multiplier of the shift to other checkable deposits or to money market accounts. See Rasche and Johannes (1987, pp. 60-69).

[18] The apparent disappearance of a positive trend after mid-1980 is not related to financial innovations. The statistical evidence below indicates that this appearance arises from the pattern of the credit-control spike in 1980 and the pattern of energy

price movements in 1974-80 compared with those in 1981-86. More importantly, the trend term captured by the constant in the first column of table 2 is not statistically significant.

19/ Rasche and Johannes (1987) argue for the superiority of a time series model over a structural approach like that used in Tatom (1982); the modifications here are made because of the sizable known effects of the two shocks included, and because of an interest in testing for a changing interest elasticity.

20/ Tatom (1985) provides evidence that money demand is affected by energy price increases. The currency-ratio effect may arise, at least in part, through gasoline purchases that affect currency demand more than the demand for checkable deposits. A related argument is that a change in the mix of personal consumption expenditures toward nondurable purchases raises the currency ratio. See Dotsey (1988), for example.

21/ The effect of the credit control program on the money stock is discussed in Tatom (1982) and Hein (1982), for example. Also see Wallace (1980) for an analysis of the effects of credit controls on currency demand.

22/ The F-statistic for a Chow test of the stability of the equation estimate in the first and second half of the whole sample period is $F_{5,110}=0.96$, which is well below the critical value (5 percent) of 2.30. Thus, the stability of the currency ratio estimate cannot be rejected.

23/ The t-statistic is significant at a 22 percent level. The F-statistic for both a current and lagged quarter effect is $F_{2,113}=0.86$, which is not statistically significant. The current quarter effect has a t-statistic of -0.73 and the lagged coefficient has a t-statistic of -0.44.

24/ In the first quarter of 1981, when nationwide NOWs were authorized and the biggest shift occurred so that the largest effect might be expected, the currency ratio actually rose at a 9.16 percent rate, while the predicted effect from the first equation in table 2 was a 0.1 percent decline. This observation is at odds with the Rasche and Johannes finding of a significant decline in the currency ratio in early 1981, although this difference may arise because they use monthly, seasonally unadjusted data, while seasonally adjusted quarterly data are used here. In the form estimated, their four-month long transitory reduction corresponds to one observation here. The tests here cannot readily test for such a brief transitory effect of financial innovations.

25/ If the logarithm of the multiplier, ml, is a function of a vector of variables, Z, prior to innovations, then [ln m1+ln(1-fs)] is a function of Z subsequently, where s is used here for s11, the ratio of other checkable deposits to M1. The proportion f of other checkable deposits measures the proportion of other checkable deposits whose movements are not offset by movements in the rest of M1. If f is zero, the other checkable deposits have no effect on the relationship of m1, or M1, and Z. On the other hand, if f is one, then all other checkable deposits must be excluded from M1 in order to maintain the original relationship of M1 and Z. For the first-difference log-linear specification here, the term 400 Δln(1-s) can be subtracted from both sides and its coefficient on the right hand side is [-f(1-s)/(1-fs)]. If f is zero, this coefficient will be zero; if f is one, this coefficient equals minus one. The expression for the coefficient is derived as follows: the derivative of ln(1-fs) with respect to s is (-f/1-fs) and the derivative of ln(1-s) with respect to s is (-1/1-s). Therefore, -Δln(1-fs) equals [-f(1-s)/(1-fs)] Δln(1-s). The use of Δln (1-s) is equivalent to using Δs since the derivative of ln(1-s) with respect to s is simply [-1/(1-s)]. Thus, [-f(1-s)/(1-fs)] Δln(1-s) could be replaced with [f/(1-fs)]Δs.

26/ The coefficient, -0.006, along with that on the lagged dependent variable, provides an independent estimate of the coefficient on the last term, but together they imply an estimated value of f that is negative.

[27] A correction for first-order autocorrelation does not affect the estimates; the first-order coefficient, 0.10, is insignificant (t=1.07).

[28] When the predicted growth rate of the currency ratio from the first equation in table 2 is added to equation 4, it is significant and the only other significant variables are D6, the current shift variable for other checkable deposits and the shift in the interest elasticity. The checkable deposit shift variable has a coefficient of -0.452 which is nearly identical to the -0.479 value in equation 4. Similarly, the interest elasticity shift coefficient is -0.090, not significantly different from the -0.102 coefficient in the same equation. Thus, both effects that are absent from the currency equation remain significant and of about the same magnitude when the predicted value of the currency ratio is included. This indicates that these effects arise completely from movements in the reserve ratio. The same conclusions are also obtained when the growth of the ratio of adjusted bank reserves to total checkable deposits is regressed on the same variables as in equation 4.

