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The Effects of Financial Innovations on Checkable Deposits, M1 and M2

DURING THE EARLY 1980s, 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 gave rise to increased uncertainty in explaining movements in the monetary aggregates and questions about the relationship of the monetary aggregates 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 by these innovations and therefore remains a useful target—is almost as widely shared. While an apparent change in the linkage between M1 and economic performance in the 1980s has buttressed the impression that financial innovations distorted M1 and

[1]These uncertainties have been a continuing source of concern for the Federal Open Market Committee (FOMC). This concern has focused primarily on M1. See Hafer (1986) and Nuetzel (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. 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 M2. See Hafer (1985) for a discussion of the effects of 1983 innovations on policy deliberations.

[2]Some examples are: Hafer (1984), Barnett (1982), Spindt (1985), Morris (1982), Cox and Rosenblum (1989), Darby, Mascaro and Marlow (1989), Friedman (1988), Haraf (1986), Hetzel (1989), Hetzel and Mehra (1989), Judd and Trehan (1987), Judd, Motley and Trehan (1988), Keeley and Zimmerman (1986), Kopcke (1987), Porter and Offenbacher (1984), Mehra (1989), 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 (1984) and Tatom (1982, 1983a, 1983b). These studies follow an earlier theoretical and empirical tradition which suggested the ineffectiveness of deposit rate regulations. This literature includes such works as Barro and Santomero (1972), Bradley and Jansen (1986), Cox (1966), Frodin and Startz (1982), Kareken (1967), Benjamin Klein (1970, 1974), Michael Klein (1974), Saving (1971, 1977, and 1979), Santomero (1974), Startz (1979) and Tatom (1971).

impaired its usefulness, few quantitative studies have assessed the actual effects of financial innovations on the monetary aggregates.

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. It then assesses the validity of this hypothesis by examining whether the turnover rate for checkable deposits, currency preferences, and M1 and M2 demand (velocity) have been affected as the hypothesis suggests.[3]

MONETARY AGGREGATES AND FINANCIAL INNOVATIONS

Table 1 shows the components of M1 and M2 in 1989. M1 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 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.

As figure 1 shows, the share of other checkable deposits in total checkable deposits (demand and other checkable deposits) rose from about 10 percent in late 1980 to more than 25 percent by the end of 1981, the first year that nationwide NOW accounts were authorized. This share continued to rise, in part because of the introduction of super-NOW accounts (interest-bearing other checkable deposits with unregulated interest rates) in early 1983. By 1989, other checkable deposits had risen to $278.5 billion, nearly half of total checkable deposits and about 36 percent of M1.

M2 is the sum of M1, saving and small time deposits at all financial institutions, overnight (and continuing contract) repurchase agreements issued by all commercial banks, overnight Eurodollars issued to U.S. residents by foreign branches of U.S. banks and money market accounts (MM),

Table 1
M1 and M2 in 1989 (billions of dollars)

Components	Amount
Currency	$217.5
Demand deposits	280.4
Other checkable deposits	278.5
Travelers checks	7.3
M1	$783.7
Money market mutual funds component[1]	$276.3
Money market deposit account balances	475.0
Savings	410.0
Small time	1,105.5
Overnight Eurodollars[2] and repurchase agreements	79.1
M2	$3,129.5[3]

[1]General purpose and broker-dealer funds.

[2]Eurodollar deposits issued to U.S. residents by foreign branches of U.S. banks.

[3]Components do not add to total because of rounding.

which include both general purpose and broker-dealer 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 MMMF, rose by less than 17 percentage points; the share of total money market balances, rose from 10 percent 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. The share of MM in M2, called s22 below, rose to nearly 25 percent of M2 by 1989 (see table 1 and figure 2).

[3]Numerous other financial innovations have occurred over the past several decades. This article focuses solely on the introduction of the principal new types of monetary assets that are included in the monetary aggregates. Moreover, the analysis is limited solely to the effects of these innovations on M1 and M2; it ignores the effects on broader aggregates or on differently weighted aggregates, like the divisia or turnover-weighted aggregates. These other measures are discussed by Barnett (1982) and Spindt (1985).

Figure 1
Share of Other Checkable Deposits in Total Checkable Deposits

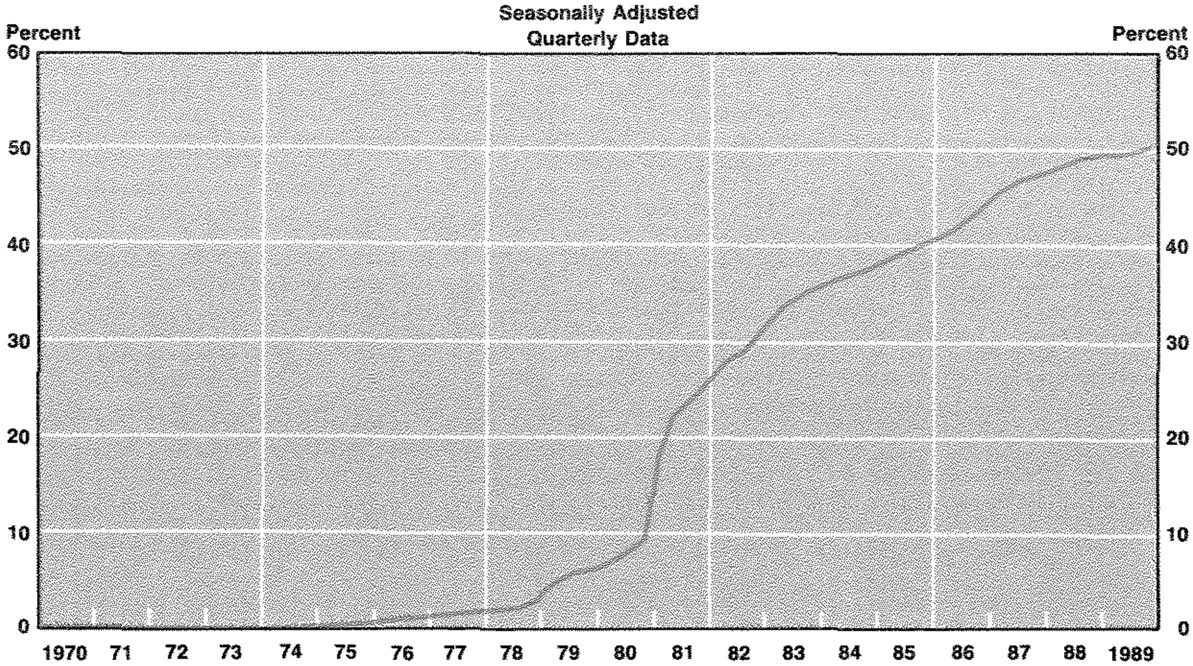
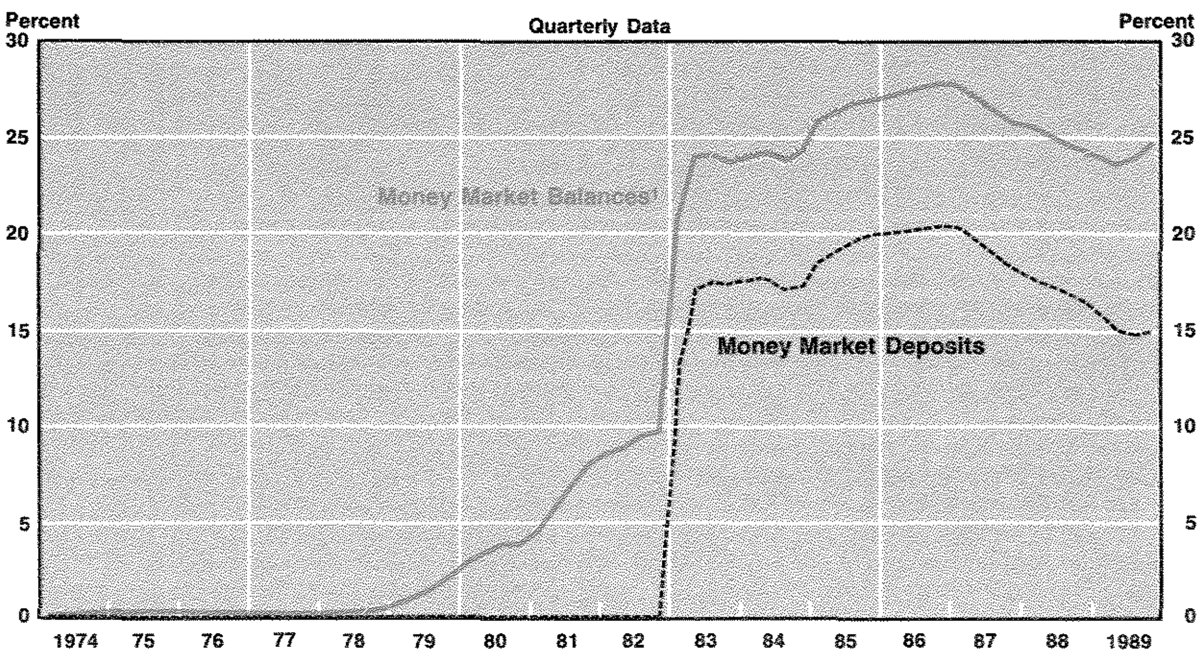


Figure 2
Share of Money Market Instruments in M2



[1]Money market balances include both the money market deposit account and money market mutual fund components of M2, which are not seasonally adjusted.

THE FINANCIAL INNOVATIONS HYPOTHESIS

The financial innovations hypothesis described here focuses primarily on the effects of the growth 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 checking instead of their 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 raise the interest elasticities of their demands.[4]

In addition, movements of funds from savings to checkable deposits were expected to take place among components of M2, so that the total demand for M2 was 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 expansion of MMDAs was not expected to boost M2.[5] One implication of this hypothesis is that the growth of MMDAs, or of MMMFs earlier, did not affect the demand for M1, its use or its composition.[6] If these assets provide transaction services that are substitutes for total checkable deposits, however, then shifts to these balances should reduce the demand for total checkable deposits relative to currency holdings, or raise the currency ratio. Such shifts would also reduce the overall demand for M1. Whether money market innovations had any significant effects is also tested below.

