Federal Reserve Bank of San Francisco

Summer 1984

Economic Review

Number 3

The Federal Reserve Bank of San Francisco's Economic Review is published quarterly by the Bank's Research and Public Information Department under the supervision of Michael W. Keran, Senior Vice President. The publication is edited by Gregory J. Tong, with the assistance of Karen Rusk (editorial) and William Rosenthal (graphics).

For free copies of this and other Federal Reserve publications, write or phone the Public Information Department, Federal Reserve Bank of San Francisco, P.O. Box 7702, San Francisco, California 94120. Phone (415) 974-3234.

The "Great Velocity Decline" of 1982-83: A Comparative Analysis of M1 and M2

John P. Judd and Brian Motley*

In 1982 and early 1983 the velocity of M1 declined sharply, leading the Federal Reserve to place "less than the usual emphasis" on M1 and to give more attention to M2 as an indicator of monetary policy. It was argued that deposit rate deregulation made the demand for M1 unstable and so caused it to become a less reliable indicator. In this paper, we examine the stability of the demand both for M1 and for M2 during this period, with a view to testing whether demand instability was an important cause of the velocity decline. We conclude that the velocity decline was related more to the unexpected fall in inflation and nominal interest rates than to money demand instability. In particular, M1 appears to have been a surprisingly robust indicator in the face of deregulation. Although M2 was somewhat affected, deregulation was not the primary source of its velocity decline.

Over most of the period in which the Federal Reserve has established explicit target ranges for the monetary aggregates, M1 has been regarded as the primary aggregate or at least has been given equal weight with M2 in formulating monetary policy. The Federal Reserve considered M1 to be the most reliable monetary aggregate on both empirical and theoretical grounds. Taken as a whole, empirical studies provide more evidence of a close relationship between monetary aggregates and macroeconomic variables such as real GNP and prices, in the case of narrow (transactions-type) aggregates than in the case of broader (asset-type) aggregates. These studies are consistent with the theoretical expectation that the public's demand to hold transactions balances is more stable than the demand to hold balances for savings purposes. However, the status of M1 changed in mid-1982, when the FOMC began placing "less than the usual weight" on M1 and giving more attention to the broader aggregates, especially M2.

One problem apparently leading to the change was the sharp decline in the velocity of M1—the ratio of nominal GNP to M1—in 1982 and early 1983. The growth rate of M1 velocity fell far below its 3 percent trend of the previous 20 years. Uncertainty as to whether this change in the relationship between M1 and GNP would continue made it difficult to set targets for M1. A potential explanation lay in the deregulation of deposit rates, which might alter the public's demand to hold M1. The introduction of interest-bearing NOW accounts could cause an inflow of savings-type funds into M1 and thereby change its basic nature as a measure of transactions balances. The resulting impact on the M1-demand

*Research Officer and Senior Economist, respectively. Research assistance was provided by Kenneth Khang, David Murray, Mary Byrd Nance and David Taylor.

relationship might make the relationship between M1 and GNP less reliable, both currently and in the future, and this would make it more difficult for the Federal Reserve to formulate M1 targets that were consistent with its macroeconomic objectives.

Although these potential problems with M1 were widely debated, less attention seems to have been paid to the possibility that M2 also could be affected by similar factors. Problems with M2 appear to be at least equally likely, since the broader aggregate has undergone even more deregulation in recent years. Therefore, the de-emphasis of M1 in favor of M2 as a guide to monetary policymaking cannot be fully evaluated without a *comparative* analysis of the two aggregates. In this paper, we attempt such a comparison.

We test the stability of the public's demand both for M1 and for the non-M1 component of M2 in recent years, and especially in the 1982-83 period of velocity declines. Our findings are that deregulation had no substantial effect on M1-demand in the 1981-83 period when interest-bearing NOW accounts became a substantial portion of that aggregate. The unexpected fall in the velocity of M1 appears to have been related more to an unexpected decline in inflation and nominal interest rates than to the effects of deregulation or any other source of money demand instability. (See the article in this volume by Michael Keran for another analysis of velocity.)

With respect to the non-M1 component of M2, the decline in the velocity of that aggregate also seems to have been mainly related to the inflation and interest rate decline, and not to instability in the public's demand. However, our tests do find changes in the responsiveness of non-transactions M2 to interest rates at two points in time: (1) in mid-1978 when Money Market Certificates, with interest rate ceilings tied to market rates of interest, were introduced; and (2) in 1983, when Money Market Deposit Accounts, with unregulated yields, were introduced. This second change poses a problem for the use of M2 in monetary policy at the present time because only a relatively small amount of data is available to estimate the new relationship.

Thus, our main conclusion is that the demand for M1 appears to have been surprisingly robust in the face of deregulation, whereas M2 demand appears to have been more substantially affected. This, of course, does not rule out the possibility of future problems with M1, but it does provide a reason to doubt that M1's value as an indicator relative to M2 will diminish in the future as deregulation continues.

This paper is organized as follows: Section I discusses the great velocity decline of 1982-83, and the policy debate surrounding it. Sections II and III present empirical evidence on the stability of the demand for M1 and M2, respectively. Section IV presents conclusions.

I. The "Great Velocity Decline"

The velocity of money—the ratio of GNP to the outstanding volume of a given monetary aggregate—is a crucial concept in monetary targeting. If one could accurately forecast the growth in velocity, one could be assured of estimating growth rate targets for the monetary aggregates that are consistent with any desired growth rate of nominal GNP. In practice, predicting velocity is not an easy matter as it depends on several key underlying behavioral relationships in the economy.

Problems in forecasting velocity were experienced in 1982 and early in 1983 when, in a distinct break from its long-run upward trend, the velocity of M1 fell sharply. M1 velocity declined at a 5.7 percent annual rate between the fourth quarter of 1981 and the first quarter of 1983, compared with its 3 percent trend rate of increase over the previous 22 years. Although this decline in M1 velocity was given the most attention, there was also a large decrease in the velocity of M2. Over the same five quarters, it fell at a 7.6 percent rate compared to its previous one-half of one percent trend rate of growth. Moreover, the decline in M2 velocity did not simply reflect the decline in its M1 component; the velocity of the non-M1 component of M2 fell at an 8.3 percent rate over these five quarters. Compared to the previous variability of these velocities, each of these declines was statistically significant.[1] The velocities of these three variables are shown in Chart 1.

