# Alternative Explanations of the 1982-1983 Decline in Velocity

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| **Working Paper Number** | 1983-019B |
| **Revision Date** | January 1983 |
| **Citable Link** | https://doi.org/10.20955/wp.1983.019 |
| **Suggested Citation** | Tatom, J.A., 1983; Alternative Explanations of the 1982-1983 Decline in Velocity, Federal Reserve Bank of St. Louis Working Paper 1983-019. URL https://doi.org/10.20955/wp.1983.019 |

ALTERNATIVE EXPLANATIONS OF THE 1982-1983
DECLINE IN VELOCITY*

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83-019
Revised

*Paper prepared for the Federal Reserve Bank of San Francisco Conference on Monetary Targeting and Velocity, December 4-6, 1983. The views expressed do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis or the Federal Reserve System.

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JOHN A. TATOM

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The velocity of money declined sharply in 1982 and early 1983, sparking concern and controversy over the extent of the decline, the source of the decline, and implications for the conduct of monetary policy.[1/] The response to recent developments has been sharply divided.

On the one hand, the Council of Economic Advisers has given credence to the notion of an unexplained or "not fully understood" shift in money demand due to the "historically atypical" behavior of velocity (Economic Report of the President, 1983, pp. 21-22). Robert J. Gordon has asserted that "monetarism has been decimated by the collapse of velocity in 1982," implying that monetary targeting has become a questionable, if not perverse, practice for the conduct of monetary policy.[2/] Blinder has concluded that the lesson of velocity shifts during the recent recession is: "he who targets on the growth rate of money when velocity is behaving erratically is looking for trouble."[3/]

The Fed has also noted the velocity decline and attempted to adjust policy for it. This is particularly apparent in a recent review of monetary policy in 1982 and policy objectives for 1983 where the projected 1983 ranges for M1 and M2 were raised and that for M1 was widened.[4/] It is not so clear, however, that the velocity decline was the rationale for rapid M1 and M2 growth in 1982-83, as a casual review of experience might suggest. The record pace of M1 growth that began in July 1982 and the deemphasis of the M1 target after October 1982 were fostered initially by concerns for the depth and world-wide extent of the recession, the strength of the dollar, potential credit problems of the U.S. banking system and, beginning in October 1982, by the anticipated effects of All Savers Certificate redemptions and the introduction of Money Market Deposit accounts. Throughout 1982 (as in former years) there was continuing concern over unusual velocity developments; there is little evidence that the FOMC adjusted its targets or acquiesced to double-digit money growth due to velocity concerns however.[5/]

Other analysts have been less impressed by recent developments. Friedman has continued to argue that "Changes in the public's desire to hold money balances, rather than spend them, 'are not frequent enough, are not large enough and are not sufficiently long lasting, to vitiate the usefulness of a 'monetarist' policy.' Talk about such changes . . . 'is simply a red herring introduced by the Federal Reserve to cover up mistakes in its policy.'"[6/] Jordan has argued that "What has been unusual about the past few years is the frequency of assertions that money demand has shifted. That no doubt reflects the apparent increase in the short-run volatility of money growth which the policymakers do not wish to be blamed for."[7/]

What is at issue, apparently, is whether the recent decline in velocity represents a break with historical relationships, and, to the extent that it does, whether it has any implications for the conduct of monetary policy. This paper focuses on why velocity declined and the implications of the recent experience for policymakers.

In a recent paper I enumerated several hypotheses for the velocity decline, including: erratic monetary policy and its associated cyclical experience, declining interest rates, financial innovations, a shift in foreign demand for the dollar, and unprecedented strength in the response of velocity to declining interest rates or inflationary expectations, due seemingly to an unprecedented break in expectations or innovations in financial markets, economic structure or some combination of the two.[8/] Most of these explanations were rejected casually by noting that the timing and magnitude of the changes did not match up with the velocity movements they purported to explain. Hence, most of the hypotheses were not formally tested.

The pattern of money growth and the recession induced by it, were found to be the major source of the velocity decline. A model that emphasized traditional factors such as trend, cycle, interest rate movements, as well as other transitory variations arising from monetary, fiscal, and other shocks explained velocity movements from 1948 to 1981 quite well and predicted subsequent velocity movements without significant errors or evidence of structural change.

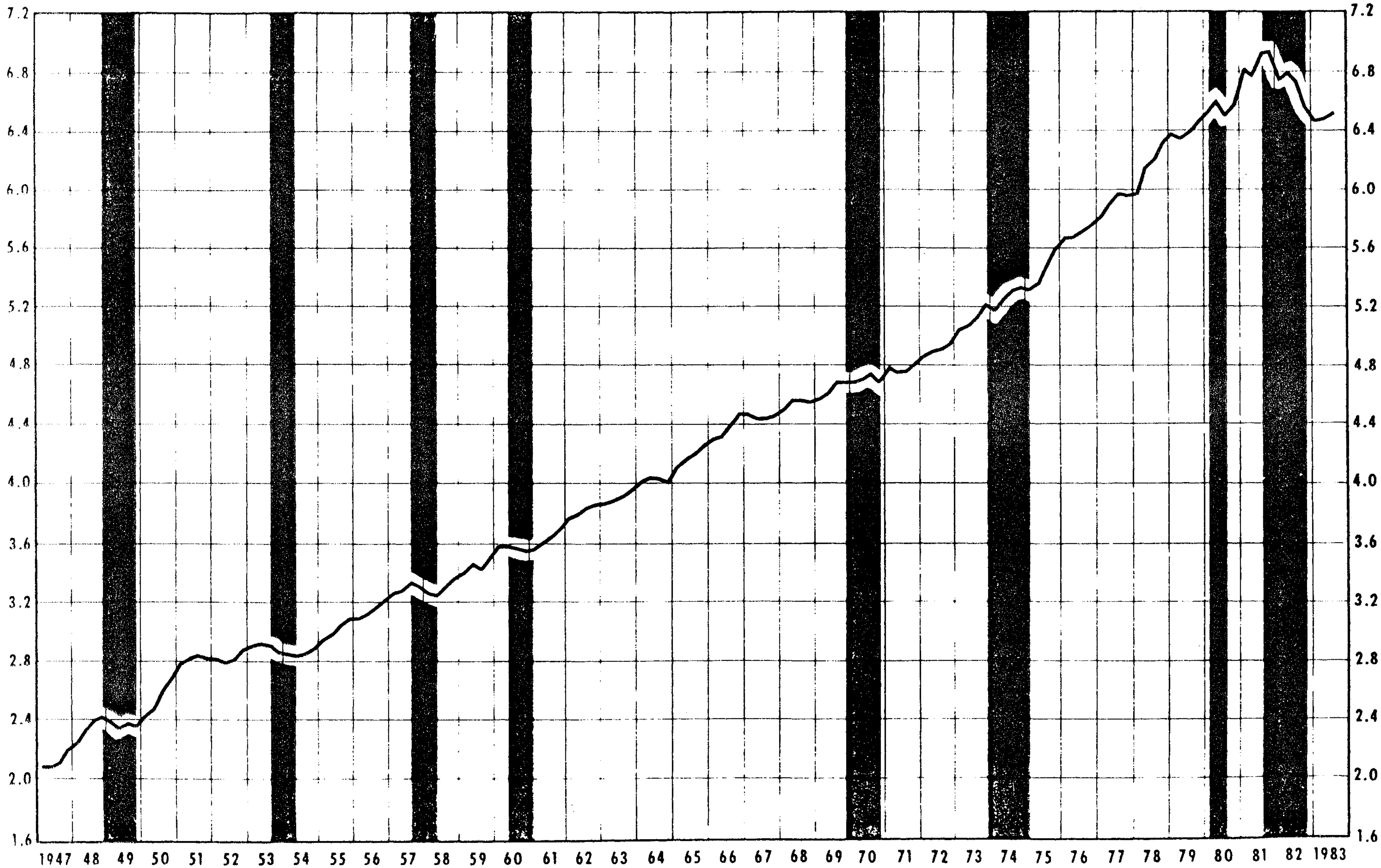
This paper expands on that work by providing some technical improvements, particularly accounting for longer lags in the effects of interest rates on velocity, and more important, by formally testing some of the "new" hypotheses within the framework of this model. To anticipate the results, none of the tests suggest important revisions in the earlier conclusions. Interest rate effects were not statistically significant previously, but are in the model presented here. Their lag pattern is similar to other models, but prove to be no more important in explaining recent velocity movements than in the more naive model. Before turning to this evidence, however, it is useful to put the empirical problem in perspective. At the end of the paper, I turn to the issue of the implications of recent developments for monetary targeting.