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 16.6 percent annual rate in the first half of 1983. While this movement ran counter to the financial innovations hypothesis, many thought that it was transitory and carried little implication for future economic performance.[7]

Testing the Financial Innovations Hypothesis

In this article, the financial innovations hypothesis is tested by examining whether these new assets have influenced the use, composition or demand for total checkable deposits, M1 and M2 as predicted. If total checkable deposits and M1 are boosted by inflows of savings into other checkable deposits, then the total checkable deposit 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 = OCD/TCD). Similarly, the desired ratio of the currency component of M1 to the total checkable deposit component also should be inversely related to s1.[8]

When the effects of other checkable deposits on M1 and M2 are investigated, the innovations measures used are their ratios to M1 (s11 = OCD/M1) and to M2 (s12 = OCD/M2), respectively. If M1 is increased by an inflow of savings into other checkable deposits, then the demand for M1, given its other determinants, must be *positively* related to s11. According to the financial innovations hypothesis, the impact of money market balances, measured relative to M1 (s21 = MM/M1), on M1 demand is zero. Similarly, if the hypothesis is correct, the demand for M2 should

[4]Rasche (1988a) cites several studies which argue that financial innovations lowered the interest elasticity of money demand. More recent proponents of a financial innovations effect argue for an increase in this elasticity. 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), Mehra (1989) and Poole (1988) also have pointed to the rise in the interest elasticity of M1 demand, although for different reasons. The first four studies suggest that this effect arose from financial innovations, while Poole suggests that it is not a recent development; instead, only its recognition is recent.

[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]Some analysts, however, point to the similarities between super-NOW and money market accounts; the latter offer 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.

[7]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 a further boost to M2 due to new MMDAs. Hafer (1985) discusses these developments and their effects on the FOMC deliberations in detail.

[8]The appendix to this article presents a more formal discussion of the tests of the effects of financial innovations.

be unrelated both to other checkable deposits, measured by s12, and to money market balances, measured by s22.

Testing for a Shift in the Interest Rate Elasticity

The effect of other checkable deposits on the interest elasticity of each relationship also is examined. The financial innovations hypothesis indicates that the weighted average cost of holding total checkable deposits and M1 and the interest elasticity of various monetary linkages are functions of the relative size of other checkable deposit balances. The implication is that the relevant interest elasticity rose, on average, after the introduction of other checkable deposits. Under the financial innovations hypothesis, the rise in the interest elasticity is a function of s1, the relative size of other checkable deposits. Thus, if β_0 is the interest elasticity before the introduction of other checkable deposits (that is, when s1 is zero), then following this innovation the interest elasticity becomes $\beta^* = \beta_0 + \beta_1$ s1.

In the log-linear relationships estimated below, the interest elasticity following the advent of other checkable deposits is found from the β coefficients in the expression: β_0 lni + β_1(s1 lni); the interest elasticity is β_0 plus β_1 weighted (multiplied) by the average value of s1. In a first-difference equation, the appropriate expression is: β_0 Δlni + β_1 Δ(s1 lni). Whether the interest elasticity has increased as a result of this financial innovation is indicated by the sign and statistical significance of β_1.

In summary, in this study the financial innovations hypothesis is rejected if: (1) measures of other checkable deposit innovations have no significant effect on the M1-related variables and their interest elasticities, (2) these same measures have a significant effect on the size or interest elasticity of M2 demand, or (3) measures of money market innovations have any significant effect on the use, composition or demand for M1 or the demand for M2. These relationships are examined below.

FINANCIAL INNOVATIONS AND THE DEPOSIT TURNOVER RATE

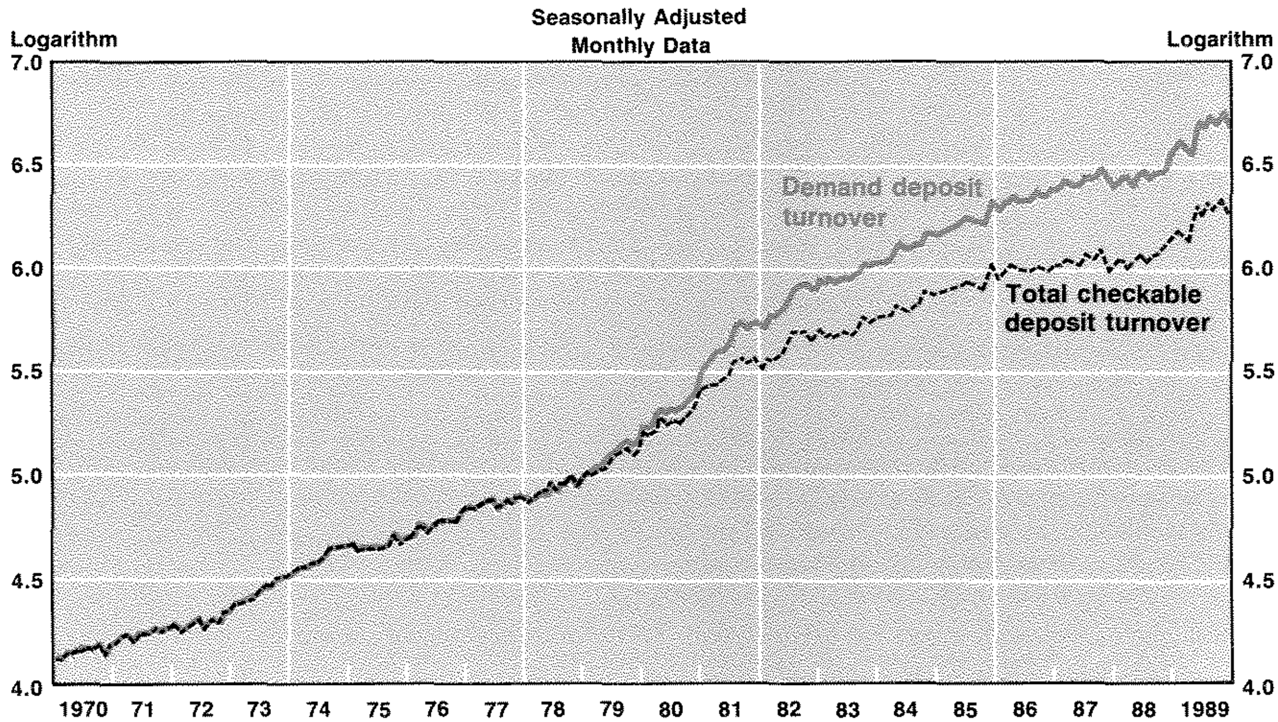
The turnover of other checkable deposits, their debits per dollar of deposits, is lower than the turnover of demand deposits. For example, in May 1989, the annual rate of debits per dollar of demand deposits at banks outside New York (where demand deposit turnover is nearly seven times larger) was 467.5; turnover on ATS and NOW accounts at commercial banks was only 18.2 times per year, much closer to the 3.6 rate on savings deposits at commercial banks.[9] The similarity between the turnover of ATS and NOW balances and that on saving deposits is sometimes taken as evidence to support the financial innovations hypothesis.

The hypothesis says that other checkable deposits include balances that would have been held in savings or other non-M1 balances before interest-bearing checking accounts became available. As these savings flowed into other checkable deposits, the turnover of total checkable deposits should have fallen, and its interest elasticity should have been altered.

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 important, however, the turnover rate for total checkable deposits *rose* in 1981, counter to the decline predicted by the financial innovations hypothesis. Overall, the turnover rate for total checkable deposits looks more like a continuation of the 1970-78 demand deposit turnover series than does the demand deposit turnover series itself.

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

Figure 3
Demand Deposit and Total Checkable Deposit Turnover



Deposit turnover measures are velocity measures; as such, they are related to the same factors, like interest rates and income, that influence the demand for money. Higher interest rates, by increasing the cost of holding checkable deposits, should reduce the quantity of these deposits demanded and increase their turnover rates. As income rises, the demand for these deposits should rise; whether the turnover rate rises or falls, however, depends on whether debits rise more or less than the demand for checkable deposits. The continuous annualized growth rate of monthly total checkable deposit turnover, $\dot{CDT}$, was estimated as a function of the continuous annualized rates of increase of the three-month Treasury bill rate, $\dot{R}$, and real personal income, $\dot{y}$, for the period January 1979 to January 1989.

The financial innovations hypothesis indicates (1) that a rise in s1 should significantly reduce the turnover of total checkable deposits and (2) that a rise in money market balances, measured here by a rise in the ratio of money market balances to total checkable deposits, s2, should not affect it. This was tested by adding current and up to 12 lagged values of the annualized first-differences of s1 and s2, labeled Ds1 and Ds2, respectively, to the turnover equation; adding lagged effects beyond one month, however, was uniformly unnecessary.

The estimate for total checkable deposit turnover that contains the most statistically significant innovations term is:

$$(1)\quad \dot{CDT}_t = \underset{(5.22)}{13.00} - \underset{(-1.36)}{0.043\dot{R}_t} + \underset{(3.62)}{0.110\dot{R}_{t-1}} - \underset{(-2.45)}{1.013\dot{y}_{t-1}} + \underset{(0.76)}{0.227Ds1_{t-1}}$$

$$\hat{\rho}_1 = \underset{(2.80)}{0.255} \qquad \hat{\rho}_2 = \underset{(2.68)}{0.244} \qquad D.W. = 2.00$$

$$\bar{R}^2 = 0.15 \qquad S.E. = 29.255$$

(The numbers in parentheses in the equation estimates reported here are t-statistics.)

The results in equation 1 show that the share of other checkable deposits has not significantly depressed the turnover of checkable deposits; instead, the estimated effect is positive, but statistically insignificant.[10] This result is counter to the financial innovations hypothesis.

If financial innovations increased the interest elasticity of total checkable deposits turnover, then the coefficients on the interest rate terms ($\dot{R}_t$, $\dot{R}_{t-1}$) in equation 1 should be related to s1. To test whether these coefficients have increased with the rise of the share of other checkable deposits in total checkable deposits, the annualized change in the product ($s1_i \ln R_i$) for the current and past month are added to equation 1. The sum of these coefficients is positive, 0.03, but it provides no significant explanatory power to the equation. The F-statistic for testing whether these coefficients are zero is $F_{2,112}$ = 0.04, well below the critical value (5 percent) of 3.08. Thus, financial innovations, as defined here, have had no significant effect on the interest elasticity of total checkable deposit turnover. Again, this result is counter to the financial innovations hypothesis.