Chart 1A

Annual Growth Rates of M1 Velocity

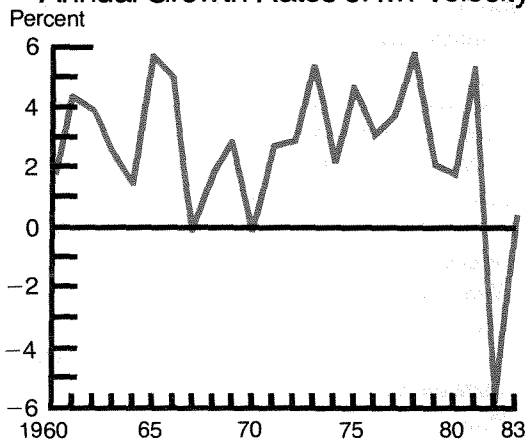


Chart 1B

Annual Growth Rates of M2 Velocity

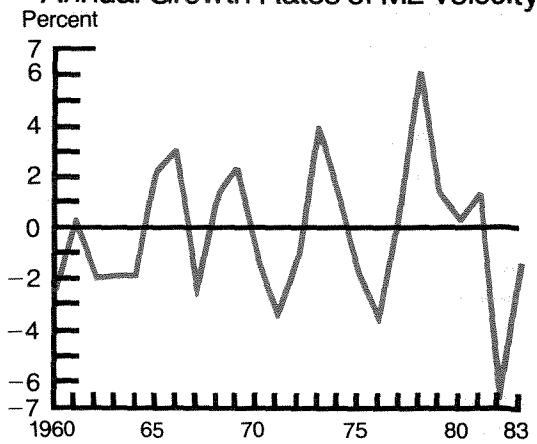
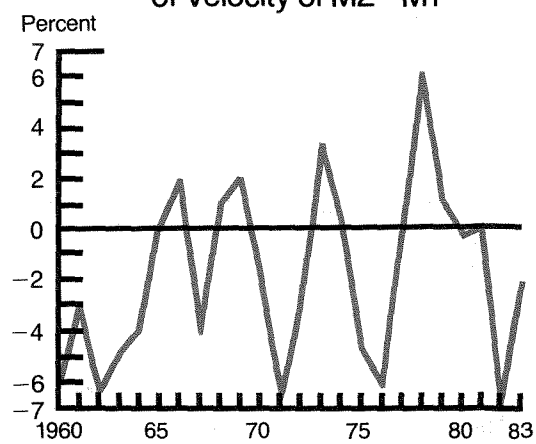


Chart 1C

Annual Growth Rates of Velocity of M2−M1



The unexpected behavior of M1 and M2 velocity in 1982 suggested that one or more of the relationships underlying velocity had changed. One such relationship is the public's demand to hold money. According to traditional economic theory, this demand depends positively on GNP, and negatively on the opportunity cost of holding money—measured by the spread between the market rate of interest on short-term securities and the interest rate paid on money itself. If the money demand function "shifts"—the public chooses to hold more or less money at *given interest rates and GNP levels*—the ratio of GNP to the stock of money (velocity) will change. Velocity may also behave unexpectedly if the responsiveness of money demand to the variables (income and interest rates) that determine it change. For example, if demand becomes more responsive to interest rates, a given decline in rates will lead to a larger increase in money demand and hence a greater fall in velocity than would be expected on the basis of past experience. In addition, velocity can change unexpectedly if one of the determinants of money demand, such as the market interest rate or the rate paid on money, changes unexpectedly. This last proposition means that the money demand function can be perfectly stable even while velocity exhibits surprising behavior.

Although velocity and money demand are closely related, not all variations in velocity may be related to money demand. Since velocity is the ratio of nominal GNP to money, it also may increase or decrease as a result of a change in the determinants of GNP. If, for example, there is a change in the public's aggregate demand for goods and services *at given interest rates*, nominal GNP, and hence velocity, also will change, even though there is no shift in money demand.[2]

The De-emphasis of M1

Beginning with its October 1982 meeting, the Federal Open Market Committee (FOMC) began placing "less than the usual weight" on M1, and paying more attention to the broader monetary

aggregates, especially M2. At the time, the major reasons cited were possible distortions to M1 caused by the reinvestment of funds from maturing All Savers Certificates and uncertainty about the public's response to the introduction of MMDAs. As time passed, some analysts argued that the introduction of NOW accounts on a nationwide basis in 1981 (and the introduction of Super-NOW accounts in 1983) had caused M1 to include a larger share of "savings-type" balances. Both of these new instruments permit explicit interest on checking accounts —regular NOWs permit a higher *fixed* rate to be paid, while Super-NOWs permit the payment of variable market rates. However, the latter accounts still constitute only a small part of M1.

Portfolio shifts induced by the introduction of NOWs could have altered the basic transactions character of M1. Specifically, the public's demand to hold these savings-type balances in M1 might have become more sensitive both to changes in market interest rates and to variations in investor sentiment than the transaction balances traditionally held in the narrow aggregate. As a result, past empirical relationships between M1 and macroeconomic variables such as income and interest rates might be a poor guide to current and future relationships.

These potential sources of instability in the public's demand for M1 appeared to be materializing with the great velocity decline of 1982-83, which suggested that the demand to hold M1 was shifting upward. Many argued that this shift was occurring because the public was responding to the uncertainty of the recession by accumulating precautionary balances in NOW accounts.[3] This change in investor sentiment supposedly demonstrated that the demand for M1 had become unstable. In prior business cycle downturns, this precautionary build-up would have shown up mainly in the non-M1 component of M2, but now that M1 also had savings balances in it, the narrow aggregate also was subject to such swings in investor sentiment.

A second, and related, potential problem with M1 also was raised during this period. In August 1982, *market* interest rates fell sharply and contributed to a sharp boost in growth in the monetary aggregates. Some argued that for M1 this boost was significantly larger than that predicted by past historical relationships, and they inferred that the responsiveness of M1 demand to changes in market interest rates had increased compared to earlier years.[4] Two reasons for such an increase in interest elasticity were proffered. First, with M1 now containing more savings balances, it was possible that it would be more sensitive to market yields than it was in the past, when it was closer to a pure transactions aggregate. Second, since NOW accounts pay explicit interest but demand deposits do not, a given change in market interest rates causes a larger *proportional* change in the opportunity cost (the market rate minus the rate on money) of holding NOWs than of demand deposits. As a consequence, changes in market rates might cause larger changes in NOWs than in demand deposits, thereby increasing the responsiveness of M1 as a whole to interest rate changes as NOWs become a larger fraction of M1[5].