Is There Evidence of a Significant Shift in Velocity?

The most obvious case for a shift in velocity comes from a glance at the data. Chart 1 shows velocity (GNP/M1) on a quarterly basis from 1947 to II/1983. While there are clearly earlier declines (especially during recessions), the decline in 1982 looks unusual. Such visual evidence can be deceiving, however.

Chart 3

## Velocity (GNP/M1)




Shaded areas represent periods of business recessions

Previous levels of velocity may as readily appear high compared to trend, so that 1982-83 velocity may represent a return to trend levels, shifting the "velocity problem" to prior economic developments. For example, when the annual average of velocity (ln V) from 1959 to 1976 is regressed on a trend and extrapolated to 1982, the level in 1982 is virtually identical to the trend projection. The fitted values for 1978-81 underpredict velocity by 3 to 5 percent; in 1982, the error is 0.07 percent. More systematic evidence of a shift can presumably be obtained by examining money demand models.

Evidence from Conventional Money Demand Studies

A fairly standard example of a transformed money demand equation can be used to assess the extent of the recent decline in velocity. The functional form is that used by Higgins and Faust in two studies that point to the past instability of money demand and the absence of velocity effects due to the introduction of nationwide NOW accounts.[9/] It is sometimes referred to as a "nominal stock adjustment model." The only major departure here is that the 4-6 month commercial paper rate is used instead of their weighted average of seven yields for a broad spectrum of financial assets and stocks. For a sample period from II/1959 to III/1981, the estimated growth rate of velocity (dots represent annualized differences in logarithms) is:

$$\dot{V}_t = \underset{(2.13)}{0.681} + \underset{(9.40)}{0.734}\,\dot{X}_t + \underset{(3.48)}{0.018}\,\dot{r}_t + \underset{(6.47)}{0.637}\,(\dot{P}_t - \dot{M}_{t-1})$$

$\bar{R}^2 = 0.55$ S.E. = 2.69 D.W. = 2.17 $\hat{p} = -0.41$ (-4.26)

where X is real GNP, P is the implicit price deflator, and M is the money stock, M1. When this equation is used to simulate the velocity experience from IV/1981 to II/1983, the results are those shown in Table 1.

The mean error of -2.26 percent is fairly small compared with errors observed by Higgins and Faust for their equation from mid-1974 to the end of 1977 and is smaller than their average underprediction of velocity (without shift adjustment of M1) for 1981 (1983, p. 10). There are two significant errors in the table; in the first and fourth quarter of 1981 when velocity plummeted at record rates. The root-mean squared error is 5.09 percent, however, slightly less than twice as large as the in-sample standard error. Note that negative velocity growth is predicted by the equation in six of the seven quarters, half again as frequently as the actual occurrences of negative velocity growth over the period; negative velocity growth can hardly be viewed as an extraordinary occurrence.

This experiment does not provide evidence of a serious breakdown in velocity based on the information from a conventional money demand approach. Higgins and Faust (1983, p. 10) show that the 1981 experience (which some observers

Table 1
Error Statistics for a Money-Demand Based Velocity Growth Model

| Quarter Ending | Actual Velocity Growth | Predicted | Error |
|---|---|---|---|
| IV/1981 | 0.43% | -1.27% | 1.70% |
| I/1982 | -11.86 | -2.37 | -9.49 |
| II/1982 | 3.24 | -1.84 | 5.08 |
| III/1982 | -3.43 | -1.10 | -2.33 |
| IV/1982 | -10.43 | -3.65 | -6.79 |
| I/1983 | -5.92 | -2.67 | -3.26 |
| II/1983 | 0.23 | 0.95 | -0.72 |
| III/81-II/83 | -3.96 | -1.71 | -2.26 |
| | | RMSE | 5.09 |

believed would be distorted by financial innovations) also did not suggest any breakdown. These results are all the more remarkable, given the earlier instability claimed for money demand and velocity.

One exception to this conclusion comes from the money-demand function estimated by Hafer and Hein.[10/] Hein's "stable" money demand function for the period I/1960-IV/1979 is stable through 1980 ($F_{3, 75} = 1.76$), when the money supply shock he describes that occurred in II/1980 is controlled for. When the sample period is extended further to II/1983, however, the equation "breaks down." In particular, the F-statistic for the additional 10 quarters (I/1981 to II/1983) is $F_{10, 68} = 6.75$, so that the stability hypothesis is rejected. Part of this difficulty is a large <u>rise</u> in velocity in I/1981 that is discussed below. That simulation error does not persist, but from IV/1982 to II/1983, the end of the simulation, there are significant, one-sided errors of 1.0 to 1.5 percent, indicating a shift up in money demand or down in velocity. Three errors that are two to three times the in-sample standard error are not conclusive, but suggest a once-and-for-all shift in money demand late in 1982 that persisted. Fortunately, this result is exceptional, and, given the simplicity of the model, may not pose a serious challenge to the stability results of others.

Other studies of money demand show substantially smaller errors over the recent period than those in Table 1, indicating that the stability results above are not unusual. Judd has produced results showing the stability of money demand in 1982 based on simulations of the San Francisco money demand equation for the five quarter period IV/1981 to I/1983.[11/] Moreover, Brayton, Farr and Porter (1983) have examined a number of quarterly and monthly models of money demand, expressed in levels and growth rates.[12/] With the exception of the standard Federal Reserve Board model, all seem to do quite well in out-of-sample simulations for the period I/1982 to I/1983.[13/]

The monthly models examined tend to perform better than quarterly models, using mean error or RMSE criteria (the statistics for the five quarters below are based on quarterly averages). The mean error of an updated monthly standard Board model is 0.1 percent, with an RMSE of 2.46 percent. A nonlinear monthly Board model that allows the interest elasticity of money demand to be an increasing function of the interest rate yields a mean error of 0.58 percent, with an RMSE of 2.49 percent. The San Francisco model results compare well with these results; in that model money growth is <u>overpredicted</u> with a mean error of -0.48 percent and RMSE of 2.47 percent.

All of the quarterly models for money growth are products of the Board staff. The best of the five examined is an aggregate model with the nonlinear characteristic above. Its mean error is 1.15 percentage points and the RMSE is 2.52

percent. The worst simulation is that produced by the standard Board model; its mean error is 4.08 percent and its RMSE is 4.61 percent. This mean error is only slightly worse than the 3.36 percent mean error in Table 1 for the same five-quarter period; the RMSE of the standard Board model is sharply lower than the RMSE of 5.97 percent for the same five quarters from the simulation of the simple model in Table 1.

While the Brayton-Farr-Porter results suggest some improvements in money demand estimation, the essential conclusion is that "a number of the models can fairly accurately explain the behavior of M1 over 1982 and the first quarter of 1983" (p. 18).[14/] It does not appear, then, that conventional estimates of money demand have exhibited unusual instability or provided strong reasons to believe that the decline in velocity was unusual. Nonetheless, numerous hypotheses have been advanced and tests of these hypotheses are warranted. Such testing is subject to more than the typical caution about the nature of the data, however, and these reservations are taken up in the next section.