[29] This outcome highlights the difference between the components of M1 and M2 as transactions

balances versus savings. The only difference between the two measures is the inclusion of various savings balances in M2 (see table 1). Apparently, the transaction effects of higher energy prices raise currency demand, lowering the M1 and M2 multipliers, but the savings components of M2 apparently are also raised relative to checkable deposits, and by just enough to eliminate any effect on the M2 multiplier from higher energy prices.

30/ When the interest elasticity shift variables are added to the M2 multiplier equation without the insignificant energy price and lagged interest rate variable, the t-statistic for the current and lagged shift are -0.48 and 1.21, respectively.

31/ Hetzel and Mehra (1989) and Judd, Motley and Trehan (1988) both take this view; indeed the central issue in the money demand literature, at least as indicated by these two papers, seems to be, first, whether the recent shifts and instability of M1 demand are permanent or will disappear after some transition to a deregulated environment. Secondly, if the breakdown in M1 demand is transitory, will its statistical properties again dominate those of M2 demand when it settles down. Judd, Motley and Trehan are more optimistic about a return to normal than Hetzel and Mehra. Carlson and Hein (1980), Hafer (1981) and Tatom (1983a) report evidence on the breakdown of the M2-GNP link after 1977, however. Tatom (1983b) and Darby, Poole, et al. (1987) provide a fuller treatment of the potential causes and consequences of the change in the behavior of M1-velocity.

32/ Rasche (1988b) extends his (1987) analysis for M1 to M2, M3 and broader measures.

33/ He conjectures, however, that the shift in the drift arises from the decline in inflationary expectations or a rise in the instability of the economy.

34/ Several coefficient restrictions are tested in Rasche (1987) and used in Rasche (1988a) and (1988b), but those restrictions are not imposed here. These restrictions enhance the elegance of the statistical model, but could bias the tests of the financial innovations hypothesis here.

35/ Rasche (1988b) omits the first and second quarters of both 1980 and 1981 in arriving at his stability results. These quarters are included here; the adjusted R^2 and standard error actually improve when these quarters are included in estimating equation 6. For the M2 results, the adjusted R^2 reported below falls slightly when these quarters are included, but no other noticeable changes occur in any of the coefficients.

[36] The case for M1A has been argued most strongly in Darby, Mascaro and Marlow (1987) and Hafer (1984). One of the more curious arguments supporting the distortion of M1 by other checkable deposits claims that the rise in M1A velocity is evidence that the demand for money shifted down by an amount that is nearly equal to the amount taken out by shift adjustment. Thus, the fact that shifts to other checkable deposits did not raise the demand for measured M1 reflects an equal-sized and equal-timed shift down in the demand for M1 or M1A. This argument and some sources for it are cited in Tatom (1982).

[37] No attempt was made to adjust the T-bill rate for the average rate paid on the components of M2 in order to better measure the opportunity cost of M2. Rasche (1988b) notes that in an estimate like equation 7, inferior overall results were found when such a measure is used instead of the T-bill rate.

[38] When $D82_t$ and $D82_t{*}DR13_t$ are added to the estimate they are not statistically significant; the coefficient on $D82_t$ is -0.529 ($t=-0.56$), and that for the shift in the interest elasticity is 0.004 ($t=0.12$).

[39] These results are not dependent on including the four quarters that Rasche omits. When they are omitted the standard error falls only to 1.966 percent and the other properties of the estimate are similarly

nearly identical. The same results also obtained when all four quarters of 1983, when the largest shifts occurred, are omitted; in particular, the t-statistic for the s2 innovation term is -2.74.

40/ This adjustment adds 0.217 $\ln(1\text{-}s2)_t$ to the logarithm of M2 to obtain a series that is independent of s2.

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Appendix

Interest on Deposits, The Cost of Holding Money and the Interest Elasticity of Money Demand

Considerable confusion exists over the effects of competitive interest payments on the cost of deposits and of money and on the interest elasticity of demand for money. This appendix examines several cases to clarify the issues. The general model assumes that money, M, is currency held by the public, C, and deposits at financial institutions, D. Currency bears no interest and has no other cost than the foregone interest rate, i. Checkable deposits earn rate r_D, which is less than the interest rate. The amount of money and deposits in the economy are constrained by the currency preferences of the public expressed as the desired ratio of currency to deposits, k, and the average and marginal reserve ratio required on checkable deposits, ρ. Excess reserves are assumed to be zero.

In such a model, the cost of holding checkable deposits is $(i-r_D)$ and the cost of M is $[ik + (i-r_D)]/(1+k)$. When r_D is zero, the typical assumption for the period prior to financed innovations, the cost of deposits and of M is the rate of interest, i; the interest rate elasticity of the cost of M is one, so the interest elasticity of money demand and the elasticity of money demand with respect to its cost are identical.