The introduction of NOW accounts was believed by some analysts to have caused demand for M1 to become unreliable not only because *its* velocity declined dramatically, but also because the velocity of M1A (M1 minus interest-bearing NOWs) stayed closer to normal cyclical growth rates.[6] The velocity of M1A remained essentially unchanged between the fourth quarter of 1981 and the first quarter of 1983 in contrast to the 5.7 percent decline in the velocity of M1. Simply stated, this argument involved four points: (1) the velocity of M1 behaved "abnormally" while the velocity of M1A behaved "normally"; (2) if the velocity decline was not the result of instability in M1 demand, one would expect M1A velocity also to have behaved abnormally; (3) the difference between M1 and M1A is NOWs; (4) thus, the unusual behavior of M1-velocity must have had something to do with NOW accounts. In Section II, we test the hypothesis that the public's demand for M1A was stable in 1982-83, as well as the hypothesis that the demand for M1 was unstable in that period.

M2 Also Could Have Problems

Despite the extensive analysis and discussion of potential problems with M1 during this period, far less concern was focused on M2. It appears that there was more confidence in M2 than M1 because the former aggregate is broader. Presumably, M2 would internalize many of the problems associated with portfolio shifting that could distort M1. For example, while increased precautionary demands would cause M1 demand to shift up, they would be

less likely to distort M2 because many of the portfolio substitutions might come from instruments in M2.

This view has some merit. However, it neglects a number of other potential problems that can distort M2. First, although no one would dispute that M2 has a far larger savings component than M1, it is not nearly broad enough to internalize all the portfolio substitutions that are likely to occur. For example, large CDs and Treasury bills are not in M2, yet they are close substitutes with some of the instruments in that aggregate. Changes in yield spreads and investor sentiment can cause shifts between these instruments, thus distorting M2.

Second, M2 has been deregulated to an even greater extent than M1. This deregulation began in mid-1978, when depository institutions were permitted to issue six-month money market certificates with ceiling rates tied to other short-term market yields. Before that date, most of the instruments included in M2 yielded a fixed rate of return. For example, more than sixty percent of M2 consisted of passbook savings accounts (with fixed ceilings) plus M1 in early 1978. Today, almost all of the non-M1 component of M2 yields market-determined rates of return.[7] This situation contrasts with M1, since regular NOW accounts, the main interest-bearing component, still have fixed ceilings.

This institutional change in M2 since 1978 is important because the demand to hold M2 is affected by the *spread* between the rate of return on the instruments in that aggregate and the market rate on competing instruments. When the own-rate on M2 was held constant by government regulation, changes in the market rate produced equal changes in this spread. The gradual deregulation of deposit rates after 1978 made the own rate on non-transactions M2[8] increasingly responsive to changes in interest rates on other market instruments. As a result, the spread between the own and the market rate—that is, the opportunity cost of holding M2—became increasingly *unresponsive*.

This effect of deregulation is illustrated in Table 1, which compares the response of the own-rate on non-transactions M2 to changes in the commercial paper rate before and after July 1978.[9] In the earlier period, a 100 basis point rise in the commercial paper rate led to only a 5 point rise in the own-rate in the same month and to a 41 point rise after 12 months. By contrast, the equation estimated over the 1978-1983 period implies that the 100 basis point rise produces a 39 point rise within a month and

Table 1

The Own Rate on Non-Transactions M2 (M2-M1)*

Months after Change in Market Rate	Cumulative Response of Own Rate to One-Percent Change in Market Rate	
	1970:11–1978:06	1978:07–1983:12
0	0.05	0.39
1	0.09	0.65
2	0.12	0.79
3	0.15	0.86
4	0.17	0.89
5	0.20	0.91
6	0.23	0.92
7	0.27	0.94
8	0.30	0.97
9	0.34	1.01
10	0.38	1.02
11	0.41**	1.04***

*Derived from an equation regressing the own rate on non-transactions M2 (see footnote 9) on a distributed lag of the six-month commercial paper rate.

**Statistically different from zero at the 99 percent level.

***Statistically different from zero at the 99 percent level, but insignificantly different from unity.

roughly a 100 point rise after nine months. Thus, a given change in the market rate now has a significantly smaller impact on the interest rate spread in the short-run and is associated with no significant change in the spread in the long-run. This is a major departure from the situation before 1978.

The demand to hold non-transactions M2 depends both on the own-rate on that aggregate and on market rates on competing instruments. However, the finding that the own-rate itself responds primarily to changes in market rates implies that the demand can be expressed as depending only on market rates. Moreover, because the response of the own-rate to market rates has become larger and quicker since 1978, we expect the long-run elasticity of demand with respect to market rates to have declined since 1978, and the lag between changes in the market rate and in the growth rate of non-transactions M2 to have shortened. Such a change in the demand function for the non-transactions component of M2 would impair the usefulness of M2 as an intermediate target of monetary policy, at least during a transition period before these new relationships could be pinned down.

II. The Stability of M1 Demand

As noted above, the 1982 decline in the velocity of M1 was attributed by some analysts to two closely related developments: (1) an upward shift in M1 demand as the public's precautionary demands for liquid savings balances increased in the recession, and (2) an increase in the size of the response of M1 demand to changes in market interest rates related to the increased proportion of savings-type balances in M1. Both of these developments, if they actually occurred, would suggest that the transactions character of M1 had been altered by deregulation, and that M1-demand is likely to be less stable in the future.

The staff of the Federal Reserve Bank of San Francisco (FRBSF) has advanced an alternative view. It presented evidence from its M1-demand equation that the decline in velocity did not represent instability in the demand for money *function*, but rather was the result of the sharp decline in nominal interest rates associated with the slowing of inflation after late-1981.[10] The decline in nominal interest rates caused the quantity of money demanded to rise according to normal and predictable response patterns, while the decrease in inflation prevented this *nominal* interest rate decline from being translated into a reduction in *real* interest rates and so prevented an acceleration in nominal GNP. As a consequence, velocity fell.

A corollary of this explanation is that the surprise in 1982 was not a shift in money demand but rather an unusually sharp drop in inflation. At the beginning of that year, the reduction in inflation raised real interest rates and contributed to weakness in real income. With the income elasticity of M1 demand less than unity at least in the short-run, this slower growth in income was reflected in the decline in velocity in the early part of 1982. After mid-year, weakness in the economy induced the Federal Reserve to ease monetary policy. The associated drop in nominal interest rates was the major factor in the velocity declines in the latter part of 1982 and into 1983.