FINANCIAL INNOVATIONS AND THE CURRENCY-DEPOSIT RATIO

The currency ratio, the ratio of currency held by the public to its total checkable deposits, is a principal determinant of the money multiplier (the ratio of a monetary aggregate to the adjusted monetary base). Moreover, it is the principal channel through which financial innovations can affect the link between Federal Reserve actions and the monetary aggregates.[11] 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 they did earlier, then the increase in the share of other checkable deposits in total checkable deposits should have lowered the currency ratio. In addition, if money market accounts are a substitute for checkable deposits included in M1, then the introduction and spread of money market holdings should have reduced total checkable deposits relative to currency holdings and raised the currency ratio.[12] According to the financial innovations hypothesis outlined above, however, this latter effect should be zero.

Figure 4 shows quarterly data on the ratio of the currency and the checkable deposit components of M1. This ratio does not decline in early 1981 or early 1983 when the largest boosts in savings held in other checkable deposits presumably would have occurred. Nor does the currency ratio rise in early 1983 when money market accounts surged.

A modified time series model is used to test the effects of these shifts on the currency ratio. The growth rate of the currency ratio can be described as a first-order autoregressive time

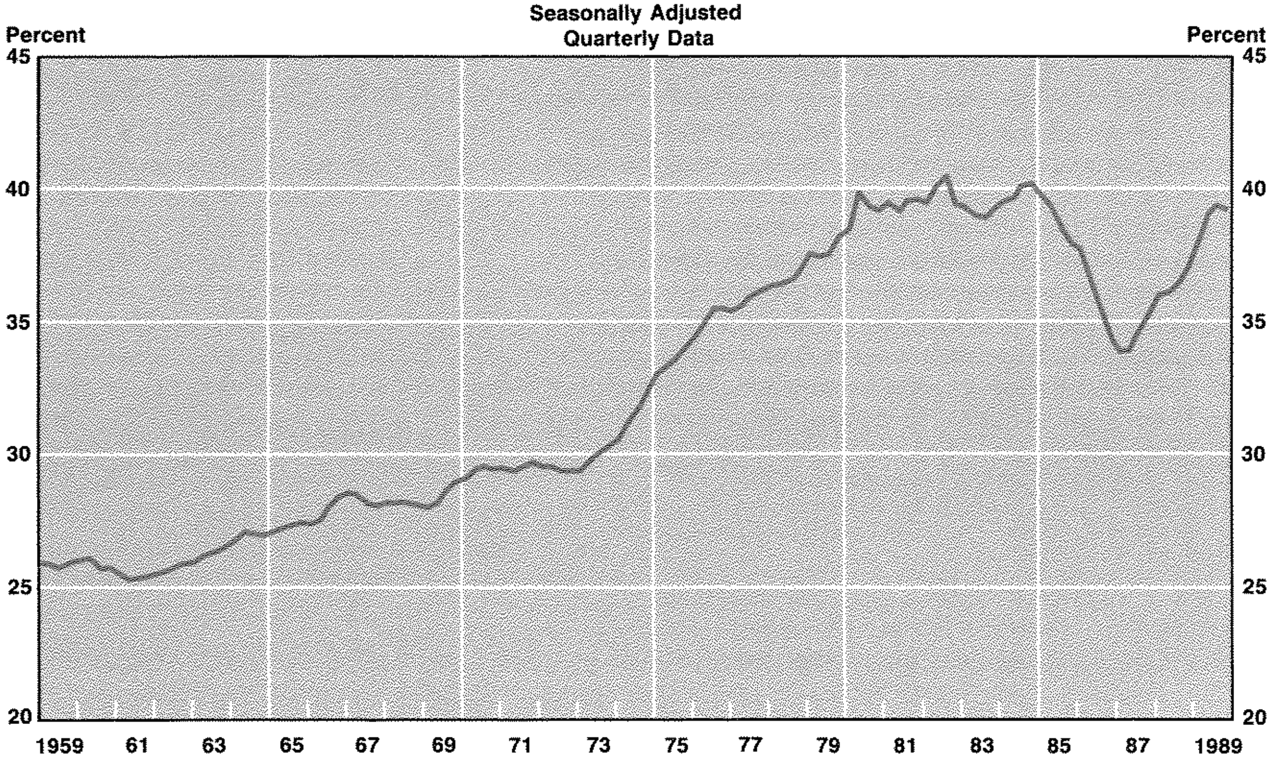
[10]Either the current or first-lagged value of Ds1 is strongly and positively statistically significant when added to an identical equation for demand deposit turnover growth. When both current and lagged Ds1 values are included, however, neither is statistically significant. The standard error of the estimate is lower when the current value is used instead of the lagged value. The coefficient on the current value is 1.025 (t = 3.49). The result in equation 1 is unaffected by regressing the growth rate of total debits on the same right-hand-side variables and on the growth rate of total checkable deposits; the coefficient on $Ds1_{t-1}$ is 0.282 (t = 0.95) in this case. Finally, when equation 11 in the appendix is estimated using the nonlinear least squares method, neither f nor gδ is significantly different from zero. The estimates of f and gδ are 0.005 (t = 0.01) and 0.021 (t = 0.37), respectively.

The turnover rate for deposits, excluding demand deposits in New York (and their debits) was also examined. Its growth rate is white noise and is independent of interest rates or real personal income. It is also not significantly correlated with the current or lagged values of the changes in the financial innovation shares. For example, the correlation coefficient for the growth rate of turnover of total checkable deposits, excluding New York demand deposits, and the first lagged change in s1 is 0.023. This insignificnat correlation rejects the implication of the financial innovations hypothesis that this correlation is significantly negative.

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

[12]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 included a shift of savings to these accounts equal to about the 27.5 percent of such funds in the first four months of 1981. While this proportion also was suggested by the staff of the Federal Reserve Board, they suggested that it would have a continuing effect and applied it for all of 1981. Rasche and Johannes, on the other hand, argue that this shift significantly, but only temporarily, reduced the currency ratio and raised the money multiplier. They find no evidence that the shift to other checkable deposits or money market accounts had a permanent effect on the currency ratio or the multiplier. See Rasche and Johannes (1987, pp. 60-69).

Figure 4
Currency/Deposit Ratio[1]



[1] Ratio of Currency Component to Checkable Deposit Component of M1

series process; two other factors also have had a major impact on the currency ratio over the past 15 years and they are controlled for in the following estimates.[13] The first factor is energy prices, which rose sharply in 1973-74 and in 1979-81 and fell sharply in 1986. A rise in energy prices raises expenditures that use currency relatively more than it raises expenditures that rely more heavily on checkable deposits. Thus, the currency ratio rises when energy prices increase.[14] The second factor is 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 retail credit.[15] Finally, the current and past quarter's three-month T-bill rates are included to examine the interest rate elasticity of the currency ratio; 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 IV/1989 is shown in the first column of table 2. The dependent variable, $\dot{k}_t$, is the annualized continuous rate of growth of the currency ratio. The annualized

[13] 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 to include the sizable known effects of the two energy price shocks and to test whether the currency ratio's interest elasticity was affected.

[14] 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).

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

continuous rate of increase of the relative price of energy resources, $\dot{p}^e$, is 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, D80, equals one in the second quarter of 1980, negative one in the third quarter of 1980, and zero otherwise. These independent variables are generally strongly statistically significant in the estimates shown in table 2.[16]

When current and lagged (up to four) values of Ds1 or Ds2 were added to the model, only the estimate with the current-quarter change in s1 (Ds1), shows a statistically significant innovations effect; it is reported in the second column of table 2. Although, the negative coefficient on $Ds1_t$ is not statistically significant at a 5 percent level in a two-tail test, it is significantly negative using a one-tail test of the negative effect predicted by the hypothesis.[17] No other individual or group of current or lagged changes of the financial innovations variables are as significant.[18] These results suggest that growth in other checkable deposits has significantly lowered the currency ratio, which is consistent with the financial innovations hypothesis.[19]

This effect is weak, however, and is quite sensitive to the exclusion of only one observation—the second quarter of 1981. When this quarter is omitted, the coefficient on Ds1 falls in absolute value to −0.073, and its t-statistic falls to −0.89, which is far from statistical significance even with a one-tail test. Thus, the significant result for $Ds1_t$ in table 2 is spurious. The largest rise in the s1 measure occurs in I/1981 not in the second quarter; the omission of the I/1981 observation, however, does not affect the significance of $Ds1_t$. The decline in the significance of Ds1 when the II/1981 observation is omitted

Table 2
Tests for the Ratio of Currency to Total Checkable Deposits (k)

Dependent Variable: 400Δlnk
Period: III/1959 to IV/1989

Constant	0.496 (1.70)	0.750 (2.32)	0.419 (1.37)
$\dot{k}_{t-1}$	0.503 (7.28)	0.477 (6.81)	0.503 (7.20)
$\dot{R}_t$	0.013 (1.95)	0.011 (1.75)	0.014 (2.02)
$\dot{R}_{t-1}$	0.025 (3.83)	0.028 (4.16)	0.023 (3.28)
$\dot{p}^e_{t-1}$	0.058 (3.13)	0.059 (3.21)	0.053 (2.81)
D80	11.292 (4.73)	10.783 (4.53)	11.398 (4.75)
$Ds1_t$		−0.135 (−1.79)	
$D(s1_t \ln R_t)$			−0.011 (−0.39)
$D(s1_{t-1} \ln R_{t-1})$			0.037 (1.30)
$\bar{R}^2$	0.55	0.56	0.55
S.E.	3.052	3.023	3.054
D.W.	2.11	2.10	2.13
h	−1.01	−0.92	−1.20

[16]The F-statistic for a Chow test of the stability of the equation using the first and second half of the whole sample period is $F_{5,111} = 0.64$, well below the 5 percent critical value of 2.30. Thus, the stability of the currency ratio estimate cannot be rejected.

[17]In earlier versions of this article, this effect was insignificant even with a one-tail test. For example, before the February 1990 benchmark revisions, the estimate for the period III/1959 to III/1989 had a coefficient of −0.101(t = −1.24). The critical t-statistic value for a one-tail test is about 1.65. The significance of the rest of the results reported here was not so affected. The nonlinear least-squares estimate of equation 17 in the appendix (when g equals zero) yields essentially the same result as in the text; in particular, the point estimate of f is 0.1324 (t = 1.83). The g parameter is set equal to zero in this estimate because it is not significantly different from zero when freely estimated.

[18]For example, the coefficient on Ds2 is 0.013 when added to the equation in the first column, and its t-statistic is only 1.19.