With competitive interest payments, r_D equals $i(1-\rho)$. In this case, the cost of deposits is ρi and the cost of M is i/m, where m is the M1 multiplier. The cost of deposits and money are lower than where r_D is constrained to zero, but the interest rate elasticity of each cost is the same, or one. Thus, the interest elasticity of money demand is the same when r_D is zero or when competitive interest is paid.

In each case above, the relative cost of holding currency or deposits is invariant to changes in interest rates. For example, when r_D is zero, both currency and deposits have the same cost, i, so the relative price is 1; when the cost of deposits is ρi, the relative price of deposits is ρ, which is less than one, but still independent of the interest rate. Thus, movements in interest rates do not affect the currency ratio, k, or the multiplier, m, in these two cases.1/

The model above can also be used for the case where r_D equals $\bar{r}$, which exceeds zero but is less than the competitive level $i(1-\rho)$. In this case, the cost of holding deposits is $(i-\bar{r})$ and the cost of money is $[i-(\bar{r}/1+k)]$. The relative price of deposits is not constant in this case, however; it equals $(1-\bar{r}/i)$. Thus, a rise in the rate of interest raises the relative cost of deposits. Such a cost change can be expected to raise the desired holding of currency relative to the more expensive deposits; k will rise. This statement may be written as $k_i > 0$, indicating the positive effect of interest rates on the currency ratio. The interest rate elasticity of the cost of M, E(CM, i), is:

$$E(CM, i) = [i/(i-\bar{r}/1+k)]\ [1+\bar{r}k_i/(1+k)^2]$$

Since the cost of money and k_i are positive, each term in brackets exceeds one, so the elasticity is bigger than one. This implies that the interest rate elasticity of money demand is larger in absolute size under the conditions here than when no interest, or competitive interest, is paid on deposits.[2/]

FOOTNOTES TO APPENDIX

[1/] The invariance of the relative cost of deposits ignores transactions and transaction prices. A rise in interest rates raises the cost of holding money relative to using it, so that desired turnover of deposits (and currency) will rise. This, in turn, can raise desired excess reserves and bank transactions prices. The latter would offset part of the rise in the rate paid on deposits. Thus, the prices of holding and using deposits rises relative to currency, so that the desired currency ratio rises. Thus, this result is not dependent on a pegged non-zero interest rate on deposits as the next case in the text might suggest. Tatom (1971) develops a model highlighting these results. Saving (1971, 1977 and especially 1979) addresses this issue.

[2/] When there is a fixed charge on deposits that is unrelated to the interest rate, the interest elasticity of money demand can be smaller than when there is competitive interest and this charge is zero, or when no interest is paid on deposits. The result requires that a negative interest elasticity of the currency-ratio is smaller than (1+k)/k in absolute value. Since the latter is quite large, this condition is easily met. This derivation is left to the reader. In the text and in Tatom (1983), evidence is provided that indicates a positive interest elasticity of the currency ratio; whether this is peculiar to the specifications of the equations or correctly isolates the interest elasticity of the currency ratio is an open question, however, and should not confuse the reader into believing that the latter is necessarily positive.

Table 1
M1 and M2 in 1988

Currency	205.3
Demand Deposits	289.0
Other Checkable Deposits	274.4
Travelers Checks	7.3
M1	776.0
Money Market Mutual Funds Component	232.3
Money Market Deposit Account Balances	517.5
Savings	426.4
Time	979.2
Overnight Eurodollars and Repurchase Agreements	78.1
M2	3,009.4 [1/]

1/ Components do not add to total due to rounding.

Table 2
Tests for the Ratio of Currency to Total Checkable Deposits (k)
Dependent Variable: $400\Delta \ln(k)$
Period: III/1959 to III/1989

Constant	0.548 (1.83)	0.734 (2.20)	0.440 (1.39)
$\dot{k}_{t-1}$	0.474 (7.04)	0.458 (6.68)	0.478 (7.04)
$\dot{R}_{t}$	0.015 (2.25)	0.014 (2.08)	0.015 (2.10)
$\dot{R}_{t-1}$	0.026 (3.93)	0.028 (4.10)	0.024 (3.39)
$\dot{p}^{e}_{t-1}$	0.056 (2.93)	0.057 (2.97)	0.052 (2.65)
D(6)	15.992 (6.52)	15.197 (6.00)	16.213 (6.47)
Dsl_t		-0.101 (-1.24)	
$D(sl_t \ln R_t)$			0.008 (0.26)
$D(sl_{t-1} \ln R_{t-1})$			0.026 (0.86)
$\bar{R}^2$	0.58	0.58	0.58
S.E.	3.131	3.124	3.140
D.W.	1.94	1.92	1.93
h	0.28	0.39	0.33