According to the above explanation, the decline in velocity would prove to be only temporary. M1 would rise relative to GNP only as long as the public's demand for money was stimulated by *declines* in interest rates. Once rates stabilized at new lower levels, their effects on money growth and hence on velocity would dissipate according to the lagged response of the demand for money to interest rates. The empirical results of the FRBSF staff suggested that these interest rate changes would have only minor effects on M1 growth after the first quarter of 1983. This result implied that M1 velocity would behave more normally beginning with the second quarter of 1983, and that it would be risky to allow a continuation of the rapid M1 growth after that date. This prediction has been broadly confirmed by subsequent developments: M1 velocity increased at an average rate of 4.2 percent between 1983/Q2 and 1984/Q2.

Empirical Evidence

The evidence of a stable money demand function mentioned earlier consisted of a set of dynamic simulations of an M1-demand equation over 1982 and 1983, and a series of three-month-ahead *ex ante* forecasts of M1 made at the beginning of each quarter of that period using the San Francisco Money Market Model. Both exercises tracked M1 quite well and showed no evidence of a shift in M1-demand large enough to have significantly distorted policy. The M1 demand equation in the Money Market Model uses as explanatory variables real personal income, the six-month commercial paper rate, the personal consumption expenditures deflator and changes in total bank loans. The model is estimated with a sample period beginning in 1976.

It has been argued that the ability of the model to predict well in 1982-83 depends upon the post-1975 estimation period. The argument is that when longer sample periods are used, the estimated interest elasticity of money demand is smaller (in absolute value), and thus that equations based on longer samples tend to under-forecast M1 (and over-forecast velocity) in 1982-83.[11] However, simulation results obtained from a conventional M1-demand equation (excluding bank loans) estimated over longer sample periods (beginning in 1959 and also beginning in 1970) yielded reasonably accurate results in 1982-83. Moreover, the estimated interest elasticities over these periods were close to those estimated over the shorter sample period.

The simulation results are shown in Table 2. In this table, the columns marked "Dynamic Simulations—A, B, C and D" show simulated values of M1 under two alternative specifications of M1 demand estimated over two sample periods. Columns A and B both were computed from M1 equations estimated over 1959/04–1981/12. The equation used for Column A constrains the interest elasticity of M1 demand to be a constant over the sample period (that is, the logarithm of M1 is regressed on the logarithm of the commercial paper

Table 2
Growth in M1 (Annual Rates)*

	Actual	Dynamic Simulations**				Forecasts***
		A	B	C	D	
1982/Q1	5.4	7.9	8.0	8.8	9.0	6.4
Q2	3.9	6.9	6.8	7.5	7.7	6.1
Q3	9.8	8.2	9.7	9.1	11.0	7.1
Q4	14.4	10.6	12.8	11.8	14.8	17.4
1983/Q1	13.0	11.0	10.9	10.7	11.9	12.5
Q2	11.5	9.9	9.7	10.1	9.8	9.5
Q3	6.2	8.8	7.6	8.0	6.9	9.4
Q4	4.9	7.9	7.1	7.9	7.8	7.4
Average:	8.6	8.9	9.1	9.2	9.9	9.5
F(24, 265)		1.88+	1.83++			
F(24, 137)				1.50	1.57	

*Calculated as last month in a quarter over last month in previous quarter.

**Estimated equations are shown in the Appendix.
Equation A: 1959/04–1981/12 estimation period, constant interest elasticity.
Equation B: 1959/04–1981/12 estimation period, variable interest elasticity.
Equation C: 1970/01–1981/12 estimation period, constant interest elasticity.
Equation D: 1970/01–1981/12 estimation period, variable interest elasticity.

***Three-month-ahead forecasts made in the middle of the first month of the forecast period using the San Francisco Money Market model. See John P. Judd, "A Monthly Model of the Money and Bank Loan Markets", *Economic Review*, Federal Reserve Bank of San Francisco, Supplement, Fall 1984 (forthcoming).

+Significant at the one-percent level.

++Significant at the five-percent level.

rate, LCPRT), whereas the equation for column B permits the interest elasticity to rise and fall with the level of the interest rate (that is, the logarithm of M1 is regressed on the commercial paper rate in percentage points, CPRT). Columns C and D are derived from equations estimated over 1970/01–1981/12, where C assumes a constant elasticity and D uses a variable elasticity. (The four estimated equations used in these columns are presented in Table A-1 of the Appendix.) The column in Table 2 headed "Forecasts" presents *ex ante* forecasts of M1 made at the beginning of each quarter using the full San Francisco Money Market Model.

Several key conclusions emerge from these results. First, all of the simulations (as well as the forecasts) capture the timing of the acceleration in M1 growth in 1982/Q3–1983/Q1, with slower growth before and after those quarters. That pattern of growth corresponds to the predictable response of M1-demand to interest rate changes over the period. It appears unlikely that this pattern had much to do with recession-induced precautionary demands, since rapid M1 growth continued into 1983, well after the recession came to an end.

Second, the results uniformly reject the hypothesis that M1 demand shifted *up*, as the deregulation view suggests. Indeed, all four equations *overpredicted* M1 growth, whereas the hypothesis of an upward shift would imply that the equations would yield under-predictions. Chow-tests for structural change in 1982-83 versus the earlier part of the sample *do* show a statistically significant shift for the sample beginning in 1959, but not for that beginning in 1970. However, if such a shift did occur, it was in a downward direction, not in the upward direction predicted by the precautionary demand hypothesis. Somewhat paradoxically, the two equations showing signs of a downward shift produced more accurate dynamic simulations than those not indicating a shift. Equations C and D, with the shorter sample period, over-predicted by an average of 0.6 and 1.3 percentage points of annualized growth, while the two longer-sample equations over-predicted by only 0.3 and 0.5 percentage points. Thus, in retrospect, the data do not seem to bear out fears that the 1982-83 velocity declines were symptomatic of shifting M1-demand relationships under deregulation.

We now turn to the argument that M1 demand has become more sensitive to interest rates, and that these greater elasticities were an important element in producing the velocity decline. To test this proposition, we estimated the same four equations used in Table 2 over the following four pairs of sample periods:

1 1959.04 – 1980.12
1a 1970.01 – 1980.12

2 1959.04 – 1981.12
2a 1970.01 – 1981.12 (Nationwide NOWs introduced)

3 1959.04 – 1982.11
3a 1970.01 – 1982.11

4 1959.04 – 1983.12
4a 1970.01 – 1983.12 (Super-NOWs and MMDAs introduced)

The first pair of samples provides a benchmark estimate of the interest elasticity prior to the introduction of nationwide NOWs. Samples 2, 3, and 4 add small increments of time to the benchmark sample to see if the elasticity changed as NOW accounts became a larger fraction of M1. All equations use intercept shift terms to remove the effects of the well-known shift in the demand for M1 in mid-1974 through mid-1976.[12] However, no intercept shift terms were used for the introduction of nationwide NOWs and Super-NOWs. The estimated interest elasticities and other statistics are presented in Table 3.