[19]Although Rasche and Johannes find a significant transitory decline in the currency ratio in early 1981, this is not found in the error in either the first or second quarter of 1981 for the first equation in table 2. 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 reduction corresponds to one observation here. The tests here cannot readily determine whether such a brief transitory effect of financial innovations took place.

does not occur from a decline in the variance of Ds1; the standard deviation of Ds1 rises from 0.076 to 0.082 when the II/1981 observation is omitted. The significant result in table 2 arises from a spurious decline in the currency ratio in II/1981, when s1 growth was relatively large.

The third column in table 2 examines whether the interest elasticity of the desired currency ratio increased in absolute value as a result of financial innovations. The results show a positive, but statistically insignificant, change in the interest elasticity. Neither interaction term is individually statistically significant, and the test statistic that they are jointly zero, $F_{2,114} = 0.91$, is not statistically significant. Therefore, the hypothesis that financial innovations raised the interest elasticity of the currency ratio is rejected.

FINANCIAL INNOVATIONS AND MONEY DEMAND

The evidence above on financial innovations influence on total checkable deposit turnover and the currency ratio rejects the financial innovation hypothesis. These results do not address the more familiar literature on M1 demand or the velocity problem; nor do they examine the implications of the financial innovation hypothesis for M2.

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 inversely reflect 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. These velocity patterns often are cited as evidence that the demand for M1, but not for M2, became less stable in the early 1980s, supporting the financial innovations hypothesis.[20]

The Demand for M1

Rasche provides a model of the demand for M1 and other monetary aggregates, which he argues has been stable for a long time.[21] He explains that the shift in M1 velocity behavior is a "shift in the drift" 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.[22] Rasche also finds evidence that the interest elasticity of M1 demand rose after 1981. He argues, however, 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. Rasche's evidence also indicates that the demand for M2 is stable.

In Rasche's model, money demand, that is, nominal money per dollar of GNP, depends upon the interest rate (the three-month Treasury-bill rate), real income and unanticipated inflation. In quarterly estimates, real income, x, is measured by real GNP, 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.[23]

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

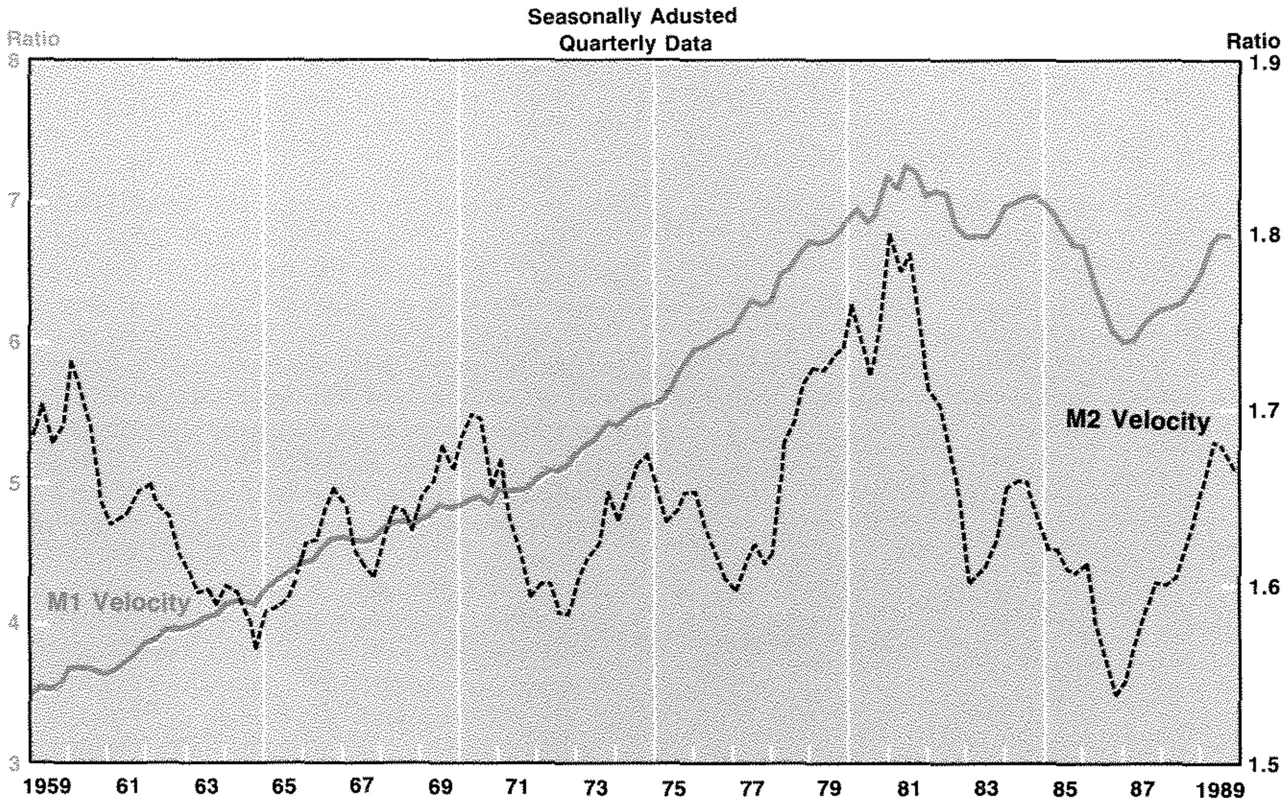
[20]Both Hetzel and Mehra (1989) and Judd, Motley and Trehan (1988) take this view; indeed, the central issue in the money demand literature, according to these papers, seems to be, first, whether the recent shifts and instability of M1 demand are permanent or will disappear after some transition to a deregulated environment, and second, if the breakdown in M1 demand is only transitory, whether its statistical properties will dominate those of M2 demand when M1 demand "settles down." Judd, Motley and Trehan are more optimistic about a return to normal than Hetzel and Mehra. More recently, Hetzel (1989) and Mehra (1989) provide arguments intended to reinforce their view. 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.

[21]Rasche (1988a) extends his 1987 M1 analysis to M2, M3 and broader measures.

[22]This argument rules out shifts in M1 velocity due to changes in its response to economic factors that determine it or to changes in the error structure of the random elements that affect it. These two sources are typically the basis for claims of increased uncertainty or increased instability in a demand function. Rasche conjectures, however, that the shift in the drift arises from the decline in inflationary expectations or a rise in the instability of the economy, but he finds no direct evidence supporting these arguments.

[23]Several coefficient restrictions are tested in Rasche (1987) and used in Rasche (1988a, 1988b). These are not imposed here because they could bias the tests of the financial innovations hypothesis.

Figure 5
Income Velocities of M1 and M2



$$
\begin{aligned}
(2)\ \dot{M1}_t - \dot{GNP}_t = &-1.989 - 0.036[400/3(\ln R_t - \ln R_{t-3})] \\
&(-4.53)\quad(-4.40) \\
&- 0.517\ \dot{P}^u_t - 0.703\ \dot{x}_t \\
&(-4.16)\qquad(-11.97) \\
&+ 0.407\ [400/2(\ln x_{t-1} - \ln x_{t-3})] \\
&(4.17) \\
&+ 2.336\ D82_t - 0.141\ D82_t DR13_t \\
&(3.28)\qquad\qquad(-6.07)
\end{aligned}
$$

$\bar{R}^2 = 0.68$ D.W. $= 1.92$

S.E. $= 2.679$ $\hat{\rho} = 0.227$
(2.74)

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 variable in brackets in the second term on the right-hand-side of the equation.[24] The significant intercept shift (D82) changes the 2.0 percent trend rate of velocity increase until 1982 into a 0.35 percent trend rate of decline subsequently; the latter rate, however, is not significantly different from zero. The last term in equation 2 tests whether the magnitude of the interest elasticity of money demand rose; according to the estimate, it rose significantly in absolute value.

[24]Rasche (1988a) 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 2. 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.

To test whether the rise in s11 has raised M1 demand, the variable 400 $\Delta s11$ is added to the equation. The financial innovations hypothesis predicts that its coefficient should be significantly positive. When this variable is added to equation 2, however, its coefficient is negative, but statistically insignificant, -0.063 ($t=-0.58$). This result refutes the financial innovations hypothesis about the effect of the growth of other checkable deposits on M1 demand.[25]

To test whether the rise in money market deposits influenced M1 demand, which the financial innovations hypothesis denies, the money market innovation measure, 400 $\Delta s21$, is added to the M1 demand equation; the result is:

$$
\begin{aligned}
(3)\ \dot{M1}_t - \dot{GNP}_t = & -1.918 - 0.035[400/3(\ln R_t - \ln R_{t-3})] \\
& \quad (-4.45) \quad (-4.35) \\
& - 0.533\ \dot{P}^u_t - 0.699\ \dot{x}_t \\
& \quad (-4.34) \qquad (-12.10) \\
& + 0.392\ [400/2(\ln x_{t-1} - \ln x_{t-3})] \\
& \quad (4.08) \\
& + 2.432\ D82_t - 0.161\ D82_t DR13_t \\
& \quad (3.49) \qquad (-6.63) \\
& - 0.034\ 400\Delta s21_t \\
& \quad (-2.36)
\end{aligned}
$$

$\bar{R}^2 = 0.70 \qquad D.W. = 1.91$

$S.E. = 2.636 \qquad \hat{\rho} = 0.22$
(2.67)

The money market innovations term is significantly negative; the introduction and growth of money market balances has statistically significantly reduced M1 demand. The coefficient on the innovations term is small, however; the rise in s21 to 1, about its level currently, has reduced the demand for M1 by 3.4 percent.

The proportion of MM that are transaction balances can be estimated from the coefficient on the innovations variable. The latter coefficient equals $-g/(1+gs21)$, where g is the share of transaction balances in MM, according to the derivation in the appendix to this article (eq. 20). Since the mean level of s21 is 21.85 percent during the sample period, the estimated average value of g is 3.4 percent.[26]

A skeptic might argue that the significance of the last two terms in equation 2 actually demonstrates the validity of the financial innovations hypothesis. After all, the demand for M1 rose and its interest elasticity increased, just as the hypothesis predicted. Rasche's timing argument indicates this is a spurious relationship, but more formal tests are possible. A test of whether the rise in the interest elasticity is related to the growth of other checkable deposits rejects this skeptical view. The term $(s1_t \ln R_t - s1_{t-3} \ln R_{t-3})$ 400/3 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 variable D82DR13 in equation 2, its t-statistic is still significant, but lower (-3.44 vs. -6.07); moreover, the equation's standard error rises (2.80 vs. 2.68). When both variables are included in equation 2, however, the t-statistic for the innovations-related shift variable falls to -1.43, while the t-statistic for D82DR13 remains strongly significant ($t= 4.83$).[27]

Similarly, the hypothesis that D82 is a proxy variable for the sharp rise in other checkable deposits in the early 1980s is tested by comparing the effect of $\Delta s11$ on equations 2 and 3 with and without D82. When this is done for equation 2, the t-statistic for 400 $\Delta s11_t$ is -0.10 when D82 is omitted and, as indicated above, -0.58 when D82 is included. When both are in-

[25]The absence of an effect of s11 on M1 demand implies that the growth of other checkable deposits is offset, dollar for dollar, by reductions in M1A (M1 less other checkable deposits). A similar test of whether no other checkable deposits should be added to M1A to obtain a stable demand is easily rejected. The proportion of other checkable deposits that must be added to M1A to obtain an aggregate whose demand is invariant to shifts in other checkable deposits is not significantly different from 100 percent. This rejects the usefulness of M1A, or at least the hypothesis that its demand is invariant to financial innovations.