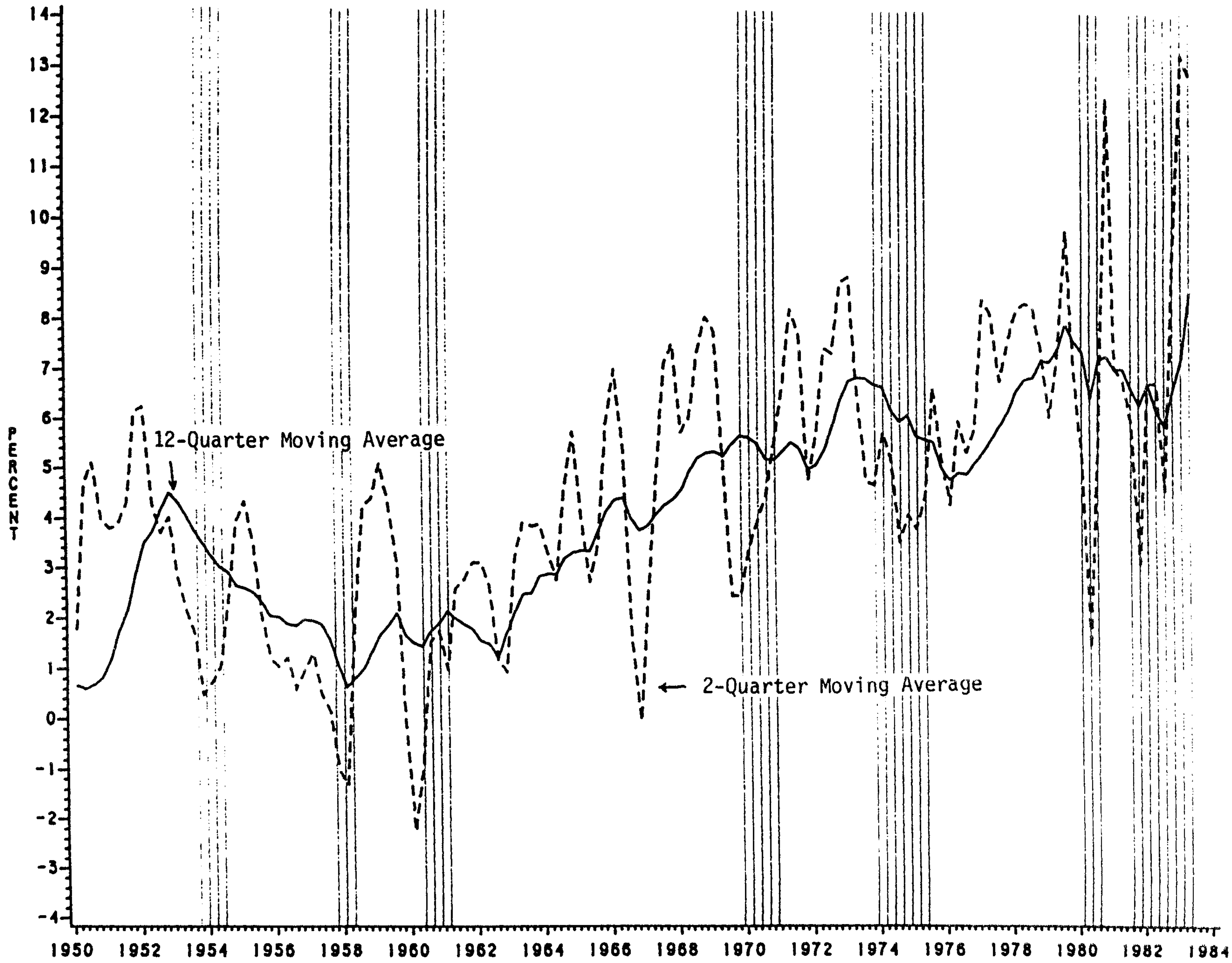
Testing Economic Hypotheses In A New Policy Environment

From 1980 to mid-1983, monetary policy actions exhibited a major departure from previous postwar experience. The growth rate of M1 has been more volatile, and it has achieved new record highs, and within short spans of time.

Chart 2 shows the growth rate of M1 from I/1950 to II/1983 in the short-run (2 quarters) and trend (12 quarters). Periods of recession are shaded. Prior to 1980, large negative deviations in short-run money growth from trend have inevitably led to recessions (with the "exception" of the 1966 mini-recession that is not shaded). Also, inflation (not shown) has tended to follow the trend growth of money. Since 1980, the gyrations of short-run money growth, absolutely or relative to trend have become substantially more pronounced and, at peaks, have achieved new records. This has been manifested, beginning in 1980, by the fastest and shortest decline in real output in the postwar record, followed by the shortest and most rapid expansion on record (III/1980-III/1981), then a recession matching that of 1973-75 in length. This experience was associated with one of the sharpest reductions in the inflation indicator, the trend growth of money, (2.0 percentage points over 12 quarters), but the descent was reversed more quickly (3 quarters).

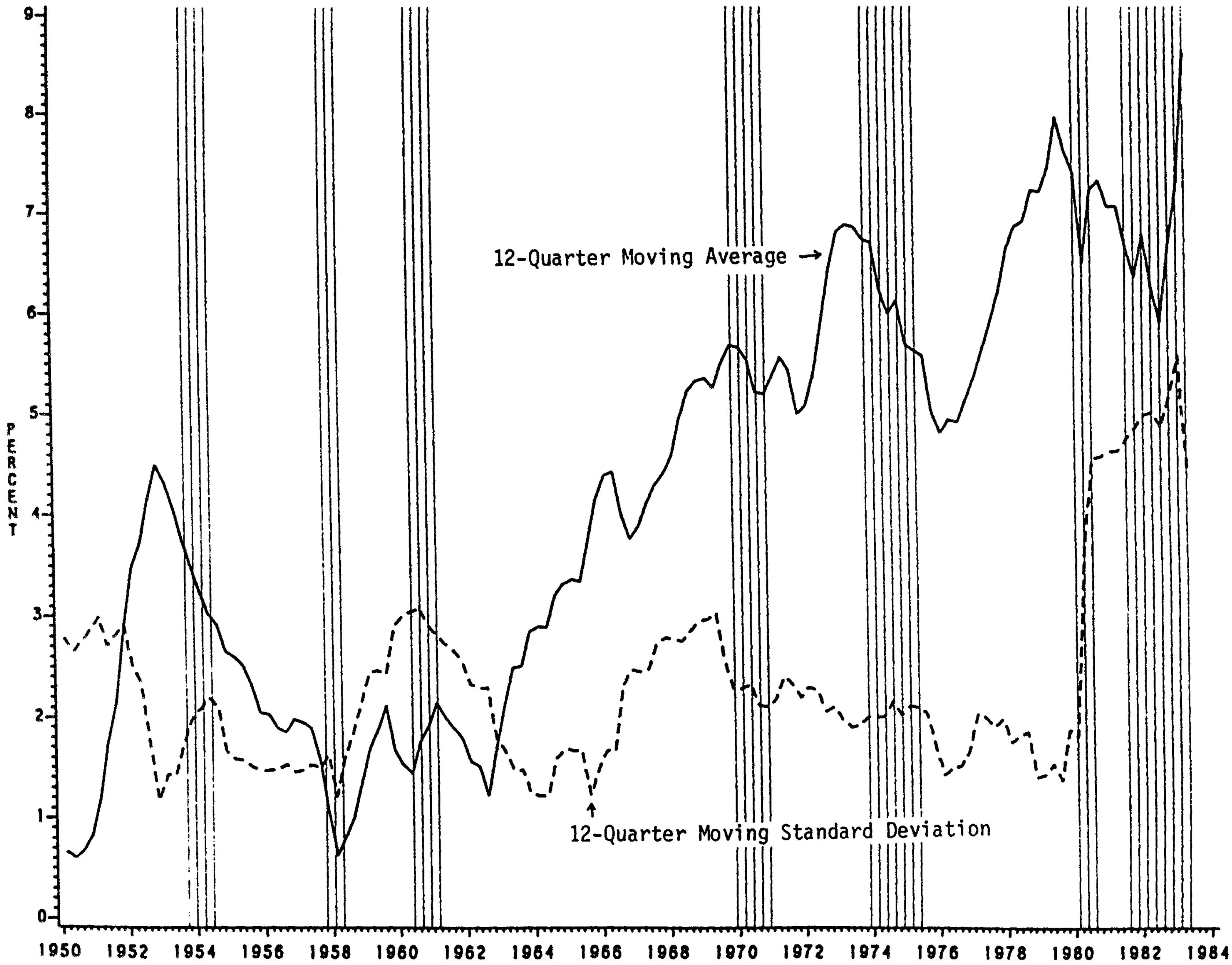
Another view of the recent volatility of money stock growth is obtained in Chart 3, which shows the standard deviation of quarterly M1 growth over three-year periods. In II/1980-II/1983, the standard deviation was over twice that observed over the prior decade and substantially higher than the previous peak volatility observed in 1960. It should also be noted that the sharp rise in the volatility of money growth

# SHORT-RUN AND TREND MONETARY GROWTH




'EST DATA PLOTTED: 1983/II

# VARIATION AND TREND OF MONEY (M1) GROWTH




LATEST DATA PLOTTED: 1983/II

has not abated since the abandonment of the nonborrowed reserves targeting procedure that has been blamed for the lack of monetary control.