Figure 1
Share of Other Checkable Deposits in
Total Checkable Deposits
Percent

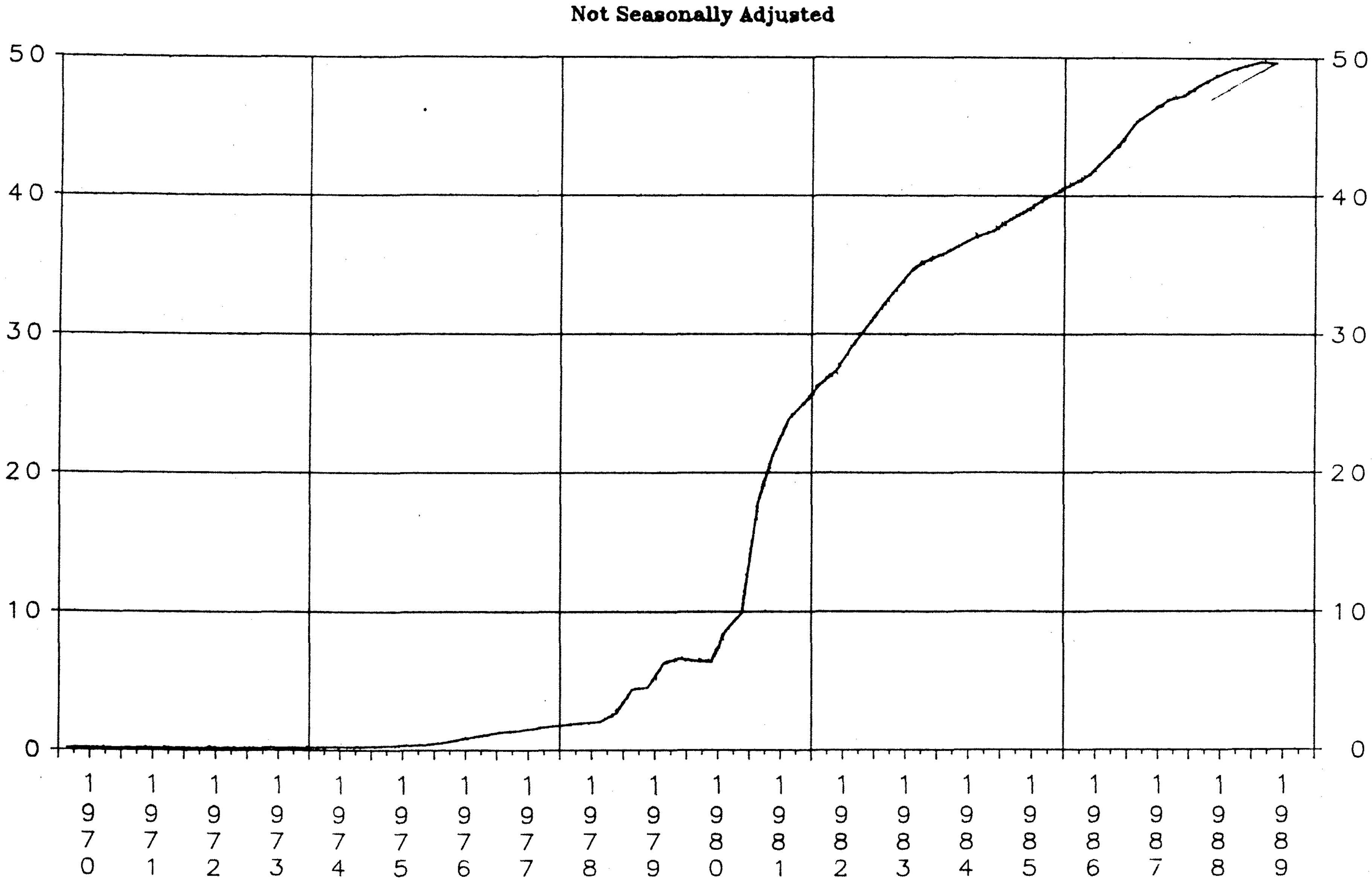
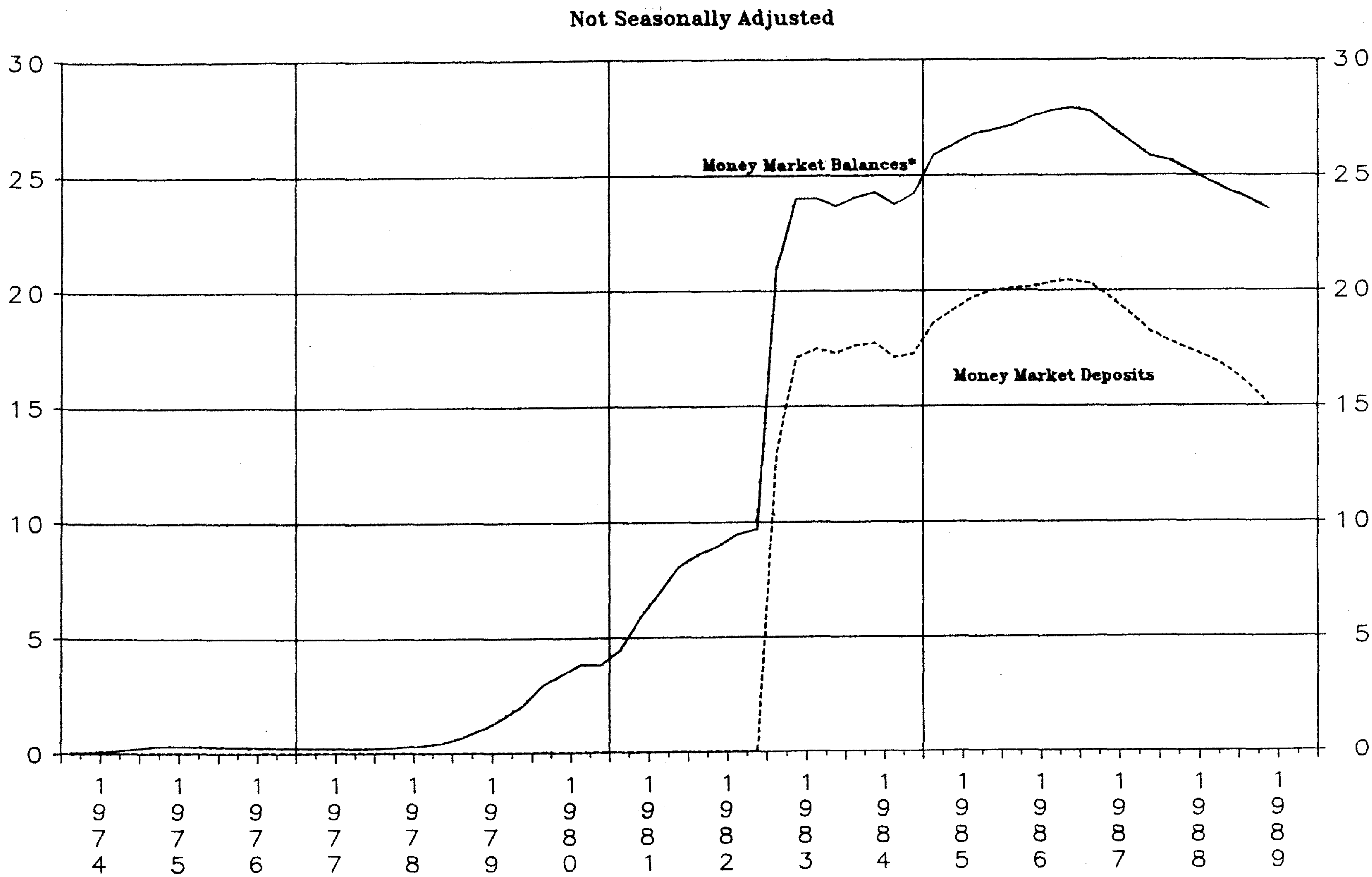