The results of these experiments show little change in the interest elasticity with the introduction of NOWs. The estimated long-run interest elasticity is quite similar for all of the sample periods considered under both specifications. Samples 2, 3, and 4, which include NOWs, yield only slightly higher interest elasticities than sample 1, which does not include NOWs. For example, for the 1959.04–1980.12 (sample 1) period, the varying and constant elasticity specifications yield elasticities of -0.12 (for a commercial paper rate of 8 percent) and -0.13. When the sample ends in 1983.12 (sample 4), the corresponding figures are -0.12 and -0.16, respectively.

Table 4 shows the results of more formal statistical tests for shifts in the interest elasticity. For these tests, the equations were estimated through 1983.12

with one additional variable, namely the product of the commercial paper rate and a zero/one dummy variable that is set at unity in the NOW account period (1981.01–1983.12) and zero elsewhere. For the sample beginning in 1959.04, the coefficient on this additional variable is not statistically significant from zero, implying that there was no shift in the interest rate coefficients in 1981/01–1983/12 versus the earlier part of the sample. For the sample beginning in 1970, the additional variable was significantly different from zero at the 95 percent confidence level. However, the implied change in interest elasticity has only small economic significance. For example, in the constant elasticity equation, the interest elasticity was -0.13 in the earlier period and -0.14 after nationwide NOWs were introduced. These results support the view that there was no important change in the interest elasticity in the NOW account period compared to the elasticity in the previous eleven years. They thus suggest that the introduction of NOWs has not had an important effect on the velocity of M1 through any alteration in the long-run interest elasticity of demand for the narrow aggregate.

Table 3

Interest Elasticities of M1 Demand Equations

	Constant Elasticity Specification			Variable Elasticity Specification			
Estimation Period	**Long-Run Elasticity**	**Mean Lag**	**Standard Error of Regression**	**Long-Run Elasticity CPRT=8.00**	**Long-Run Elasticity CPRT=12.00**	**Mean Lag**	**Standard Error of Regression**
1 1959.04–1980.12	-0.13	13.4	0.0035	-0.12	-0.17	8.1	0.0034
1a 1970.01–1980.12	-0.12	7.4	0.0039	-0.12	-0.17	5.6	0.0037
Nationwide NOWs Introduced							
2 1959.04–1981.12	-0.16	15.9	0.0036	-0.12	-0.18	8.8	0.0034
2a 1970.01–1981.12	-0.15	11.4	0.0039	-0.13	-0.19	7.0	0.0037
3 1959.04–1982.11	-0.16	16.2	0.0037	-0.13	-0.19	9.8	0.0036
3a 1970.01–1982.11	-0.16	13.6	0.0041	-0.14	-0.21	9.6	0.0039
Super-NOWs Introduced							
4 1959.04–1983.12	-0.16	14.5	0.0037	-0.12	-0.19	8.7	0.0036
4a 1970.01–1983.12	-0.15	11.9	0.0041	-0.13	-0.19	8.2	0.0039

Table 4

Tests for Changes in M1 Demand Equations

Changes in Interest Rate Coefficient in 1981.12–1983.12 versus:	**Constant Elasticity Specification**	**Variable Elasticity Specification**
a) 1959.04–1980.12	t = -1.06	t = -0.84
b) 1970.01–1980.12	t = -1.96	t = -1.89
Estimated Long Run Elasticities:		
a) 1970.01–1980.12	-0.13	-0.14*
b) 1981.12–1983.12	-0.14	-0.16*

*Assumes CPRT = 10.00

The Stability of M1A

To provide additional evidence of whether the introduction of interest-bearing checking accounts was an important cause of the 1982 velocity decline, we also estimated a demand function for M1 *excluding* interest-bearing checking accounts for the period prior to 1979, and examined its ability to explain the 1982 experience. This aggregate, which excludes NOW accounts, corresponds approximately to the variable which the Federal Reserve described as M1A up to December 1981. As noted earlier, it has been argued that the increasing share of interest-bearing NOW accounts in M1 has significantly altered the nature of M1 and that the exclusion of NOWs from M1A explains why M1A velocity exhibited more "normal" cyclical behavior in 1982-83 than M1 velocity.

However, simulations of this M1A demand equation strikingly contradict this view. As Table 5 shows, despite the fact that the estimation period[13] ended more than three years previously (in September 1978), the simulation tracks the actual course of M1 in 1982-83 quite well but over-estimates the growth rate of M1A. Apparently the growth rate of M1A in 1982 continued to be distorted downward by the shifting of funds out of demand deposits into NOW accounts. Hence, the apparent stability of M1A *velocity* was a statistical artifact.

In other words, the fact that M1 velocity declined in 1982 and that of M1A did not, does *not* mean that the demand *function* for M1 shifted upward while that for M1A remained stable. If anything, the opposite was the case—the demand function of M1A continued to shift downward and that for M1 remained stable. Indeed, the fact that a demand function for M1A is able to predict fairly accurately both the level and the average growth rate of *M1* in 1982-83 is consistent with the view that most of the growth of NOW accounts came from demand deposits, and hence that M1 does not contain a significant volume of "savings" balances.

Table 5

Dynamic Simulations of M1A Growth Rates* 1982-84

		Simulated M1A**	Actual M1A	Actual M1
1982	I	7.6	-1.4	5.4
	II	7.1	1.6	3.9
	III	8.0	5.0	9.8
	IV	9.6	9.4	14.4
1982	(Dec.–Dec.)	8.1	3.7	8.4
1983	I	8.7	3.5	13.0
	II	8.0	8.1	11.5
	III	6.8	3.4	6.2
	IV	7.2	4.1	4.9
1983	(Dec.–Dec.)	7.7	4.8	8.9
1984	I	7.4	3.4	7.5
March 1984 Level ($ Billions)		542.7	399.9	535.2

*All annual and quarterly growth rates are annualized averages of monthly rates of change.