Testing economic relationships in such an environment presents substantial risks. First, observations of money growth often have been far outside the prior postwar sample experience. A related problem is that the volatility of policy actions may itself be an important parameter in the linkage between monetary policy actions and economic performance. To the extent that more volatile money growth gives rise to greater risk in markets for goods, services, or assets, including financial assets, the demand for money can be expected to rise, reducing velocity. Such a hypothesis can be tested (and is below), but with some caution. Measures of volatility of money growth are not uniquely tied to risk. Moreover, the time period over which variations in money growth "matter" for real and nominal effects are controversial. Finally, to the extent that increased volatility of policy measures affects risk, it is reflected in interest rates. In the case of velocity at least, the effect of a risk-related rise in interest rates on velocity is difficult to disentangle from the effect of a rise in rates that is unrelated to an increase in risk.

These statistical considerations suggest that an apparent breakdown in conventional relationships in recent years would not be surprising. Moreover, there is at least an implied implication that a major factor responsible for such a breakdown could be the breakdown in money stock control, as indicated by the rise in measured volatility of the money stock. Fortunately, such a statistical breakdown does not arise below. Nonetheless, for those who find the evidence of stable velocity to be weak, the remedy for their supposed unstable velocity may not be difficult to find.

## Alternative Hypotheses Concerning The Recent Behavior of Velocity

Conventional economic theory demonstrates that the demand for money, or velocity, depends on the cost of holding money relative to other assets, including the expected rate of depreciation of money, and expected real income and wealth. Moreover, macroeconomic shocks, such as alterations in monetary or fiscal policy or aggregate supply shocks, can have transitory or permanent influences on these variables and, hence, on velocity. The latter factors are typically ignored in conventional money demand analyses such as those above. In addition, the theoretically attendant effects of movements in inflationary expectations, wealth and/or its composition on velocity are not always captured by the typical movements of income and short-term interest rates included in conventional studies. As a result, factors that influence velocity, other than income, and interest rates, must be accounted for separately.

The recent decline in velocity has prompted some analysts to propose new hypotheses concerning velocity. These fall in two groups: first, that there has been a change in the responsiveness of velocity to one of its well-known conventional determinants, in particular, inflation expectations and/or interest rates or, second, that the list of conventional determinants of velocity growth does not adequately capture some significant recent developments that have depressed velocity. Included among the latter are: the increased demand for money by foreigners, as reflected in the sharp rise in the value of the dollar since mid-1980, a sharp increase in real and financial risk induced by the change in the monetary regime in 1979, and most important, financial innovations. It is, perhaps, useful to point out that the hypothesis of a change in the responsiveness of velocity to interest rate or inflation expectations often takes on characteristics of this second group, in that what is "new" is a major break in inflationary expectations or rise in real and nominal interest rates, or both, that is poorly captured by conventional measures. Thus, this hypothesis can also suggest a once-and-for-all change in velocity, rather than a permanent change in the responsiveness of velocity to these factors.

A velocity growth model is used to test these hypotheses. The model has been used to examine the 1982 velocity decline. The theoretical basis for the model and its properties are presented in detail elsewhere.[15/] Two properties of the model merit emphasis, however. First, velocity is strongly cyclical; indeed, this is found to be a primary factor explaining the recent decline in velocity.[16/] Second, macroeconomic policy shocks, in particular, changes in M1 growth, have transitory effects on velocity; as a result, increased volatility of money growth raises the volatility of velocity.

In the model, velocity V is a function of current and past levels of the money stock (M1), high-employment federal expenditures (E), expected inflation $\dot{P}$, current and past levels of interest rates (r), past levels of the relative price of energy, ($p^e$) measured by the producer price of fuel and related products and power deflated by the implicit price deflator for business sector output, slack on the economy, measured here by the GNP gap ($G = \ln X^P - \ln X$, where $X^P$ is potential GNP and X is actual real GNP), strike activity (S), measured by days lost due to strikes relative to the civilian labor force, and trend. It is hypothesized that changes in the money stock, federal expenditures, and relative energy prices only have transitory effects on velocity. Of course, strikes are a transitory phenomenon and therefore have transitory effects. Changes in the cost of holding money are hypothesized to have permanent effects on the level of velocity. These hypotheses were tested earlier and retested here but the supportive results are not reported; the equation in Table 2 is constrained only by the money stock-velocity hypothesis. Dots over variables indicate the use of (400 $\Delta$ ln) measures, or annualized logarithmic changes.

Two modifications have been made in the model. First, a break in the trend growth rate of velocity in II/1952 has been allowed for in the original in-sample estimation period, III/1948-III/1981. This change was motivated by relatively large errors in the early period, and the expectation that trend growth in velocity is related to the pace of increase in the economy's production capacity generally. Potential output series tend to break substantially in early 1952.[17/] To adjust for the earlier faster growth of potential output and, hence, velocity over the period III/1948-I/1952, a dummy variable, D, which is one over this period, and zero thereafter, is included.

Second, many studies of money demand allow for a lagged response of money demand to interest rate changes. This was not done in the earlier estimation. When lags are included, they are significant, and F-tests indicate the inclusion of five lags.[18/] The result is an estimate of the interest rate elasticity of velocity for the period III/1948 to III/1981 of 0.125 which is close to conventional money demand estimates.[19/] This elasticity differs from others in that it refers to a long-rate, Aaa bond yields, rather than a short-rate such as the commercial paper rate. The inferiority of short-rates, general lack of significance, and erroneous sign result noted earlier continues to hold for the model reported here. For example, with five lagged values, the first two lagged values and the sum effect of $\dot{r}$, where r is the commercial paper rate, have insignificant but negative coefficients. The velocity growth equation is reported in Table 2 for the period III/1948-III/1981.[20/]

Hypothesis 1: Velocity Growth Has Been Stable in 1982-83

Out-of-sample dynamic simulation of the equation in Table 2 does not indicate that velocity growth has been unstable. The actual and simulated growth rates of velocity are reported in Table 3 along with the simulation errors. The mean error and RMSE are -1.66 and 2.51, respectively.[21/] None of the quarterly errors appear significantly large relative to the in-sample standard error. The statistic for the additional observations when they are added to the Table 2 estimation period is $F_{7,\ 115} = 1.42$, indicating that a structural breakdown can be rejected.

Table 4 shows a decomposition of the simulated quarterly changes in velocity by factors accounting for them. As reported before, interest rates and prices do not explain a large portion of the decline, despite the use here of a larger and more significant effect of interest rates on velocity. The principal factor in the swings in simulated velocity growth has been the volatile swings in the money growth rate.

Table 2
Velocity Growth: III/1948-III/1981

$$
\begin{aligned}
\dot{V}_t = {} & \underset{(10.80)}{3.296} + \underset{(4.84)}{3.613}\, D + \underset{(6.87)}{0.416}\, \Delta\dot{P}_t - \underset{(-11.17)}{0.755}\, \Delta\dot{M}_t - \underset{(-6.00)}{0.466}\, \Delta\dot{M}_{t-1} \\
& - \underset{(-3.04)}{0.267}\, \Delta\dot{M}_{t-2} - \underset{(-1.96)}{0.157}\, \Delta\dot{M}_{t-3} - \underset{(-1.71)}{0.136}\, \Delta\dot{M}_{t-4} \\
& + \underset{(1.98)}{0.021}\, \dot{E}_t - \underset{(-1.92)}{0.022}\, \dot{E}_{t-1} - \underset{(-4.28)}{0.047}\, \dot{E}_{t-2} - \underset{(-5.06)}{0.054}\, \dot{E}_{t-3} \\
& - \underset{(-17.80)}{0.907}\, \Delta G - \underset{(-3.65)}{0.208}\, \Delta S_t - \underset{(-2.14)}{0.037}\, \dot{p}^e_t \\
& - \underset{(-1.04)}{0.021}\, \dot{p}^e_{t-1} + \underset{(3.70)}{0.075}\, \dot{p}^e_{t-2} + \underset{(1.12)}{0.012}\, \dot{r}_t + \underset{(3.23)}{0.023}\, \dot{r}_{t-1} \\
& + \underset{(3.33)}{0.028}\, \dot{r}_{t-2} + \underset{(3.19)}{0.028}\, \dot{r}_{t-3} + \underset{(3.47)}{0.022}\, \dot{r}_{t-4} + \underset{(2.26)}{0.011}\, \dot{r}_{t-5}
\end{aligned}
$$