[26]When equation 20 in the appendix is estimated with the same non-innovation variables as in equation 2, the estimate of f, 0.014, is not significantly different from zero ($t=0.15$). The estimate for g, 0.037, however, is statistically significant ($t=2.40$).

[27]These tests were also conducted using equation 3 instead of equation 2. When both measures are included in the equation, the shift in the interest elasticity in 1982 remains strongly significant ($t= -5.36$), while the s1-related interest elasticity shift is not ($t= -1.00$). The coefficient (-0.031) on the money market innovations term, 400 $\Delta s21_t$, remains significant in this case ($t= -2.12$).

cluded, however, the coefficient on D82 (2.425) is the same size as in equation 2 and it remains statistically significant (t=3.32). The use of Δs11 and the s1-related shift in the interest elasticity, in place of the 1982 constant and interest rate shifts, also are easily rejected when tested jointly. Thus, the growth of the other checkable deposits does not account for the significance of the last two terms in equation 2. Similar results are obtained when these same substitutions are made in equation 3 and the significance of the money market innovations term remains unaffected by these changes.

The Demand for M2

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

$$(4)\ \dot{M}2_t - G\dot{N}P_t = \underset{(3.63)}{1.385} - \underset{(-7.82)}{0.055}\, DR13_t - \underset{(-7.41)}{0.734}\ \dot{P}^u_t$$

$$- \underset{(-15.95)}{0.761}\dot{x}_t + \underset{(5.25)}{0.428}[400/2(\ln x_{t-1} - \ln x_{t-3})]$$

$$- \underset{(-1.32)}{0.822}\ D82_t - \underset{(-3.62)}{0.072}\ D82_t DR13_t$$

$\bar{R}^2 = 0.77$ D.W. $= 1.90$ $\hat{\rho} = 0.289$ (3.55)
S.E. $= 2.177$

Unlike the M1 estimate, the M2 estimate suggests that there was no significant shift in the M2 demand intercept after 1981. The interest elasticity of M2 demand rose significantly after 1981, however, like that for M1 demand.

The financial innovations hypothesis suggests that these innovations should have had no effect on the demand for M2. To test the hypothesis, the same procedure used for M1 was followed for M2.[28] The results indicate that the contemporaneous rise in the share of money market balances in M2 (s22) has a statistically significant effect on the demand for M2, but that no other financial innovation variable (lags of s22 or current and up to four lagged values of s12) has a significant effect. Moreover, when the contemporaneous share of money market balances is included in the equation, neither the intercept shift nor the interest elasticity shift is statistically significant. The estimate, without the insignificant variables, is:[29]

$$(5)\ \dot{M}2_t - G\dot{N}P_t = \underset{(3.55)}{1.422} - \underset{(-7.73)}{0.052}\, DR13_t - \underset{(-8.29)}{0.711}\ \dot{P}^u_t$$

$$- \underset{(-18.48)}{0.802}\dot{x}_t + \underset{(4.67)}{0.373}[400/2(\ln x_{t-1} - \ln x_{t-3})]$$

$$+ \underset{(6.04)}{0.261}\ 400\Delta s22_t$$

$\bar{R}^2 = 0.81$ D.W. $= 1.79$ $\hat{\rho} = 0.44$ (5.75)
S.E. $= 2.006$

The result that the rise in the share of money market deposits significantly raised the demand for M2 runs counter to the financial innovations hypothesis.[30] According to the estimate, a 25 percent share of money market deposits in M2 (nearly its share at the end of 1989) raises M2 demand relative to GNP by about 6.5 percentage points.[31]

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 5.[32] The money-

[28]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 (1988a) notes that, in an estimate like equation 4, inferior overall results were found when such a measure is used instead of the T-bill rate.

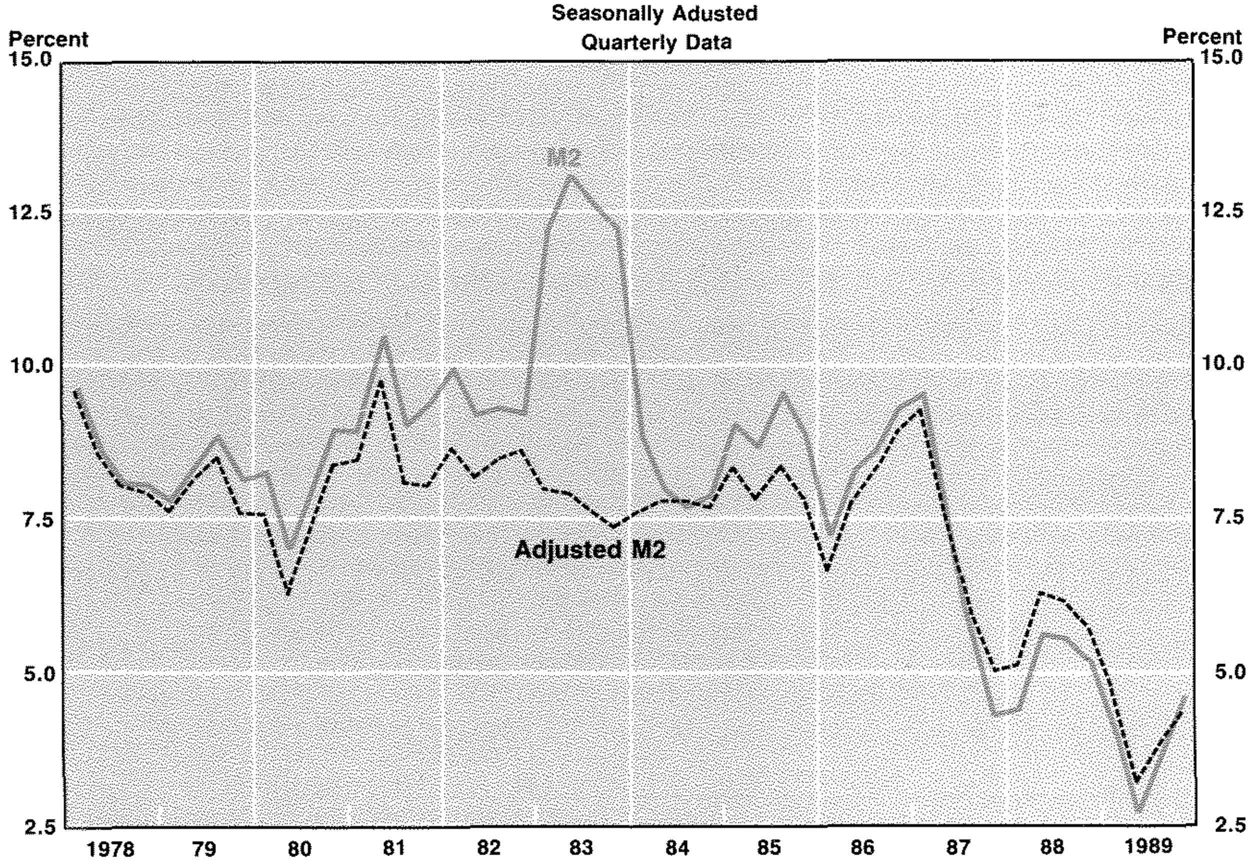
[29]When $D82_t$ and $D82_tDR13_t$ are added to the estimate they are not statistically significant; the coefficient on $D82_t$ is −0.894 (t = −1.39), and that for the shift in the interest elasticity is -0.033 (t = −1.60).

[30]These results do not depend on the inclusion of the four quarters that Rasche omits in his study. When these quarters are omitted, the standard error falls to only 1.926 percent and the other properties of the estimate are nearly identical. The same results also obtained when all four quarters of 1983, during which the largest shifts occurred, are omitted; in particular, the t-statistic for the s22 innovation term is 2.49.

[31]The theoretical value of the coefficient on 400 $\Delta s22_t$ is $g_1/(1-g_1\ s22)$, where g_1 is the proportion of MM balances that are not close substitutes for the rest of M2. This expression is derived in the appendix to this article. The sample estimate of g_1, given the sample mean value of s22 of 5.39 percent, is 25.7 percent. When equation 22 in the appendix is estimated using the nonlinear least squares method and with the same other variables as in either equations 4 or 5, the other checkable deposit innovation's coefficient is not significantly different from zero, but the money market innovation term is. Using this method, the trend shift and interest-elasticity shift again are insignificant when the money market innovation term is included. For the counterpart to equation 5 in the text, the nonlinear least squares estimate of g_1 is nearly the same, 24.2 percent, (t = 5.17).

[32]This adjustment subtracts 0.261 $s22_t$ from the logarithm of M2 to obtain a series that is independent of s22.

Figure 6
The Growth Rate of M2[1]



[1]Current rise from four quarters earlier.

market-induced shift in M2 demand had the greatest effect on the measured growth rate in 1983. In other periods, the growth rate of M2 has been affected only slightly. The adjusted growth rates ranged from 6.3 percent to 9.8 percent from 1980 until 1987. The sharp acceleration of M2 growth from 1980 to 1983 and subsequent slowing can be explained by the effect of financial innovations, in this case, by the growth of money market balances.