**Derived from a demand function for M1A estimated over 1970.01–1978.09. Simulation begins in 1978.10.

III. The Stability of M2

The results of the preceding section suggest that the introduction of NOW accounts and other changes in the financial system did not significantly reduce the reliability of M1 as a guide to policy. In this section we examine the stability of the demand for M2, using a set of tests analogous to those applied to M1. Actually, we estimate equations for the non-M1 component of M2. Since the demand for M1 was found to be stable, this means that there were no significant shifts between M1 and the non-M1 component of M2. Thus, the stability of M2 can be tested by examining its non-M1 component.

We argued earlier that deposit rate deregulation after June 1978 might lower the responsiveness of the demand for non-transactions M2 to changes in market rates of interest and also shorten the lag between interest rate changes and changes in demand. To test this possibility, we estimated demand functions for non-transactions M2 over two sample periods: January 1970–June 1978 and July 1978–November 1982. In addition, to examine the impact of the introduction of Money Market Deposit Accounts in December 1982, the second sample was extended through December 1983. As in the case of M1, both a constant and a varying interest elasticity specification were tested.[14] The constant elasticity specification provided a slightly better fit (in terms of the standard errors of the equations) in all sample periods. However, when evaluated at the sample means, the estimated elasticities implied by the varying elasticity specification were very close to those given by the constant elasticity model.

Tables 6 and 7 show the estimated long-run elasticities of non-transactions M2 with respect to the

Table 6

Demand for Non-Transactions M2

(Constant Interest-Elasticity Specification)

Estimation Sample Period*	Long Run Interest Elasticity	Mean Lag
1970.01–1978.06	-0.194	21.7 months
1978.07–1982.11	-0.140	14.7 months
1978.07–1983.12	-0.079**	14.3 months

*Estimated equations are shown in the Appendix.

**This elasticity is allowed to adjust gradually over the period from December 1982 to June 1983. The elasticity shown is the estimate for the period after this adjustment was completed.

Table 7

Demand for Non-Transactions M2

(Varying Interest Elasticity Specification)

Estimation Sample Period*	Long-Run Interest Elasticity		Mean Lag
	CPRT = Sample Mean	CPRT = 8.5%	
1970.01–1978.06	-0.194	-0.249	25.3 months
1978.07–1982.11	-0.138	-0.097	14.1 months
1978.07–1983.12	-0.100**	-0.074**	13.5 months

*Estimated equations are shown in the Appendix.

**These elasticities are allowed to adjust gradually over the period from December 1982 to June 1983. The elasticities shown are the estimates for the period after this adjustment was completed.

yield on six-month commercial paper, as well as the mean lag between changes in the independent variables and the resultant change in the dependent variable. As expected, the mean lag has shortened and the elasticity has declined since 1978. In the constant elasticity specification, for example, the mean lag is estimated to have shortened from 21.7 months before 1978 to 14.7 months after that date. In the constant elasticity specification, the long-run elasticity is estimated to have declined from -0.194 before deregulation to -0.140 in the 1978-82 sample period. Moreover, if the elasticity depends on the level of interest rates, this would be an understatement of the effects of deregulation because the average level of interest rates rose sharply between these sample periods. When the elasticities are evaluated at the mean of the whole 1970-82 period (8.5 percent), the variable elasticity specification shows a decline in the estimated elasticity from -0.249 to -0.097. This smaller but quicker response of demand to changes in market rates reflects the fact that the response of the own-rate to market rates was both more rapid and larger after deregulation.

Tables 6 and 7 also present the results from extending the end-point of the second sample period from November 1982 to December 1983. This was the period during which Money Market Deposit Accounts were introduced and rapidly became a significant component of non-transactions M2. Between December 1982 and June 1983, the share of MMDAs in non-transactions M2 went from zero to 23 percent, after which it remained approximately constant. To capture this institutional development, the intercept term and the interest rate coefficient in the equations were assumed to shift gradually over those seven months before stabilizing. The estimates imply that this latest financial change has produced a further decline in the long-run interest elasticity. After June 1983, the estimated elasticity in the constant elasticity specification is -0.079 compared to -0.140 in 1978-82. Such a decline would be expected since the own-rate on MMDAs is fully market-determined.

To examine whether the demand for non-transactions M2 remained stable during the velocity decline period, we have estimated equations prior to

Table 8

Growth in Non-Transactions M2 (Annual Rates*)

		Dynamic Simulations***			
	Actual	I	II	III	IV
1982/Q1	7.2	9.4	9.2	10.0	9.3
Q2	9.9	7.8	8.4	7.7	8.9
Q3	10.3	9.1	9.9	9.0	9.8
Q4	9.4	13.9	13.0	14.6	12.6
1982 (Dec.–Dec.)	9.2	10.1	10.2	10.3	10.2
1983/Q1	22.6	14.4	12.5	16.2	11.9
Q2	8.8	12.8	11.9	14.4	11.4
Q3	5.6	10.0	10.1	11.2	10.0
Q4	10.2	11.0	11.8	11.0	11.6
1983 (Dec.–Dec.)	11.8	12.0	11.6	13.2	11.3
1983 (Mar.–Dec.)	8.2	11.2	11.3	12.2	11.0

*Calculated as annualized average of monthly growth rates in quarter.

**Derived from equations estimated from the following sample periods and specifications.

I–Sample Period 1970.01–1981.12–Constant Interest Elasticity
II–Sample Period 1978.07–1981.12–Constant Interest Elasticity
III–Sample Period 1970.01–1981.12–Varying Interest Elasticity
IV–Sample Period 1978.07–1981.12–Varying Interest Elasticity

that period and used them to simulate that aggregate's behavior. Since our earlier results suggested that the interest elasticity of demand and the mean adjustment lag changed in 1978, it was natural to base these simulations on equations estimated from 1978.07–1981.12. However, in view of the shortness of this sample period, we also computed simulations of equations estimated over a sample period beginning in 1970.01. As before, both a constant and a varying elasticity specification were used.

These results, shown in Table 8, support the proposition that the demand for non-transactions M2 also remained relatively stable over most of the period of the great velocity decline. The average growth rate over the four quarters of 1982 is slightly over 10 percent in all four simulations, which compares to the actual average growth rate of 9.2 percent. However, the equations are less successful than those for M1 in capturing quarter-to-quarter variations in the growth rate. The simulations derived from the longer sample beginning in 1970 tend to be wider of the mark, as would be expected given our earlier finding of a change in the function in 1978. These results imply that, if the Federal Reserve could have correctly predicted the independent variables in our equations, it would not have been grossly misled in setting M2 targets for 1982 *as a whole*.