$\bar{R}^2 = 0.83$ S.E. = 1.72 D.W. = 1.96 $\hat{p} = 0.30$ $(t = 3.63)$

Table 3
A Simulation of Velocity Growth Since III/1981

| | Actual | Simulated | Error |
|---|---|---|---|
| IV/1981 | 0.43% | 0.85% | -0.42% |
| I/1982 | -11.86 | -9.29 | -2.57 |
| II | 3.24 | 0.88 | 2.35 |
| III | -3.34 | -0.12 | -3.31 |
| IV | -10.43 | -8.76 | -1.67 |
| I/1983 | -5.92 | -2.68 | -3.25 |
| II | 0.48 | 3.19 | -2.72 |
| III/1981-II/1983 | -3.93 | -2.27 | -1.66 |

RMSE = 2.51

Table 4
Decomposition of Velocity Growth Rate Simulation

| | Simulated Growth Rate | Cycle | Money Growth | Inflation | Interest | Other |
|---|---|---|---|---|---|---|
| IV/1981 | 0.85% | -9.14% | 3.12% | -0.17% | 2.53% | 4.51% |
| I/1982 | -9.29 | -6.96 | -3.99 | -1.82 | 2.04 | 1.44 |
| II | 0.88 | -5.00 | 2.44 | 0.51 | 1.22 | 1.71 |
| III | -0.12 | -2.13 | 0.02 | -0.76 | 0.35 | 2.40 |
| IV | -8.76 | -3.49 | -5.69 | 0.06 | -1.20 | 1.56 |
| I/1983 | -2.68 | -0.54 | -4.49 | 0.06 | -2.20 | 3.89 |
| II | 3.19 | 4.70 | -0.35 | -0.89 | -2.57 | 2.30 |
| Average (III/1981-II/1983) | -2.27 | -3.22 | -1.28 | -0.34 | 0.02 | 2.54 |

A large cyclical decline in the recent recession is not unusual; after all, the rise in unemployment, decline in real output, and length of the recession were among the worst in the postwar experience.[22/] A perspective on cyclical velocity declines in recessions is provided in Table 5, which provides the cyclical peak to trough growth rates (compound annual rates) for 15 recessions since mid-1914. Prior to 1947, the data are based on the GNP estimates of Robert Gordon and the Friedman-Schwartz M1 data.[23/] The recent decline in velocity is similar in magnitude to the first three postwar recessions, but smaller than most of the prewar cyclical declines in velocity.

Hypothesis 2: The Response of Velocity to Interest Rates Has Changed

Interest rates have been generally higher and more volatile in 1982 and early 1983 than might have been expected earlier (e.g., before 1979). It is conceivable that the response based on earlier experience might underestimate that which holds today. On the other hand, some analysts have conjectured that financial innovations might have changed the interest sensitivity of the demand for money by allowing more competitive own-rates of return on components of the M1 money stock.

Table 5
The Growth Rate of Velocity in the Last 15 Recessions

| Peak-Trough | Growth Rate | Peak-Trough | Growth Rate |
|---|---|---|---|
| III/1918- I/1919 | -28.8% | IV/1948- IV/1949 | -2.8% |
| I/1920-III/1921 | -6.6 | II/1953- II/1954 | -2.7 |
| II/1923-III/1924 | -6.7 | III/1957- II/1958 | -3.2 |
| IV/1926- IV/1927 | -4.4 | II/1960- I/1961 | -1.4 |
| III/1929- I/1933 | -13.6 | IV/1969- IV/1970 | 0.0 |
| II/1937- II/1938 | -5.8 | IV/1973- I/1975 | 1.5 |
| I/1945- IV/1945 | -22.5 | I/1980-III/1980 | -0.8 |
| | | III/1981- IV/1982 | -4.3 |

To test whether the interest-rate elasticity of velocity has changed, a test of changes in the coefficients on current and past interest rate changes is performed by adding the vector of interest rate changes since III/81 to the equation in Table 2, estimated over the period III/1948-II/1983. The additional contribution of interest rate movements over these seven quarters for interest rate changes in quarter t to t-5 are (t-statistics in parentheses): 0.015 (0.006), 0.241 (0.59), -0.074 (-0.57), -0.160 (-0.14), -0.640 (-0.14) and -1.696 (-0.23). The sum effect has the correct sign and is large, -2.314, but it is not statistically significant. The F-statistic for the addition of these variables is $F_{6, 116} = 1.61$, which is not significant at a 95 percent confidence level. It does not appear, then, that interest elasticities have changed significantly in the last two years.[24]

Of course, the relevant change could have occurred prior to the recent recession, biasing the test toward rejection. Two other periods for breaks were examined to check for such a bias: III/1979 and IV/1977. These periods were chosen because, in the first case, it corresponds to the adoption of a new money stock control procedure and, in the second, it precedes major movements in funds to money market mutual funds or other checkable deposits. For each period, none of the additional slope coefficients are significant. The

F-statistic for a break in III/1979 is $F_{6, 116} = 1.45$, and for a break in IV/1977 it is 0.65. Neither is significant.

Hypothesis 3: The Responsiveness of Velocity to the Inflation Rate Has Changed

Some analysts have suggested that, since 1981, the response of velocity to inflationary expectations has risen. They conjecture that velocity has fallen more than would previously have been expected, due to the slowing in inflation that has occurred. A related but similarly unverified hypothesis is that the decline in inflation since 1981 has produced, or been associated with, a disproportionate decline in inflationary expectations.

Such notions are tested by allowing the response of velocity growth to the inflation rate to change after III/1981. When this is done the additional response is estimated to be 0.674 (t = 2.23). The coefficient has the expected sign to support the hypothesis, but it is not significant. The difficulty with this result is that it could readily be spurious; there are literally only seven degrees of freedom associated with this shift. The estimated coefficient is not statistically significant at a 95 percent confidence level (two-tailed test), since the critical t-statistic is 2.37.

In addition, even if the coefficient above were significant, the contribution of the added responsiveness of velocity to inflationary expectations is small. For the period

IV/1981 to IV/1982, the effect accounts for a decline in velocity growth of 0.71 percentage points, and for the period IV/1981 to II/1983, it would account for an average rate of decline in velocity of 0.45 percentage points. Most of this additional effect occurs in I/1982 when such a shift accounts for 2.9 percentage points; in IV/1982 and I/1983 the average effect is to raise velocity by an average of 0.58 percentage points. Thus, in two of the three quarters of large velocity declines, this hypothesis fails to contribute toward the explanation. More fundamentally, this hypothesis is rejected because of the paucity of observations noted above.

Hypothesis 4: An Increase In Demand For Money By Foreigners Has Reduced Velocity

Some analysts have conjectured that an apparent increase in demand for money by foreigners has reduced velocity. This hypothesis has several defects. First, it confuses an increase in foreign demand for dollar denominated assets with an increase in demand for M1 by foreigners. Second, it ignores the fact that most of the sharp rise in the exchange value of the dollar occurred much earlier than the recent decline in velocity, and that in that earlier period, velocity growth was quite strong.

Nevertheless, it is worthwhile to examine whether the strength of the dollar exerts a depressing influence on velocity.[25/] For, among other reasons, it is possible that the domestic variables included in the velocity growth model do not adequately capture foreign influences (such as money growth or real growth) on the demand for money. This hypothesis was tested by adding current and up to six lagged values of the changes in the logarithm of a trade-weighted index of the exchange value of the dollar to the Table 2 equation, estimated over the period III/1948-II/1983.[26/] The F-tests of the sequence of lags indicate that current and two lagged values of the change in the exchange rate are significant ($F_{3,\ 119}$ = 5.10). The coefficients (t-statistics) for the current and lagged values are -0.046 (-2.46), 0.010 (0.56), and -0.066 (-3.52). The sum effect is -0.101, indicating that a 10 percent rise in the value of the dollar reduces velocity by about 1 percent. This hypothesis is supported by the estimates for the period ending in II/1983.