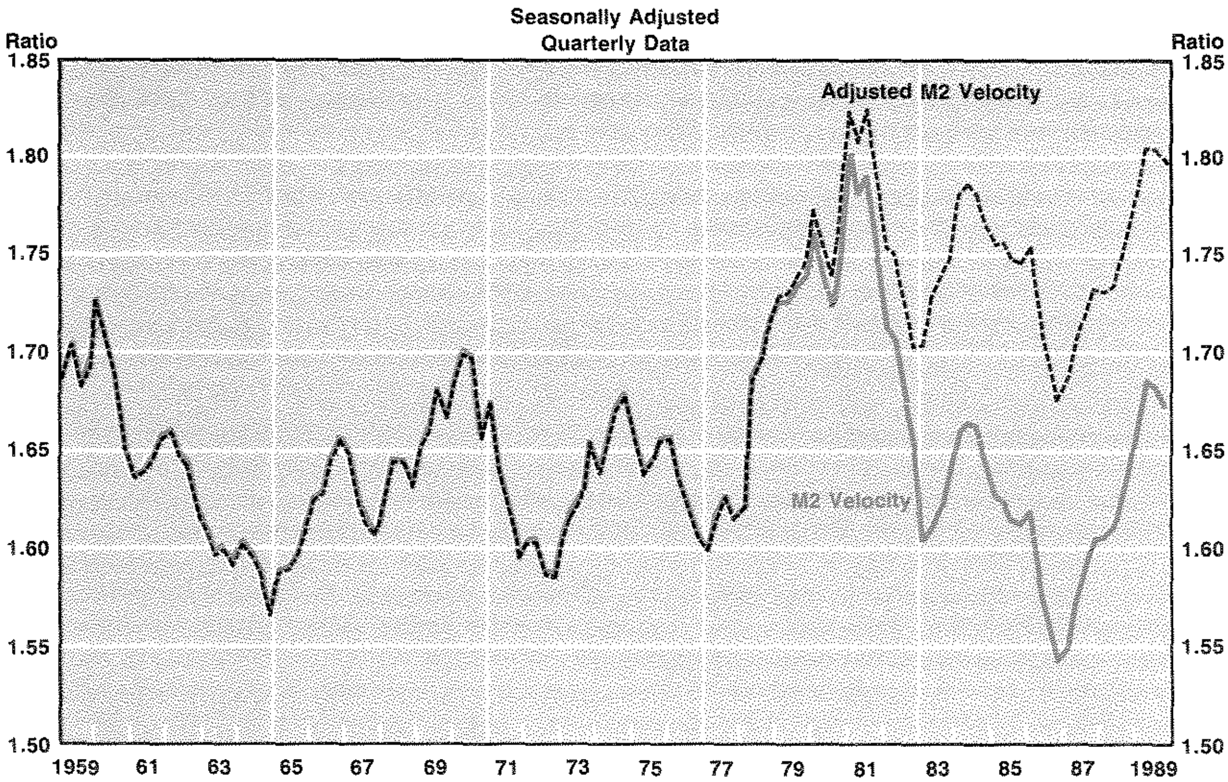
The effects on M2 velocity are shown in figure 7. Actual M2 velocity appears to vary about its mean in figure 7. When adjusted for shifts arising from money market accounts, however, M2 velocity has a positive trend, especially since the mid-1960s.

CONCLUSION

The financial innovations hypothesis that the introduction and acceptance of other checkable deposits, especially NOW and super-NOW accounts, have seriously, and perhaps permanently, distorted the measurement and effectiveness of M1, but not M2, is widely accepted today. The counterpart of this hypothesis—that the introduction and growth of money market assets like money market deposit accounts had no effects on M1 and M2—is as widely endorsed. A systematic investigation of this hypothesis, which focuses on the turnover rate of checkable deposits, the desired currency-deposit preferences of money holders, and the velocity or demand for M1 and M2, however, generally rejects its claims.

The financial innovations hypothesis implies that the turnover of total checkable deposits and the currency ratio will decline significantly as the share of other checkable deposits rises. The analysis here indicates that the turnover of total checkable deposits was not affected by these financial innovations. There was a signifi-

Figure 7
The Effect of Money Market Accounts on M2 Velocity



cant decline in the currency ratio associated with the rise in the share of other checkable deposits in total checkable deposits, but this significance is spurious in light of its sensitivity to the omission of only one observation and its refutation in the other tests presented here.

The introduction and growth of other checkable deposits has had no significant effect on the velocity of (demand for) M1. While there is evidence of a shift in M1 velocity and its interest elasticity after 1981, the tests here reject the financial innovations 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 the earlier introduction of money market mutual funds have had a significant effect on the demand for monetary aggregates. The expansive growth of these new balances has had no effect on the composition of M1 or the use of checkable deposits. The demand for M1, however, was reduced slightly because of the growth of money market balances. More important, the growth of these balances was associated with a significant rise in the demand for M2. As a result, M2 velocity was depressed by the growth of money market balances. Ironically, this reduction has provided unwarranted support to the view that M2 velocity is stationary and M2 demand is stable. Movements in the share of money market accounts have accounted for much of the variation of M2 growth over the past 10 years or so.

Proponents of the view that financial innovations have distorted M1 apparently have been focusing on the wrong innovation. According to the evidence here, explicit interest-bearing accounts have not affected the use of checkable deposits, the composition of M1 or the demand for M1 (or M2 for that matter). Instead, the growth of money market balances *has* significantly affected the aggregates, raising M2 demand and depressing its velocity. Money market deposits also appear to provide substitute transaction services for M1, so that their growth has had a small depressing effect on the demand for M1.

REFERENCES

Barnett, William A. "The Optimal Level of Monetary Aggregation," *Journal of Money, Credit and Banking* (November 1982), pp. 687-710.

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

Bradley, Michael D., and Dennis W. Jansen. "Deposit Market Deregulation and Interest Rates," *Southern Economic Journal* (October 1986), pp. 478-89.

Burger, Albert E. "The Puzzling Growth of the Monetary Aggregates in the 1980s," this *Review* (September/October 1988), pp. 46-60.

Carlson, John B. "The Stability of Money Demand, Its Interest Sensitivity, and Some Implications for Money as a Policy Guide," Federal Reserve Bank of Cleveland *Economic Review* (Quarter 3, 1989) pp. 2-13.

Carlson, Keith M., and Scott E. Hein. "Monetary Aggregates as Economic Indicators," this *Review* (November 1980), pp. 12-21.

Cook, Timothy Q., and Timothy D. Rowe. "Are NOWs Being Used as Savings Accounts?" Federal Reserve Bank of Richmond *Economic Review* (May/June 1985), pp. 3-13.

Cox, Albert H., Jr. *Regulation of Interest Rates on Bank Deposits* (University of Michigan, 1966).

Cox, W. Michael, and Harvey Rosenblum. "Money and Inflation in a Deregulated Financial Environment: An Overview," Federal Reserve Bank of Dallas *Economic Review* (May 1989), pp. 1-19.

Darby, Michael R., Angelo R. Mascaro and Michael L. Marlow. "The Empirical Reliability of Monetary Aggregates as Indicators, 1983-87," *Ecomonic Inquiry* (October 1989), pp. 555-85.

Darby, Michael R., William Poole, David E. Lindsey, Milton Friedman, and Michael J. Bazdarich. "Recent Behavior of the Velocity of Money," *Contemporary Policy Issues* (January 1987), pp. 1-33.

Dotsey, Michael. "The Demand for Currency in the United States," *Journal of Money, Credit and Banking* (February 1988), pp. 22-40.

Friedman, Benjamin M. "Lessons on Monetary Policy from the 1980s," *Journal of Economic Perspectives* (Summer 1988), pp. 51-72.

Frodin, Joanna H., and Richard Startz. "The NOW Account Experiment and the Demand for Money," *Journal of Banking and Finance* (June 1982), pp. 179-93.

Gavin, William. "M1A—M.I.A.?" Federal Reserve Bank of Cleveland *Economic Commentary* (July 1, 1987).

Gilbert, R. Alton. "A Revision in the Monetary Base," this *Review* (August/September 1987), pp. 24-29.

________ . "Revision of the St. Louis Federal Reserve's Adjusted Monetary Base," this *Review* (December 1980), pp. 3-10.

Hafer, R.W. "The FOMC in 1985: Reacting to Declining M1 Velocity," this *Review* (February 1986), pp. 5-21.

________ . "The FOMC in 1983-84: Setting Policy in an Uncertain World," this *Review* (April 1985), pp. 15-37.

________ . "The Money-GNP Link: Assessing Alternative Transaction Measures," this *Review* (March 1984), pp. 19-27.

________ . "Much Ado About M2," this *Review* (October 1981), pp. 3-18.

________ . "The New Monetary Aggregates," this *Review* (February 1980), pp. 25-32.

Haraf, William S. "Monetary Velocity and Monetary Rules," *The Cato Journal* (Fall 1986), pp. 641-62.

Hein, Scott E. "Short-Run Money Growth Volatility: Evidence of Misbehaving Money Demand?" this *Review* (June/July 1982), pp. 27-36.

Hetzel, Robert L. "M2 and Monetary Policy," Federal Reserve Bank of Richmond *Economic Review* (September/October 1989), pp. 14-29.

Hetzel, Robert L., and Yash P. Mehra. "The Behavior of Money Demand in the 1980s," Journal of Money Credit and Banking (November 1989), pp. 455-63.

Jordan, Jerry. "Financial Innovation and Monetary Policy," in *Financial Innovations: Their Impact on Monetary Policy and Financial Markets,* Proceedings of a Conference held at the Federal Reserve Bank of St. Louis, October 1 and 2, 1982 (Kluwer Nijhoff, 1984), pp. 135-50.

Judd, John P., and Bharat Trehan. "Portfolio Substitution and the Reliability of M1, M2 and M3 as Monetary Policy Indicators," Federal Reserve Bank of San Francisco *Economic Review* (Summer 1987), pp. 5-29.

Judd, John P., Brian Motley and Bharat Trehan. "The Demand for Money: Where Do We Stand?" unpublished paper presented at the Western Economics Association Meetings, Los Angeles, June 1988.

Kareken, John H. "Commercial Banks and the Supply of Money: A Market Determined Demand Deposit Rate," *Federal Reserve Bulletin* (October 1967), pp. 1699-712.

Keeley, Michael C., and Gary C. Zimmerman. "Deposit Rate Deregulation and the Demand for Transactions Media," Federal Reserve Bank of San Francisco *Economic Review* (Summer 1986), pp. 47-62.

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

________ . "The Payment of Interest on Commercial Bank Deposits and the Price of Money: A Study of the Demand for Money," unpublished Ph.D. dissertation, University of Chicago, 1970.

Klein, Michael A. "Deposit Interest Prohibition, Transactions Costs, and Payments Patterns: A Theoretical Analysis," *Metroeconomica* (November/December 1974), pp. 144-52.