Interpretation of the 1983 simulations is complicated by the surge of growth in the first quarter associated with the introduction of MMDAs. As in 1982, the equations predicted the growth rate quite well for the year as a whole, but missed the quarter-to-quarter variations. However, if the results for January to March 1983 were excluded from consideration on the grounds that M2 growth was distorted by the introduction of MMDAs, then the equation would over-predict growth in M2-M1 by from 3.0 to 4.0 percentage points.

IV. Conclusions

This paper contains a comparative analysis of the stability of the demands for M1 and M2 during the period in which the velocities of both aggregates declined unexpectedly. The analysis suggests that these velocity declines represented historically normal responses of the demands for these aggregates to the surprisingly large decline in inflation and market interest rates in 1982. This result contradicts the alternative view that M1-velocity was unstable because of deposit rate deregulation. Although M2 appears to have been influenced by deregulation, since two changes in the past six years were detected in the interest elasticity of that aggregate, deregulation was not the primary cause of the decline in its velocity.

One certainly cannot rule out the possibility that M1 will be affected by future deregulation. However, the rather substantial evidence accumulated thus far supports the view that M1 will continue to be a useful guide to policy in the foreseeable future.

APPENDIX

Table A-1
M1 Demand Regressions

(A) $LM1 = \underset{(1.59)}{0.069} - \underset{(6.96)}{0.0092LCPRT} + LPCE + \underset{(6.23)}{0.040\ LYPERS}$

$- \underset{(3.58)}{0.00086SHFT} + \underset{(2.49)}{0.000022SHFT2}$

$+ \underset{(63.57)}{0.94\ (LM1_{-1} - LPCE)} + \underset{(2.82)}{0.16\ U_{-1}}$

$\bar{R}^2 = 0.999$

$SE = 0.0036$

Sample = 1959.04 – 1981.12

(B) $LM1 = \underset{(4.06)}{0.20} - \underset{(8.14)}{0.0015\ CPRT} + LPCE + \underset{(7.53)}{0.054\ LYPERS}$

$- \underset{(4.83)}{0.0012\ SHFT} + \underset{(3.54)}{0.000033SHFT2}$

$+ \underset{(52.08)}{0.90\ (LM1_{-1} - LPCE)} + \underset{(2.93)}{0.21\ U_{-1}}$

$\bar{R}^2 = 0.999$

$SE = 0.0034$

Sample = 1959.04 – 1981.12

(C) $LM1 = \underset{(0.62)}{0.061} - \underset{(5.58)}{0.012\ LCPRT} + LPCE + \underset{(4.45)}{0.059\ LYPERS}$

$- \underset{(3.34)}{0.00097\ SHFT} + \underset{(1.99)}{0.000021\ SHFT2}$

$+ \underset{(42.4)}{0.92\ (LMI_{-1} - LPCE)} + \underset{(2.88)}{0.17\ U_{-1}}$

$\bar{R}^2 = 0.999$

$SE = 0.0039$

Sample = 1970.01 – 1981.12

$$\text{(D)}\ LM1 = \underset{(1.09)}{0.11} - \underset{(7.13)}{0.0020}\ CPRT + LPCE + \underset{(5.97)}{0.086}\ LYPERS$$

$$- \underset{(4.97)}{0.0014}\ SHFT + \underset{(2.88)}{0.000031}\ SHFT2$$

$$+ \underset{(37.18)}{0.88}\ (LM1_{-1} - LPCE) + \underset{(2.85)}{0.22}\ U_{-1}$$

$\bar{R}^2 = 0.999$

SE = 0.0037

Sample = 1970.01 – 1981.12

Table A-2
M1A Demand Equation

$$LM1A = \underset{(1.37)}{0.120} - \underset{(4.49)}{0.0076}\ LCPRT + LPCE$$

$$+ \underset{(3.34)}{0.050}\ LYPERS - \underset{(3.28)}{0.00094}\ SHFT$$

$$+ \underset{(2.70)}{0.000021}\ SHIFT2 + \underset{(30.68)}{0.919}\ (LM1A_{-1} - LPCE) - \underset{(0.20)}{0.02}\ U_{-1} - \underset{(0.90)}{0.09}\ U_{-2}$$

$\bar{R}^2 = 0.999$

SE = 0.0031

Sample = 1970.01 – 1978.09

Table A-3
Non-Transactions M2 Demand Equations

$$\text{(A)}\ LM21 = \underset{(2.99)}{-0.206} - \underset{(5.70)}{0.0090}\ LCPRT + LPCE + \underset{(3.44)}{0.075}\ LYPERS$$

$$+ \underset{(20.15)}{1.523}\ (LM21_{-1} - LPCE) - \underset{(7.63)}{0.569}\ (LM21_{-2} - LPCE)$$

$$+ \underset{(1.31)}{0.134}\ U_{-1} - \underset{(0.70)}{0.070}\ U_{-2}$$

$\bar{R}^2 = 0.999$

SE = 0.0021

Sample = 1970.01 – 1978.06

$$(B)\ LM21 = -\underset{(2.57)}{0.176} - \underset{(5.32)}{0.0012}\ CPRT + LPCE + \underset{(2.96)}{0.063}\ LYPERS$$

$$+ \underset{(20.42)}{1.546}\ (LM21_{-1} - LPCE) - \underset{(7.78)}{0.585}\ (LM21_{-2} - LPCE)$$

$$+ \underset{(1.40)}{0.142}\ U_{-1} + \underset{(0.74)}{0.75}\ U_{-2}$$

$\bar{R}^2 = 0.999$

SE = 0.0022

Sample = 1970.01 – 1978.06

$$(C)\ LM21 = -\underset{(3.60)}{0.272} - \underset{(5.44)}{0.0095}\ LCPRT + LPCE$$

$$+ \underset{(5.83)}{0.105}\ LYPERS + \underset{(8.79)}{1.030}\ (LM21_{-1} - LPCE)$$

$$- \underset{(0.877)}{0.099}\ (LM21_{-2} - LPCE)$$

$$+ \underset{(0.99)}{0.138}\ U_{-1} - \underset{(2.27)}{0.330}\ U_{-2}$$

$\bar{R}^2 = 0.999$

SE = 0.0016

Sample = 1978.07 – 1982.11

$$(D)\ LM21 = \underset{(3.46)}{-0.263} - \underset{(5.37)}{0.000808}\ CPRT + LPCE$$

$$+ \underset{(8.96)}{1.048}\ (LM21_{-1} - LPCE) - \underset{(1.06)}{0.119}\ (LM21_{-2} - LPCE)$$