When the velocity growth equation is estimated over the earlier period (III/1948 to III/1981), however, the hypothesis is rejected. The same tests of the lag structure were conducted, but none of the additional variables were significant, according to the F-tests. For the lag pattern above, the coefficients were similar (t-statistics in parentheses): -0.045 (-2.16), 0.008 (0.38), and -0.050 (-2.13). The sum of the change in the exchange rate coefficients is nearly the same, -0.088. The F-statistic for the additional variables, however, is $F_{3,\ 112}$ = 2.47, which is below the critical value of $F_{3, 112} = 2.70$, at a 5 percent significance level. Given the size of the t-statistics, multicollinearity appears to be a problem in introducing the exchange rate, but a check of the coefficients and t-statistics of the other included variables reveals no obvious changes.

The hypothesis tests are mixed. Nonetheless, it is useful to assess the strength of the hypothesis in accounting for recent velocity movements. First, an out-of-sample simulation for the III/1948 to III/1981 equation estimate was conducted. The error statistics for the seven quarter period IV/1981 to II/1983 were superior to those shown in Table 3. The quarterly simulation errors from IV/1981 to II/1983 are: 0.22, -0.04, 1.99, -1.48, -0.35, -2.57, and -1.49 percent, respectively. The mean error is only -0.53 percentage points and the RMSE is 1.54 percent, which compares favorably with an in-sample standard error of 1.67.

A decomposition of the simulation similar to that shown in Table 4 was conducted to examine whether multicollinearity is apparent. In particular, two questions arise that are of interest: what is the simulated <u>direct</u> effect of exchange rate movements over the seven quarter period, and second, are the estimated <u>direct</u> effects of the factors shown in Table 4 affected by including the insignificant exchange rate effects?

The results shown in Table 4 are not appreciably affected by this experiment, except for the simulated growth rates and "other" factor. On average, for the seven quarter period from III/1971 to II/1983, velocity growth is simulated to be -3.40 percent. The direct influence of exchange rate movements is -0.94. The influence of the cycle, money growth variability, inflation rate changes, interest rate movements and other factors over the seven quarters are -3.29, -1.27, -0.34, 0.06, and 2.50 percentage points, respectively. Thus, whether or not exchange rates are included in the model, the results for the principle factors are unaffected. The exchange rate plays a sizeable role, but only in improving the forecast, not by replacing other explanations.[27/] Since the vector of exchange rate changes is not significant in the equation generating these results, it is ignored in the remainder of the tests. Nonetheless, improved modeling of the potential influence of this factor appears promising.

Hypothesis 5: The Use of New Checkable Deposit Accounts Has Reduced Velocity

Perhaps the oldest of these innovations hypotheses examined here is the argument that M1 includes other checkable deposits that have savings characteristics, as compared with transaction balances. One variant of this argument is that some new types of checkable deposits require relatively large minimum on average balances that increase the "idle" component of M1, to the extent that these other checkable deposit accounts proliferate. This argument suggests that M1 is raised relative to spending due to the growth of other checkable deposits relative to other components of M1, or that velocity is reduced.

The principal difficulties with this hypothesis are that demand deposits earned implicit interest before the introduction of new types of checkable deposits, and required or relatively high desired minimum balances were held for demand deposits without complicating the measurement or interpretation of the money stock, M1. Interest prohibitions worked to prohibit explicit payments to depositors so that only depositors who held average deposit holdings that were relatively high compared to transaction and other account services were constrained from receiving a competitive interest rate or deposit holdings; even some of the latter customers, if not all, received competitive interest on deposits through discounts on other bank services, such as loans.

The introduction of NOW accounts or automatic transfer services, or later super-NOW accounts only improved the efficiency of the market for deposits; it should not, in principle, have affected the returns from holding money. Not surprisingly, higher minimum balances tended to be required for those accounts, and only depositors who held these balances formerly in demand deposit with relatively low turnover would be expected to switch. Competitive interest on transaction balances generally tends to be insufficient, compared with other nonmoney financial assets, to attract new funds to transaction accounts so little or no effect is registered in the demand for money.

The direct manner to evaluate the hypothesis is to empirically examine the extent to which shifts to other checkable deposits are related to velocity movements (or more generally, a host of other behavioral relationships that would be expected to be distorted, if the hypothesis is correct). To test this hypothesis, current and lagged changes in the ratio of other checkable deposits to the money stock ($\Delta$OCDR) were added to the basic equation in Table 2, estimated over the period III/1948 to II/1983.[28/] Lagged levels of the ratio (OCDR) were also tested to examine whether financial innovations could permanently alter the <u>growth</u> rate of velocity. A priori, one might expect that the appropriate lag structure for such a variable is the same as that for accelerations in nonadjusted M1 growth, but such a restriction was not imposed. Lags of $\Delta$OCDR up to six quarters were examined, as well as $\sum_{j=0}^{n-1} \beta_j \, \Delta OCDR_{t-j} + \beta_n \, OCDR_{t-n}$, for values of n up to seven quarters. The "best" lag structure was chosen using sequential F-tests.[29/]

In the model without permanent effects ($\beta_n = 0$), the optimum lag length is six quarters and the F-statistic for the vector of lagged changes in the ratio is $F_{7,\ 115} = 2.65$, which is statistically significant at a 95 percent confidence level. The estimated components of this vector are:

$$\underset{(2.88)}{89.245}\ \Delta OCDR_t - \underset{(-2.71)}{84.389}\ \Delta OCDR_{t-1} + \underset{(0.36)}{12.448}\ \Delta OCDR_{t-2}$$

$$- \underset{(-0.43)}{14.668}\ \Delta OCDR_{t-3} - \underset{(-2.24)}{72.102}\ \Delta OCDR_{t-4} + \underset{(2.69)}{85.045}\ \Delta OCDR_{t-5}$$

$$- \underset{(-2.21)}{71.911}\ \Delta OCDR_{t-6}$$

This is a seemingly paradoxical result, as shifts to OCD initially <u>raise</u> velocity significantly, contrary to the hypothesis above, although later the sum effect becomes negative.

Moreover, the model which allows permanent effects on velocity growth has a different and superior lag structure. There the optimum lag structure is

$$\underset{(2.48)}{81.433}\ \Delta OCDR_t - \underset{(-2.67)}{13.850}\ OCDR_{t-1}$$

and again the t-statistics suggest significant positive effects of shifts to OCD but subsequently they are negative. For longer lags, the permanent effect is not significantly different from zero. The F-statistic for the addition of these two variables is $F_{2,\ 120} = 3.87$, which is again significant. To discriminate among the two models, an F-test of the additional information on lags of OCDR from t-2 to t-6 contained in the former model, results in an $F_{5,\ 115} = 2.09$, which is below the critical $F_{5,\ 115} = 2.30$ at the 95 percent confidence level. Thus, it appears that a shift toward OCD raises velocity initially, then lowers it, leaving a permanent negative impact on velocity growth.

Both estimates are contrary to the financial innovations hypothesis, suggesting the possibility of spurious correlations. An examination of the velocity growth residuals and the pattern of adoption of other checkable deposits bears this out. The largest quarterly change in OCDR occurs in the first quarter of 1981 when the ratio rose from 6.4 percent to 12.3 percent due to the extension of NOW accounts nationwide. (The increase in that quarter makes up about a quarter of the total rise in the ratio to 23.7 percent in II/1983.) It so happens that during that quarter, the velocity of M1 <u>rose</u> by an unusually large amount, at a 14.8 percent compound annual rate. The in-sample residual for the equation in Table 2, was relatively large in that quarter (a 3.9 percent compound annual rate), which is significantly above the in-sample standard error.

This surge in velocity and its unexplained residual may simply reflect the previous effects of the record breaking growth of M1 at a 13.3 percent rate from II/1980 to IV/1980, and to an extent, the contemporaneous slowing to a 5 percent rate in I/1981. The prior in-sample experience contains no comparable rapid level or swing in money growth. Lacking better estimates, perhaps the residual should be tentatively referred to as the "Reagan effect" on confidence, reducing the demand for money and raising velocity. Whatever the source of this residual, the results reported above are strongly influenced by it.

To insulate the tests, at least partially, from this development, the unusual velocity experience in that quarter was "zeroed out" by including a (0, 1) dummy variable (D1) on the right-hand-side with a value of one in that quarter. Subsequent effects that might spuriously arise from relating the large change in OCDR in that quarter to subsequent velocity growth residuals were not controlled for, or eliminated.