Figure 2
Share of Money Market Instruments in M2
Percent



*Money market balances include both the money market deposit account and money market mutual fund components of M2.

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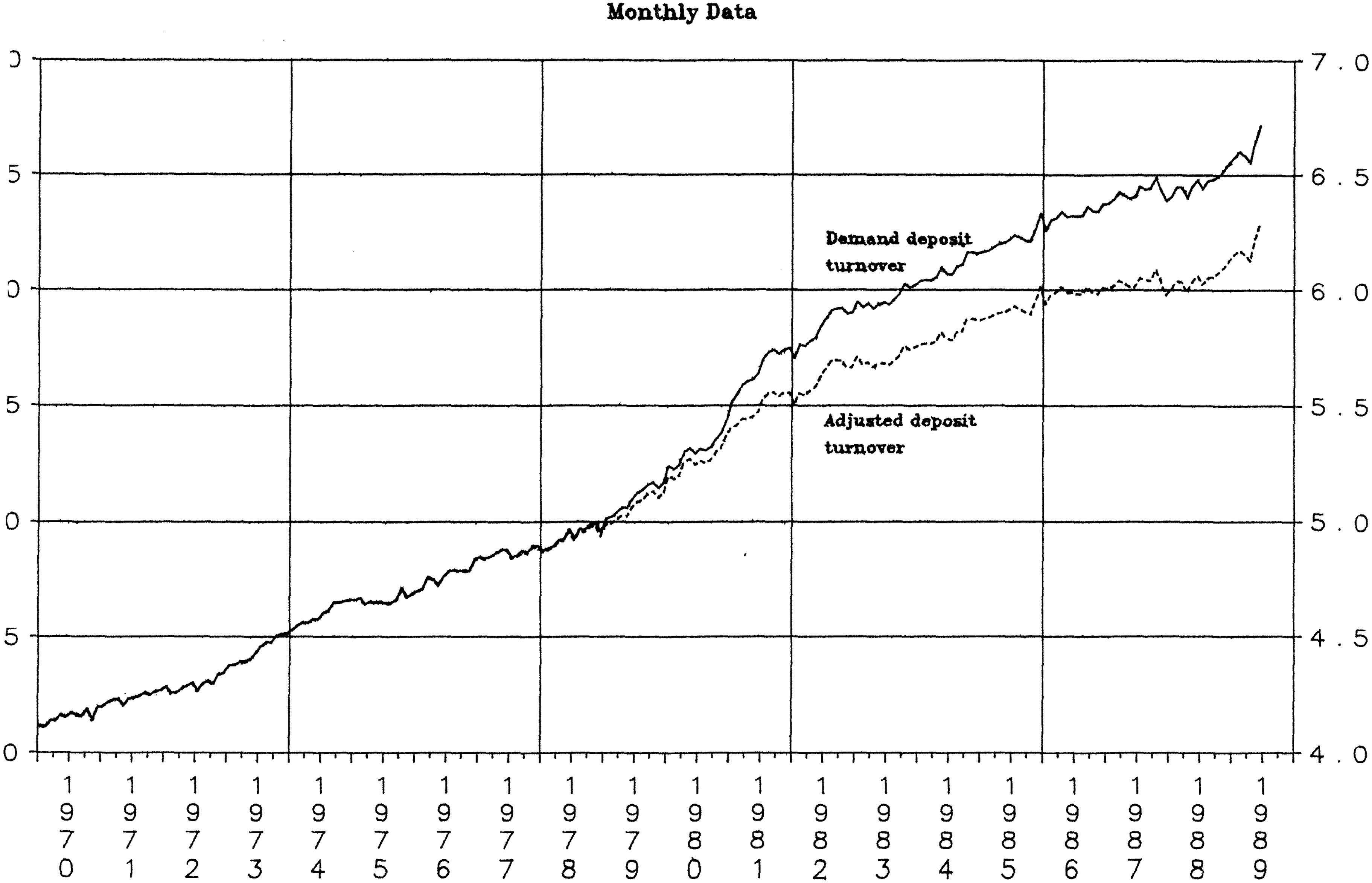

Last observation is June 1989.