$$+ \underset{(8.96)}{0.124}\ U_{-1} - \underset{(1.06)}{0.304}\ U_{-2}$$

$\bar{R}^2 = 0.999$

SE = 0.0016

Sample = 1978.07 – 1982.11

$$
\begin{aligned}
\text{(E)}\ LM21 = {} & \underset{(3.70)}{-0.260} + \underset{(8.27)}{1.061}\ DUM - \underset{(8.33)}{0.304}\ DUM2 + \underset{(8.35)}{0.022}\ DUM3 \\
& -(\underset{(6.09)}{0.0096} + \underset{(8.19)}{0.496}\ DUM - \underset{(8.25)}{0.142}\ DUM2 + \underset{(8.26)}{0.01015}\ DUM3)\ LCPRT \\
& + LPCE + \underset{(6.57)}{0.105}\ LYPERS \\
& + \underset{(15.12)}{1.136}\ (LM21_{-1} - LPCE) - \underset{(2.85)}{0.206}\ (LM21_{-2} - LPCE) \\
& - \underset{(0.41)}{0.053}\ U_{-1} - \underset{(1.40)}{0.182}\ U_{-2}
\end{aligned}
$$

$\bar{R}^2 = 0.999$

SE = 0.0017

Sample = 1978.07 – 1983.12

$$
\begin{aligned}
\text{(F)}\ LM21 = {} & \underset{(3.64)}{-0.261} + \underset{(8.43)}{0.508}\ DUM - \underset{(8.47)}{0.145}\ DUM2 + \underset{(8.49)}{0.010}\ DUM3 \\
& -(\underset{(6.03)}{0.000836} + \underset{(8.24)}{0.0598}\ DUM - \underset{(8.29)}{0.0171}\ DUM2 + \underset{(8.31)}{0.001222}\ DUM3)\ CPRT \\
& + LPCE + \underset{(6.52)}{0.107}\ LYPERS \\
& + \underset{(14.96)}{1.126}\ (LM21_{-1} - LPCE) - \underset{(2.77)}{0.200}\ (LM21_{-2} - LPCE) \\
& - \underset{(0.32)}{0.042}\ U_{-1} - \underset{(1.29)}{0.168}\ U_{-2}
\end{aligned}
$$

$\bar{R}^2 = 0.999$

SE = 0.0017

Sample = 1978.07 – 1983.12

List of Symbols

LM1 = log of M1
LM21 = log of M2 minus M1
LM1A = log of M1 excluding Other Checkable Deposits
CPRT = 6 month commercial paper rate
LCPRT = log of 6 month commercial paper rate
LPCE = log of personal consumption expenditure deflator
LYPERS = log of real personal income
SHFT = 1, 2, . . . , 24 in 1974.07–1976.06,
= 0 before 1974.07,
24 after 1976.06.
SHFT2 = Square of SHFT
DUM = 1, 2, 3, 4, 5, 6, 7 in 1982.12–1983.06,
= 0 before 1982.12,
7 after 1983.06
DUM2 = Square of DUM
DUM3 = Cube of DUM
U_{-1} = error term lagged one month
U_{-2} = error term lagged two months

FOOTNOTES

1. Over the period from 1960 to 1981, the standard deviations of the annual growth rates of M1, M2 and M2-M1 were 1.76 percent, 2.55 percent and 3.56 percent.

2. This source of velocity changes operates unless the elasticity of money demand with respect to nominal income is exactly equal to one.

3. See **Record of Policy Actions**, October 1982.

4. Flint Brayton, Terry Farr, and Richard Porter, "Alternative Money Demand Specifications and Recent Growth in M1", Unpublished Paper, Board of Governors of the Federal Reserve System, May 23, 1983.

5. This point would be invalid if the demand for M1 responds to basis point rather than to proportionate changes in interest rates. Regression results presented later in this paper show that a specification in which percent changes in money demand respond to basis point changes in interest rates (that is, a semi-log specification) fits the data as least as well as a constant elasticity specification.

6. For two examples of this line of argument, see R.W. Hafer, "The Money-GNP Link: Assessing Alternative Transactions Measures", **Review**, Federal Reserve Bank of St. Louis, Volume 66, No. 3, March 1984, and Stephen H. Axilrod, "Issues in Monetary Targeting and Velocity," in **Monetary Targeting and Velocity**, Federal Reserve Bank of San Francisco, December 1983.

7. The only significant remaining component of the non-M1 portion of M2 that bears a fixed return is passbook saving accounts. These accounts now represent less than one-fifth of the non-M1 portion of M2.

8. We use this phrase to mean M2 excluding M1 even though some assets in this aggregate provide limited checking facilities.

9. The own rate of return on M2-M1 is represented by the so-called "Fitzgerald rate." It is the deposit ceiling rate yielding the highest instantaneous holding period yield. It is calculated by fitting the Treasury yield curve through each ceiling deposit rate, and extending each curve back to the point where maturity equals zero. The highest rate calculated in this way in a particular month is the Fitzgerald rate for that month.

10. John J. Balles, "Defining the Issues", in **Monetary Targeting and Velocity**, Federal Reserve Bank of San Francisco, December 1983, pp. 14-21; Michael W. Keran, "Velocity and Monetary Policy in 1982" **Weekly Letter**, Federal Reserve Bank of San Francisco, March 18, 1983; John P. Judd, "The Recent Decline in Velocity: Instability in Money Demand or Inflation?", **Economic Review**, Federal Reserve Bank of San Francisco, Spring 1983, pp. 12-19; John P. Judd and Rose McElhattan, "The Behavior of Money and the Economy in 1982-83", **Economic Review**, Federal Reserve Bank of San Francisco, Summer 1983; and Brian Motley, "Money, Inflation and Interest Rates", **Weekly Letter**, August 5, 1983.

11. See Thomas D. Simpson, "Changes in the Financial System: Implications for Monetary Policy." **Brookings Papers on Economic Activity**, 1, 1984.

12. See John P. Judd and John L. Scadding, "The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature", **Journal of Economic Literature**, September, 1982, pp. 993-1023.

13. The estimated equation used in this test is shown in the Appendix.

14. See the Appendix for details of the equations estimated. Various alternative specifications were tested as well as those reported here. For example, the distributed lags also were estimated using the Almon method: the resulting estimates of the long-run elasticities were essentially identical to those in Tables 6 and 7. Preliminary tests in which both the commercial paper rate and the own-rate were included in the estimating equations produced unstable parameter values, presumably reflecting the high degree of collinearity between these rates.