When this is done, the results change markedly. The current quarter effect of $\Delta$OCDR takes on the expected negative sign but it is not significant in any of the equations estimated. When the model is constrained so that there is no permanent effect of a shift in OCDR on velocity growth, additional lags (up to seven) are insignificant and the best model contains the addition of:

$$\underset{(2.78)}{8.626}\ D1 - \underset{(-1.33)}{69.057}\ \Delta OCDR_t$$

The addition of $\Delta OCDR_t$ is not statistically significant, although the coefficient has the hypothesized negative sign. When permanent effects on velocity growth are allowed, the optimal lag structure is the same, i.e., the additional variables are

$$\underset{(1.49)}{5.856}\ D1 - \underset{(-0.18)}{12.658}\ \Delta OCDR_t - \underset{(-1.13)}{7.627}\ OCDR_{t-1}$$

The former expression is simply a constrained version of the second. The F-statistic for the constraint is $F_{1,\ 119}$ = 1.05, which is not significant, so that the constraint cannot be rejected. Thus, it is concluded that shifts to other checkable deposits do not have permanent effects on velocity growth, or significant permanent or transitory effects on the level of velocity. Only when the unusual rise in velocity in I/1981 is not controlled for, does it appear that shifts to other checkable deposits are significant, but then the initial effect on velocity is counter to the innovations hypothesis.

Hypothesis 6: The Growth of Money Market Instruments Has Affected Velocity

A second financial innovation that is, in many respects, more important than the advent of deregulated interest on checking account balances is the development of money market funds and, more recently, money market deposit accounts. An effect of these funds on velocity has received little or not attention.[30/] All of the other hypotheses explored here are of interest for explaining the decline in velocity. This one, nonetheless, qualifies as a new hypothesis concerning velocity behavior. Moreover, because of the effect of such assets on M2 and its velocity, the hypothesis deserves some attention.[31/] These assets offer limited checking services. Their availability has increased opportunities or the availability of nonmoney financial assets, perhaps with smaller costs of buying and selling such assets in exchange for money. The inventory-theoretic approach to the demand for money would suggest that these opportunities should raise the velocity of M1.

To test this hypothesis, the growth of new money market instruments (MM) relative to the money stock is added to the equation. These instruments are the sum of the money market mutual fund component of M2 and, since IV/1982, money market deposit balances. The ratio of MM to M1 has risen from zero at the end of 1973 to about 10.2 percent at the end of 1979, with most of this growth occurring in 1979. Since then, the ratio rose sharply to 34.0 percent in III/1981, 49.1 percent in III/1982, and with the introduction of MMDAs, surged to 106 percent in II/1983.

Current and lagged values of the change in the ratio, $\Delta$ (MM/M1), are added to the velocity growth equation estimated over the III/1948 to II/1983 period. Sequential F-tests of the current and lagged values up to six quarters earlier, indicate that none of the variables are significant. Moreover, the current change in each case has the wrong sign. For example, when only the current change is included, its coefficient is -5.70 (t = -1.39). This result could arise from the pattern of residuals since III/1981 and the rapid growth of the ratio since then. Indeed, when the same tests are performed over the period ending in III/1981, the current quarter effect is uniformly positive as the hypothesis requires; when only the current quarter change in the ratio is included, its coefficient is 8.38 (t = 0.34). No additional lagged values are significant in the earlier period, for lags up to six quarters, so the overall conclusion of the independence of M1 velocity growth and the use of money market assets holds for the earlier period as well.32/

Hypothesis 7: Increased Variability of Money Growth Has Reduced Velocity

Meltzer and Mascaro, among others, have argued that increased monetary variability has raised the demand for money, raising nominal interest rates and reducing real GNP; thus, their argument suggests that such an increase in variability has reduced velocity.33/

The theoretical mechanism by which this hypothesis works is straightforward. Higher risk increases the demand for money (precautionary). Such a shift, in standard IS-LM models, raises nominal and real interest rates and reduces output, given the price level, or reduces prices, given real output. Aggregate demand declines due to increased monetary volatility. One could raise qualifications to the theoretical results. For example, the rise in interest rates is insufficient to compensate for the risk premium arising from increased volatility so that, on a risk-adjusted basis, real and nominal rates fall. It is also likely that the IS curve is affected by risk, shifting down as households attempt to shift from current consumption to money holdings and firms reduce the investment demand planned at any expected cost of funds. Finally, increased risk raises the cost of doing business, especially for firms where holding stocks of inventory or unfilled orders are important, so that the price level effect is not necessarily unambiguous.

The purpose here is more limited, but more problematic, that is to empirically assess the effects of increased volatility on velocity. The first problem with such an assessment is to define a measure of volatility. The 12-quarter standard deviation of money growth (400 d ln) is used here. The relevant period of past volatility, whether more recent volatility should be weighted more heavily, whether shifts in volatility lead to lagged adjustment of money demand and other variables, and finally the importance of measuring quarterly variability relative to expected money growth are among the critical questions in implementing a test of such a hypotheses.

The second problem, and one which is critical here, is that according to the theory, an increase in volatility has effects on several of the right-hand-side variables in the velocity model, especially interest rates. More important, adjustments of velocity to the rate of change of money growth already embody aspects of the volatility argument. Their effects in the velocity model capture the hypothesized <u>transitory</u> influences of the money stock on the level of velocity. The monetary volatility hypothesis tested here asserts that there are <u>permanent</u> effects of the level of volatility on the level of velocity. The issue is whether variance measures add to the transitory effects of changes in the money stock.

If velocity is a function of variability, then the growth rate of velocity should be a function of changes in variability. The quarterly change in the 12-quarter standard deviation of money growth is added to the Table 2 equation estimated over the period III/1951-II/1983. The sample period begins later because the measure of monetary volatility requires 12 quarters of money growth data; the basic equation is not altered by this change. Up to five lagged quarterly changes were examined, but none of them were statistically significant individually or as a group, including the current change.[34/]

Proponents of the variability hypothesis tend to emphasize known changes in variability, with the presumption that current money growth and its variability are largely unknown. Moreover, lags arising from costly adjustment or information are not emphasized. In such a world, only last period's new information on expected risk or monetary uncertainty would affect velocity. When this variable

($\Delta\sigma_{t-1}$) is added to the equation estimated over the period III/1951 to II/1983, its coefficient is -0.739 (t = -1.17). While it has the right sign, it is statistically insignificant.

Finally, it may be of some use to note a spurious result that appears to lend support to the volatility hypothesis. A preliminary estimation was conducted using the level of monetary variability, including current and up to five lagged values for both periods III/1951-III/1981 and III/1951-II/1983. When lags were included, no t-statistic exceeds one in absolute value. When only the contemporaneous value, $\sigma_t$, or only the lagged value is included, the results were different.

For the full period (to II/1983), the coefficient on the contemporaneous level ($\sigma_t$) is -0.492 (-2.25) and when only the lagged level is included ($\sigma_{t-1}$), its coefficient is -0.426 (t = -1.93). In the constrained version, including $\sigma_t$ and $\sigma_{t-1}$ (or $\sigma_{t-1}$ and $\sigma_{t-2}$) where their coefficients are constrained to sum to zero, the constraints cannot be rejected and the resulting equation outperforms (has a lower standard error) the estimates including only the first level of $\sigma$. More important, when the sample ends in III/1981, both results disappear. Including only $\sigma_t$ results in a coefficient of -0.453 (t = -0.75), and including only $\sigma_{t-1}$ results in a coefficient of -0.242 (t = -0.79).

Thus, the apparent significance of the level of volatility not only fails to meet the correct specification of the hypothesis, it arises for spurious reasons. Note in Chart 3 that the standard deviation of money growth has not changed appreciably since III/1980; over the added period IV/1981 to II/1983, $\sigma_t$ has varied from 4.5 percent to 5.6 percent, averaging 5.0 percent with a standard deviation of only 0.3 percent, about 6 percent of the mean over the period. It appears, then, that the recent significance arises from the fact that monetary variability has been unusually high, while the residual error, without $\sigma$, has been negative, on average, over the seven additional quarters. I conclude that, appropriately tested, monetary variability has played no significant direct role in permanently reducing velocity. There is, on the other hand, growing evidence of the influence of variability on interest rates.[35/]

## Summary of Tests of Alternative Hypotheses

The dominant factor responsible for the large and negative growth rates of velocity in several quarters over the recent past has been the volatile pattern of money growth. This effect has been both direct, as shown in Table 4, and indirect, through the cyclical experience created by the periods of relatively slow money growth. A model of velocity that includes conventional variables that influence the demand for money such as income, interest rates and inflation, as well as factors that temporarily affect the demand for money such as transitory influences of changes in the rates of money or high-employment federal expenditure growth, and aggregate supply shocks such as changes in the relative prices of energy or strike activity, explains recent velocity movements quite well and yields the conclusion above. Conventional factors such as interest rate or inflation movements do not appear to play a major role in explaining recent velocity changes.