Kopcke, Richard W. "Financial Assets, Interest Rates and Money Growth," *New England Economic Review* (March/April 1987), pp. 17-30.

Mehra, Yash P. "Some Further Results on the Source of Shift in M1 Demand in the 1980s," Federal Reserve Bank of Richmond *Economic Review* (September/October 1989), pp. 3-13.

Moore, George R., Richard D. Porter and David H. Small. "Modeling the Disaggregated Demands for M2 and M1 in the 1980s: The U.S. Experience," in *Financial Sectors and Open Economies: Empirical Analysis and Policy Issues*, Proceedings of a May 1988 Conference of the Board of Governors of the Federal Reserve System, forthcoming.

Motley, Brian. "Should M2 be Redefined?" Federal Reserve Bank of San Francisco *Economic Review* (Winter 1988), pp. 33-51.

Morris, Frank E. "Do the Monetary Aggregates Have a Future as Targets of Federal Reserve Policy?" *New England Economic Review* (March/April 1982), pp. 5-14.

Nuetzel, Philip A. "The FOMC in 1986: Flexible Policy for Uncertain Times," this *Review* (February 1987), pp. 15-29.

Poole, William. "Monetary Policy Lessons of Recent Inflation and Disinflation," *Journal of Economic Perspectives* (Summer 1988), pp. 73-100.

Porter, Richard D., and Edward K. Offenbacher. "Financial Innovations and Measurement of Monetary Aggregates," in *Financial Innovations: Their Impact on Monetary Policy and Financial Markets*, Proceedings of a Conference held at the Federal Reserve Bank of St. Louis, October 1 and 2, 1982 (Kluwer Nijhoff, 1984), pp. 49-98.

Rasche, Robert H. "Demand Functions for U.S. Money and Credit Measures," Paper 8718, Department of Economics, Michigan State University (May 1988a) to be reprinted in *Financial Sectors and Open Economies: Empirical Analysis and Policy Issues* (Board of Governors of the Federal Reserve System, forthcoming).

________ . "Monetary Policy and Financial Deregulation in the United States," *Kredit und Kapital* (Heft 3, 1988b), pp. 451-68.

________ ."M1 Velocity and Money Demand Functions: Do Stable Relationships Exist?" in Karl Brunner and Allan H. Meltzer, eds., *Empirical Studies of Velocity, Real Exchange Rates, Unemployment and Productivity*, Carnegie-Rochester Series on Public Policy (North Holland, Autumn 1987), pp. 9-88.

Rasche, Robert H., and James M. Johannes. *Controlling the Growth of the Monetary Aggregates* (Kluwer, 1987).

Roth, Howard L. "Has Deregulation Ruined M1 as a Policy Guide?" Federal Reserve Bank of Kansas City *Economic Review* (June 1987), pp. 24-37.

Santomero, Anthony M. "A Model of the Demand for Money by Households," *Journal of Finance* (March 1974), pp. 89-102.

Saving, Thomas R. "Money Supply Theory with Competitively Determined Deposit Rates and Activity Charges," *Journal of Money, Credit, and Banking* (February 1979), pp. 22-31.

________ . "A Theory of The Money Supply With Competitive Banking," *Journal of Monetary Economics* (July 1977), pp. 289-303.

________ . "Transactions Costs and The Demand for Money," *American Economic Review* (June 1971), pp. 407-20.

Siegel, Diane F. "The Relationship of Money and Income: The Breakdowns in the 70s and 80s," Federal Reserve Bank of Chicago *Economic Perspectives* (July/August 1986), pp. 3-15.

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

Spindt, Paul A. "Money is What Money Does: Monetary Aggregation and the Equation of Exchange," *Journal of Political Economy* (February 1985), pp. 175-204.

Startz, Richard. "Implicit Interest on Demand Deposits," *Journal of Monetary Economics* (October 1979), pp. 515-34.

Tatom, John A. "Interest Rate Variability and Economic Performance: Further Evidence," *Journal of Political Economy* (October 1985), pp. 1008-18.

________ . "Money Market Deposit Accounts, Super NOWs and Monetary Policy," this *Review* (March 1983a), pp. 5-16.

________ . "Alternative Explanations of the 1982-83 Decline in Velocity," in *Monetary Targeting and Velocity*, Federal Reserve Bank of San Francisco, Conference Proceedings, December 4-6, 1983b, pp. 22-56.

________ . "Recent Financial Innovations: Have They Distorted the Meaning of M1?" this *Review* (April 1982), pp. 23-35.

________ . "Transactions Cost and the Supply of Real Average Demand Deposits," unpublished Ph.D. dissertation, Texas A&M University, 1971.

Thornton, Daniel L. "The FOMC in 1982: Deemphasizing M1," this *Review* (June/July 1983), pp. 26-35.

________ . "The FOMC in 1981: Monetary Control in a Changing Financial Environment," this *Review* (April 1982), pp. 3-22.

Wallace, Neil. "Integrating Micro and Macroeconomics: An Application to Credit Controls," Federal Reserve Bank of Minneapolis *Quarterly Review* (Fall 1980), pp. 16-29.

Wenninger, John. "Responsiveness of Interest Rate Spreads and Deposit Flows to Changes in Market Rates," Federal Reserve Bank of New York *Quarterly Review* (Autumn 1986), pp. 1-10.

Appendix
A Formal Statement of the Hypotheses Tested

The financial innovations hypothesis, as presented and tested in this paper, states that the introduction and growth of other checkable deposits, OCD, distorted the measurement of both total checkable deposits and M1, but left the overall demand for M2 unaffected. Moreover, according to this hypothesis, the introduction and growth of money market balances (MM) had no effect on M2. Instead, the growth of these balances came at the expense of other non-M1 funds within M2, so that it had no effect on total checkable deposits, M1 demand, or the composition of M1.

The hypothesis suggests that some fraction, f, of other checkable deposits is not held as total checkable transaction balances and that money market deposit balances do not yield transaction services or are not held as part of total checkable transaction balances. Thus, the amount of total checkable deposits, TCD, that are "truly" transaction balances equals (1-fs1) TCD, where s1 is the share of other checkable deposits in total checkable deposits. If some proportion, g, of MM are also transaction balances, then the total MM component of transaction balances can be written as gs2, where s2 is the ratio of MM to TCD. Total transaction balances, TTB, can be defined as:

(1) $TTB = (1-fs1+gs2)\ TCD$.

In this framework, the financial innovations hypothesis is that $1 \geq f > 0$ and $g = 0$.

Prior to financial innovations, s1 and s2 were zero and TTB equaled TCD. The effective quantity of M1 was C+TCD, where C is the currency component of M1. The effective quantity of M1, designated M1*, when s1 and s2 are not zero, is C+TTB, or M1-fOCD+gMM. If s11 is defined to be the ratio (OCD/M1) and s21 is defined to be the ratio (MM/M1), then

(2) $M1^* = M1(1-fs11+gs21)$.

Since M1 equals (1+k) TCD, where k is the ratio of currency to total checkable deposits, s11 equals s1/(1+k) and s21 equals s2/(1+k).

An effective quantity of M2, called M2*, can be defined similarly. Whether or not certain proportions of OCD and MM balances are appropriately considered part of TTB and M1*, they are definitionally part of M2. This is the central reason that the hypothesis claims that M2 is unaffected by these innovations. If, however, some fraction of these new deposits are not close substitutes for M2, then the effective quantity of M2, M2*, should exclude these fractions of the new deposits.

In particular, if some fractions, f_1 of other checkable deposits and g_1 of MM balances, are held for non-M2*-related reasons, then shifts in holdings of these funds will boost M2 relative to M2*, that is,

(3) $M2^* = M2(1-f_1 s12-g_1 s22)$,

where s12 is the ratio of other checkable deposits to M2 and s22 is the share of money market balances in M2. According to the financial innovations hypothesis, the growth of other checkable deposits or MM involves substitutions within M2 and does not affect its total; therefore, M2 equals M2* and g_1 and f_1 equal zero.[1]

The hypothesis is tested below using the relationships in equations 1-3. In particular, two important economic variables, the turnover rate for total checkable deposits and the currency ratio, relate debits and currency holdings, respectively, to desired holdings of checkable transaction balances. Movements in other checkable deposits or money market deposits have predictable or systematic effects on the ratio of checkable transaction balances to observed total checkable deposits and, therefore on debits or currency holdings relative to total checkable deposits. Similarly, growth in these new assets affects the relationship of M1* and M2* to their observed counterparts and, therefore, systematically affect the relationship of the observed aggregates, M1 and M2, to the factors that influence the demands for M1* and M2*, respectively. The hypothesis also suggests that the interest elasticity of demand for transaction balances,

[1]Since $M2 = (1+k+t)$ TCD, where t is the ratio of the non-M1 components of M2 to M2, the ratios s12 and s22 are simply $(1+k+t)^{-1}$ times s1 and s2, respectively.

M1 and M2 have been affected by financial innovations. The specific form of the hypotheses and tests are derived below.

THE TURNOVER RATE FOR TOTAL CHECKABLE DEPOSITS

The turnover rate for total checkable transaction deposits is the ratio of debits, D, on these deposits to their total, TTB. If v, the turnover rate of deposits held for transaction purposes is a function of a vector of variables, z_0, then

(4) $D = v(z_0)TTB$.

Substitution of equation 1 in equation 4 yields:

(5) $D = v(z_0)\ (1-fs1+gs2)\ TCD$.

The left-hand side of equation 5 includes any third-party debits on MM balances held for third-party payment, i.e., as checkable transaction balances, (gMM). For simplicity, assume that debits include only third-party payments and thus exclude cash-withdrawal debits on both TCD and MM balances. If debits on money market balances, D_m, are also a function of gMM and the vector z_0 above, or

(6) $D_m = v_m(z_0)\ gs2\ TCD$,

then the debits measured against total checkable deposits D_t, are

(7) $D_t = D-D_m = v(z_0)\ [1-fs1+gs2\delta]\ TCD$,

where $\delta = (1\text{-}v_m/v)$ and the turnover ratio for total checkable deposits is

(8) $d = D_t/TCD = v(z_0)[1-fs1+gs2\delta]$.

A rise in s1 reduces the turnover ratio for total checkable deposits; if f is zero, however, then movements in s1 have no effect on v. If g and v_m are not zero, movements of funds into MM balances (relative to TCD) will affect the turnover of total checkable deposits. The sign of this effect depends on whether δ is positive, zero or negative, or whether transaction balances in MM have relatively low, the same or high turnover compared with the weighted average turnover of total transaction balances, v.