Figure 4
Currency–Deposit Ratio
Percent

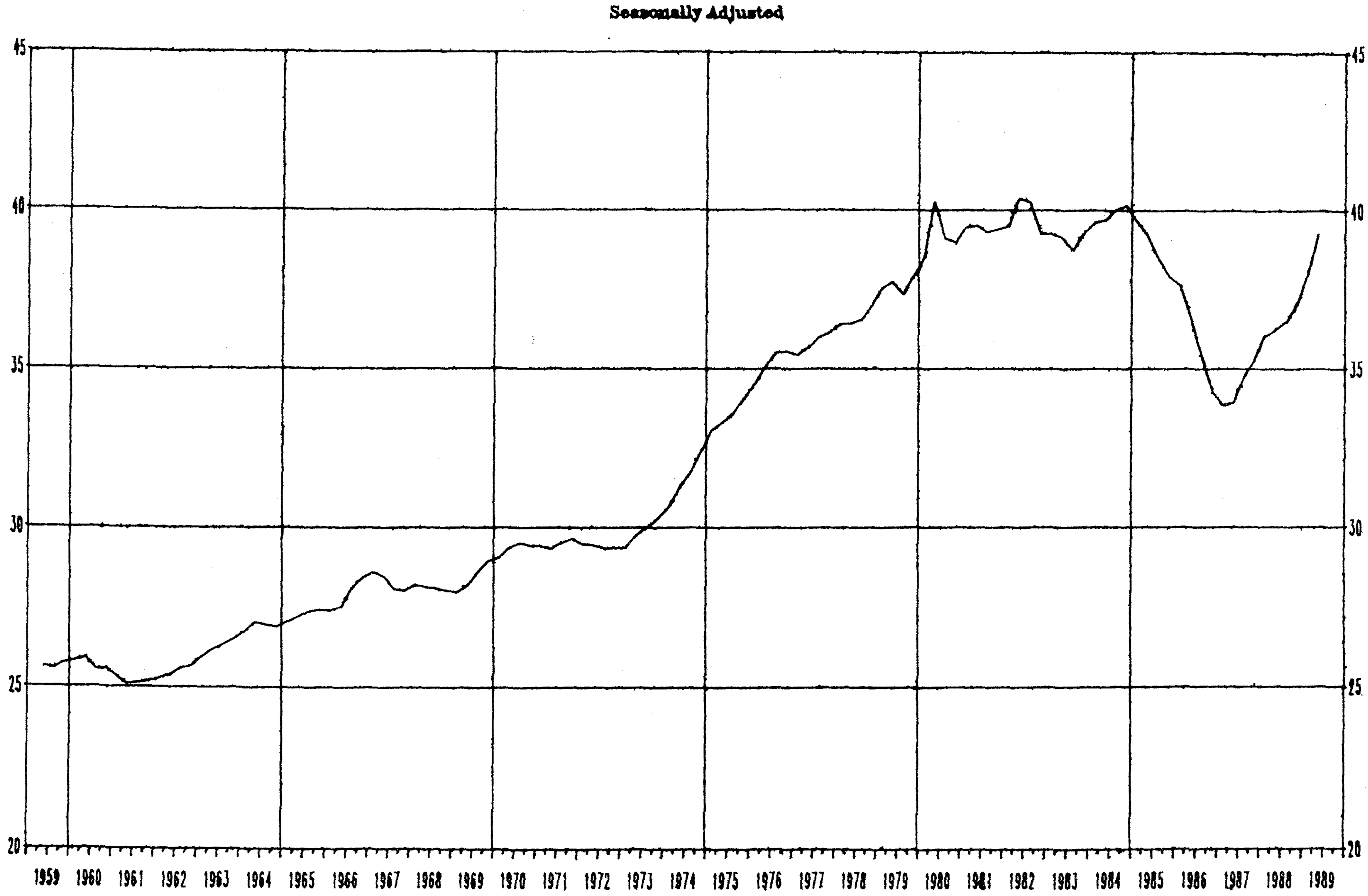

Figure 5
Income Velocities of M1 and M2

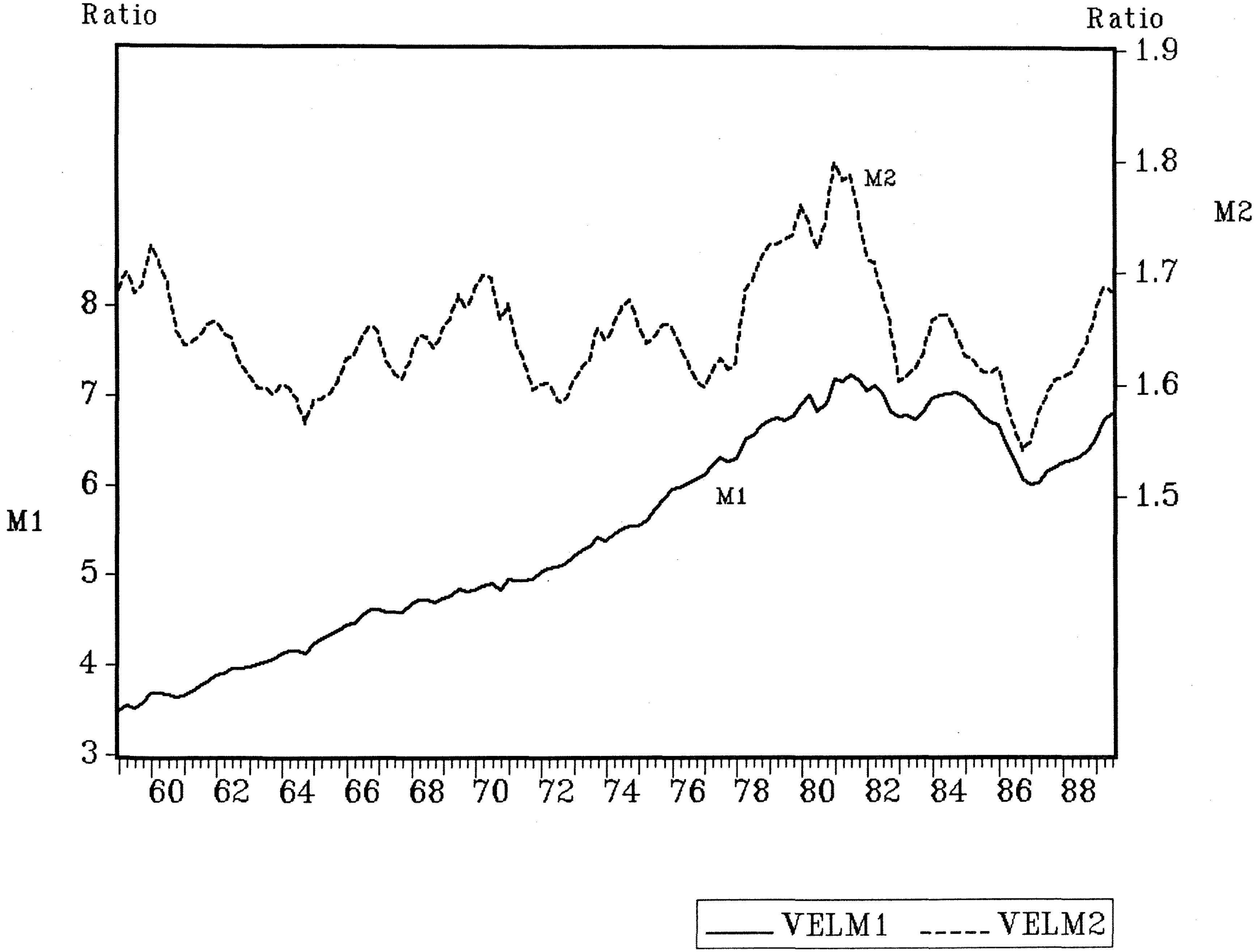

Figure 6

The Growth Rate of M2

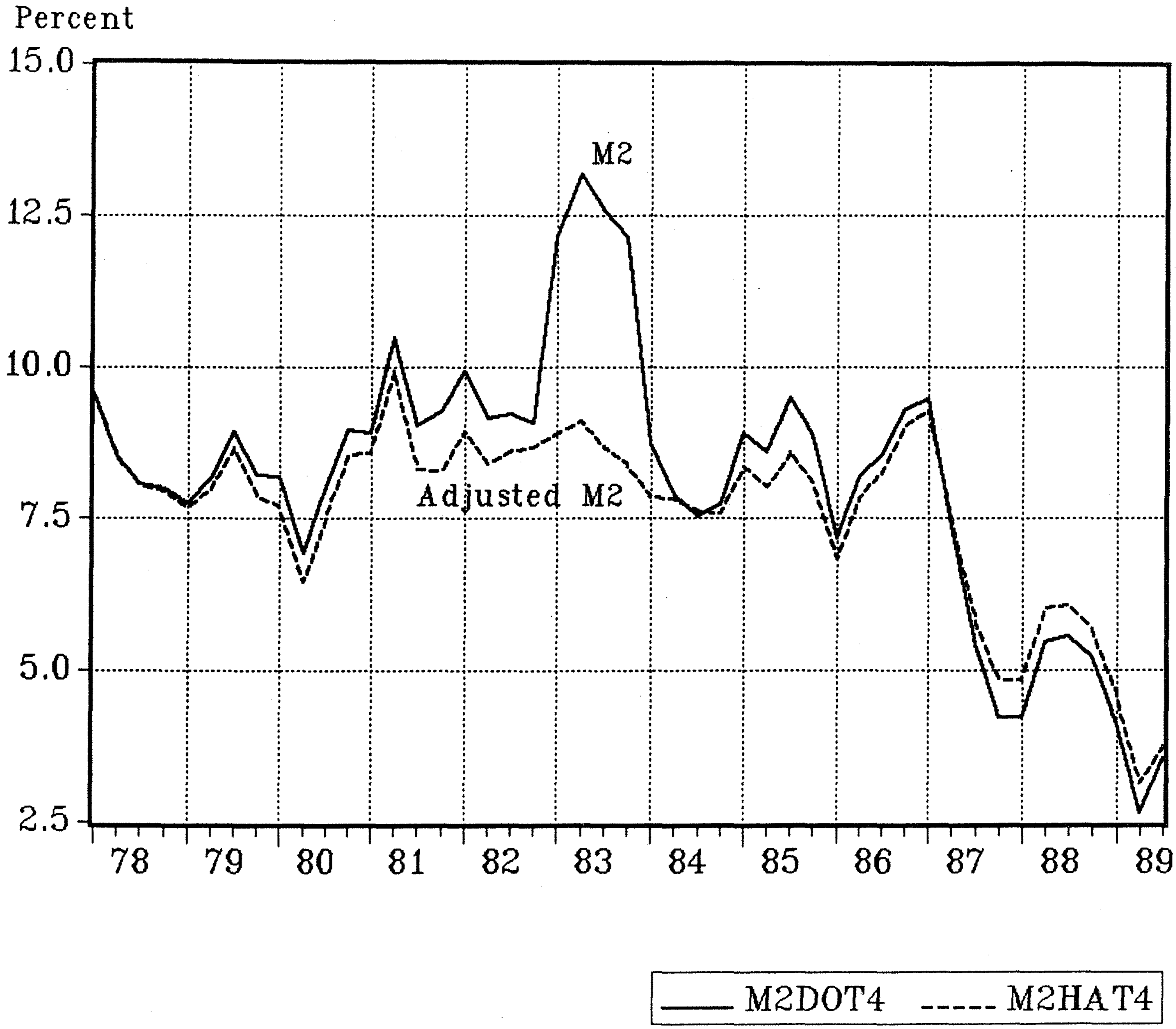

Figure 7
The Effect of Money Market Accounts on M2 Velocity