A log-linear specification of $v(z_0)$ is used, where z_0 includes the current and past interest rate (i_t, i_{t-1}) and real personal income, y_t, or

(9) $\ln v_t = \beta_0 + \beta_1 \ln i_t + \beta_2 \ln i_{t-1} + \beta_3 \ln y_t$.

The log-linear specification of equation 8 is

(10) $\ln d_t = \beta_0 + \beta_1 \ln i_t + \beta_2 \ln i_{t-1} + \beta_3 \ln y_t + \ln(1-fs1 + g\delta s2)$,

where v_m/v is assumed constant. When equation 10 is differenced, the result is:

(11) $\Delta \ln d_t = \beta_1\ \Delta \ln i_t + \beta_2\ \Delta \ln i_{t-1} + \beta_3\ \Delta \ln y_t + \Delta \ln(1-fs1+g\delta s2)$.

The last variable in equation 11 is unknown because f, g and δ are unknown. This problem is addressed indirectly in the paper.[2] If f, g and δ are constants, then

(12) $$\Delta \ln_t(1-fs1+g\delta s2) = -\frac{f}{1-fs1+g\delta s2}\,ds1 + \frac{g\delta}{1-fs1+g\delta s2}\,ds2.$$

The difference in the logarithm in the last term in equation 11 can be approximated using the total differential of the expression in parentheses and replacing ds1 and ds2 with $\Delta s1$ and $\Delta s2$.[3]
Thus, equation 11 can be written as:

(13) $\Delta \ln d_t = \beta_0 + \beta_1\ \Delta \ln i_t + \beta_2\ \Delta \ln i_{t-1} + \beta_3\ \Delta \ln y_t + \beta_4\ \Delta s1_t + \beta_5\ \Delta s2_t$,

[2]All the estimates in this article contain a term like $\Delta\ln(1-fs1+g\delta s2)$ in equation 11. Estimating the constants like f and ($g\delta$) directly by non-linear least-squares yields no differences from the result reported in the text for the financial innovations hypothesis. If f is correlated with movements in s1 or its counterpart measures below, the estimated coefficient on the share variables would be biased; if the correlation is positive, as proponents of the financial innovations might argue, this biases up the coefficient and biases the tests in favor of the financial innovation hypothesis. The same argument applies to g. The opposite bias would arise if f and the other checkable deposit share were negatively correlated, but this is counterintuitive. There is no *a priori* reason to expect f or g (or f_t and g_t below) to change, especially to change systematically with movements in the shares, however.

[3]The coefficients on $\Delta s1$ and $\Delta s2$ involve s1 and s2. These coefficients are estimated as constants and are evaluated at the sample period average values for f, $g\delta$, s1 and s2. Note that $g\delta$ is estimated from the s2 coefficient; consequently, the hypothesis that g equals zero cannot be tested. If δ equals zero (the turnover of transaction balances held in MM is the same as for the rest of such balances), then the coefficient on s2 will be zero; however, this does not imply that g is necessarily zero.

where β_0 is an intercept which should have a value of zero, unless a significant time trend has been omitted from equation 10. Under the financial innovations hypothesis, $\beta_4 < 0$ and $\beta_5 = 0$.

The Interest Elasticity of the Turnover Rate

The financial innovations hypothesis tested in the text implies that the interest elasticity of money demand rose as a result of financial innovations. Since turnover is a velocity measure, a test is conducted of whether the interest elasticity of the turnover rate of total checkable deposits rose in proportion to the growth of s1. In equations 9 and 10, this elasticity is constant and equals $(\beta_1 + \beta_2)$. If β_1 and β_2 are functions of s1, for example, $\beta_1 = \beta_1^\circ + \beta_1'\ s1_t$ and $\beta_2 = \beta_2^\circ + \beta_2'\ s1_{t-1}$, then the terms $(\beta_1 \ln i_t + \beta_2 \ln i_{t-1})$ in equations 9 and 10 must be replaced with $(\beta_1^\circ \ln i_t + \beta_1'\ s1_t + \beta_2^\circ \ln i_{t-1} + \beta_2'\ s1_{t-1} \ln i_{t-1})$. In equation 13, β_1° replaces β_1, β_2° replaces β_2, and the additional terms $\beta_1'\ \Delta(s1_t \ln i_t)$ and $\beta_2'\ \Delta(s1_{t-1} \ln i_{t-1})$ must be included. Whether the interest elasticity rose depends on whether β_1', β_2' and $(\beta_1' + \beta_2')$ are statistically significantly positive.

THE CURRENCY RATIO

The currency ratio is the ratio of currency to total checkable transaction balances. Currency demand relative to total checkable transaction balances is

(14) $C = k(z_1)\ TTB$,

where z_1 is a vector of the determinants of the desired ratio. With the advent of OCD and MM balances, currency holding competes with all other transaction-related balances, or TTB. Substitution of equation 1 in equation 14 yields

(15) $C = k(z_1)\ (1 - fs1 + gs2)\ TCD$.

When s1 rises, currency demand declines, given TCD, z_1, f and g, if $0 < f \leq 1$. Changes in s2 have no effect on the currency ratio under the hypothesis that $g = 0$.

The variables in z_1 that determine the desired currency ratio, and are controlled for in testing the financial innovations hypothesis, include the autoregressive component, a first lag of the currency ratio, the current (i_t) and past (i_{t-1}) interest rate, energy prices, p^e, and a credit control dummy variable, c. The first-difference of the log-linear form of equation 15, with the appropriate substitutions for z_1, is:

$$(16)\ \Delta \ln(C/TCD)_t = \delta_0 + \delta_1 \Delta \ln i_t + \delta_2 \Delta \ln i_{t-1} + \delta_3 \Delta \ln p_t^e + \delta_4\ D80 + \delta_5 \Delta \ln(C/TCD)_{t-1} + \Delta \ln(1 - fs1 + gs2)_t$$

where D80 equals Δc.

The last term on the right-hand-side can be approximated using the same argument used above for equations 11 and 12 since $d\ln(1 - fs1 + gs2)$ equals $[-f/(1 - fs1 + gs2)]ds1 + [g/(1 - fs1 + gs2)]ds2$. Thus, equation 16 can be written as:

$$(17)\ \Delta \ln (C/TCD)_t = \delta_0 + \delta_1 \Delta \ln i_t + \delta_2 \Delta \ln i_{t-1} + \delta_3 \Delta \ln p_t^e + \delta_4\ D80 + [-f/(1 - fs1 + gs2)]\ \Delta s1_t + [g/(1 - fs1 + gs2)]\ \Delta s2_t.$$

The financial innovations hypothesis, $0 < f \leq 1$, is tested by whether $\Delta s1_t$ has a significant negative coefficient. The hypothesis $g = 0$ is tested by whether $\Delta s2_t$ has a significant coefficient.

Whether the interest elasticity of the currency ratio is affected by the growth of s1 is also tested. The sum $(\delta_1 + \delta_2)$ in equation 16 or 17 is the interest elasticity of the currency ratio. If each of these components is a function of s1, then the interest components in $k(z_1)$ can be written as $(\delta_1^\circ + \delta_1' s1) \ln i_t + (\delta_2^\circ + \delta_2'\ s1) \ln i_{t-1}$, and $[\delta_1^\circ + \delta_2^\circ + \delta_1'\ s1_t + \delta_2'\ s1_{t-1}]$ is the interest elasticity of currency demand in this case. In the first-difference form given in equation 17, the interest rate components are replaced with $\delta_1^\circ \Delta \ln i_t + \delta_2^\circ \Delta \ln i_{t-1} + \delta_1'\ \Delta(s1_t \ln i_t) + \delta_2'\ \Delta(s1_{t-1} \ln i_{t-1})$. If financial innovations affect the interest elasticity, then δ_1' and/or δ_2' are significantly different from zero. Since δ_1 and δ_2 are negative, for the interest elasticity to become larger in absolute value requires that, $\delta_1', \delta_2' \leq 0$ and $(\delta_1' + \delta_2') < 0$.

MONEY DEMAND

Suppose "true" or effective M1 demand, $M1^*$, is a function of a vector of variables z_3. Substituting equation 2 yields:

(18) $(1 - fs11 + gs21)M1 = D(z_2)$.

In log-linear form, this equation can be rearranged as

(19) $\ln M1 = \ln[D(z_2)] - \ln(1 - fs11 + gs21)$.

When this is first-differenced and a similar substitution is made for the last term as was made in equation 13 and 17, the result is:

(20) $\Delta \ln M1 = \Delta \ln[D(z_2)] + \delta_6 \, \Delta s11_t + \delta_7 \, \Delta s21_t$,

where

$\delta_6 = f/(1 - fs11 + gs21)$, and

$\delta_7 = -g/(1 - fs11 + gs21)$.

If f is zero, then δ_6 equals 0. If $0 < f \leq 1$, however, then δ_6 is positive; that is, a rise in s11 should raise M1 demand, given the variables in z_2. If g equals 0, then δ_7 equals 0; if g is positive, then δ_7 is less than zero.

The variables included in z_2 are the interest rate, income and unanticipated inflation. The specification of $\ln[D(z_2)]$ also includes a shift in the interest rate elasticity of money demand and a shift in the level of M1 demand, where both shifts occur in 1982. Therefore, tests are conducted to determine if these two components of z_2 arise from financial innovations.

For M2 demand, the same set of tests are conducted. In particular, if "true" M2 demand, M2* in equation 3, is a function of variables z_3, $E(z_3)$, then substituting this in equation 3 yields

(21) $(1 - f_1 s12 - g_1 s22) \, M2 = E(z_3)$.

In the text, the z_3 vector includes the same set of other money demand variables as M1, that is, z_3 equals z_2. In differenced log-linear form and using the exact differential to derive the discrete $\Delta \ln(1 - f_1 s12 g_1 s22)$, equation 21 becomes

(22) $\Delta \ln M2_t = \Delta \ln E(z_3) + \delta_8 \, \Delta s22_t + \delta_9 \, \Delta s12_t$

where

$\delta_8 = [g_1/(1 - f_1 s12 - g_1 s22)]$ and

$\delta_9 = [f_1/(1 - f_1 s12 - g_1 s22)]$.

Under the financial innovations hypothesis, f_1, g_1, δ_8 and δ_9 are all zero. The coefficients δ_8 and δ_9 are positive if the proportions g_1 of MM or f_1 of OCD are positive; this result would indicate that these proportions are not a close substitute, given z_3, for the rest of M2.