Six other hypotheses were assessed using this model of velocity. Except for exchange rate movements, where the results were mixed, none of them were supported by the statistical tests. In particular, it does not appear that the recent decline in velocity was related to a change in the responsiveness of velocity to interest rates or inflation. Moreover, effects on the demand for money due to financial innovations, including shifts to new money market mutual funds, money market deposit accounts, and "higher yielding" other checkable deposits, are not statistically significant. Finally, independent permanent effects of increased volatility of money growth are found to be insignificant, once the transitory effects of money growth and interest rate effects are controlled for (as well as other factors).

Exchange rate movements do appear, at least recently, to have had a significant impact on velocity, but these results are clouded by their insignificance prior to the recent recession. Moreover, the inclusion of the imputed contribution of exchange rate does not alter the basic conclusions for other factors.

## The Implications for Monetary Targeting

There are three principal policy implications arising from these results. The most trivial is that concern over financial innovations or alterations in historical relationships of velocity to its determinants have been unnecessarily diversionary. The hypotheses that these factors have affected velocity are rejected by the tests here.

The second implication is that monetary targeting on a fourth quarter to fourth quarter basis is not sufficient to stabilize GNP growth. The path is important as well. The experience with monetary targeting since III/1979 has been associated with a sharp increase in the volatility of money growth as measured by quarter to quarter accelerations (decelerations) of money growth, by deviations of money growth from trend or by the standard deviation of money growth. This increase is in marked contrast to the earlier experience with monetary targeting before III/1979.

The third implication is that Blinder's maxim (quoted above) is misstated. Recall that his generalization from recent experience is that "he who targets on the growth rate of money when velocity is behaving erratically is looking for trouble." The results here indicate that the appropriate

Averages of the in-sample errors yielded by the Table 2 equation for four-quarter periods shed some light on this issue. For the period III/1949 to III/1981, the average error for four-quarter periods is 0.01 percent and the standard deviation of the four-quarter residual is 0.87 percent, about half the one-quarter standard error shown in Table 2. This standard error indicates considerable precision in controlling GNP growth over four-quarter periods, assuming that the feedback information from past monetary actions is utilized and that contemporaneous information is known. The minimum in-sample error for a four-quarter period is -2.3 percent for the four quarters ending in IV/1953 and the maximum is 2.2 percent for the four quarters ending in IV/1978.

For the recent period of concern (IV/1981 to II/1983), the four-quarter average errors from one-quarter ahead simulations have been "large" and generally negative. Large, however, means that the residual has exceeded 1 percent twice, in I/1983 and II/1983 when it equalled -1.1 percent and -2.3 percent, respectively. The latter, of course, matches the largest in-sample negative error, but it did not arise from unusually large quarterly residuals.

While recent velocity residuals behavior pose a problem for policymakers and economists, it is difficult to regard the experience as a serious challenge to the possibilities for monetary policy or monetary-targeting, in particular. Indeed, most of the apparent problem, the actual decline in velocity, has been the result of policy actions as reflected in the growth rate of money stock M1. Only a small part of the decline has arisen from what appears to be stochastic disturbances. Viewed in that light, the unusual behavior of velocity recently has been the result of unusual monetary policy actions. The solution to the apparent problem is to adopt steadier quarter-to-quarter growth rates of the monetary aggregate, M1.

FOOTNOTES

*The views expressed do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis or the Federal Reserve System. I am indebted to Jane Mack for her excellent assistance.

1/This paper focuses on M1 velocity measured as the ratio of GNP to M1. Other measures that use final sales or different monetary aggregate measures such as the adjusted monetary base or M2 could be examined. Their analysis would differ, but tend to reflect "unusual" movements relative to their postwar patterns. This is especially true for M2, since the ratio (M2/M1) has been fundamentally altered for several years due to financial innovations and deregulation. Final sales measures show less of an apparent shift since 1981, because final sales velocity is less cyclical; transitory inventory shocks also affect GNP velocity. Final sales velocity is discussed in the appendix to this paper.

2/See "The Failure of Monetarism," Business Week, April 4, 1983, pp. 64-67.

3/See also Allan S. Blinder, "Fun With M1 and M2," Washington Post, August 10, 1983.

4/See Federal Reserve Board, Monetary Policy Objectives for 1983, Summary Report of the Federal Reserve Board, February 16, 1983, especially pp. 2, 6, 17 and 18; and Midyear Review of the Federal Reserve Board, pp. 2, 13, 18 and 19. In the latter, the range for M1 was raised further and rebased to II/1983 but no reason was given.

5/See Board of Governors of the Federal Reserve System, Midyear Monetary Policy Report to Congress Pursuant to the Fuel

Employment and Balanced Growth Act of 1978, July 20, 1982; and "Record of Policy Actions of the Federal Open Market Committee, meeting held on October 5, 1982, especially pp. 6-12. The former document explicitly notes the "unusual weakness" in velocity in early 1982 and indicates a willingness and expectation that monetary aggregate growth would put aggregates "close to the upper ends of their ranges, or perhaps above them," (p. 19) at the end of 1982. This intention was expressed as early as February 1982, however, before evidence of the velocity decline was developed, and based on the rapid pace of money growth experienced late in 1981 and in January 1982. Moreover, at the time (July 1982), M1 had then been brought down to just within the top of the 2-1/2 through 5-1/2 percent range, by growth at only a 3.0 percent rate in the six months ending in July. Thus, the initial spurt of M1 to a 12.2 percent growth rate from July to September did not represent a departure from the policy adopted much earlier, or from the short-term objective established in June and reaffirmed in August. In September 1982, M1 was almost exactly at the top of the long-term range set in February 1982.

6/See H. Erich Heinemann, "Monetary Control: A Partisan Debate," New York Times, July 25, 1983.

7/See Jerry L. Jordan, "Financial Innovation and Monetary Policy," in Federal Reserve Bank of St. Louis, Financial Innovations: Their Impact on Monetary Policy and Financial Markets, Proceedings of a Conference held at St. Louis, Missouri, October 1 and 2, 1982 (forthcoming). This argument is contrasted with a maintained consistency over 15 years to employ "ad hoc explanations for why accelerations in money growth are not expansionary and decelerations or declines are not contractionary."

8/See John A. Tatom, "Was the 1982 Velocity Decline Unusual?" Federal Reserve Bank of St. Louis Review (August/September, 1983), pp. 5-15.

9/See Byron Higgins and Jon Faust, "Velocity Behavior of the New Monetary Aggregates," Federal Reserve Bank of Kansas City Review (September-October 1981), pp. 3-17; and "NOW's and Super Now's: Implications for Defining and Measuring Money," Federal Reserve Bank of Kansas City Economic Review (January 1983), pp. 3-18.

10/See R.W. Hafer and Scott E. Hein, "The Shift in Money Demand: What Really Happened?" and Scott E. Hein, "Short-Run Money Growth Volatility: Evidence of Misbehaving Money Demand?" Federal Reserve Bank of St. Louis Review (February 1982), pp. 11-16, and (June/July 1982), pp. 27-36, respectively.

11/See John P. Judd, "The Recent Decline in Velocity: Instability in Money Demand or Inflation?" Federal Reserve Bank of San Francisco Economic Review (Spring 1983), pp. 12-19; Michael W. Keran, "Velocity and Monetary Policy in 1982," Federal Reserve Bank of San Francisco Weekly Letter (March 1983).

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

13/Brayton-Farr-Porter do not present in-sample error statistics for money demand, so it is not possible for the reader to assess the recent stability of money demand for their models. The models are considerably more detailed than that above.

14/It should be noted that they emphasize that the models which do the best, have relatively high interest elasticities of demand for money. The highest interest elasticity for models with a constant elasticity is -0.15 in the San Francisco model. In the monthly Board standard and updated standard models, it is a more conventional -0.13 and -0.12, respectively, while in the quarterly model, it is -0.065. The models examined by Brayton-Farr-Porter with nonconstant interest elasticities show widely varying estimates and elasticities that are estimated to fall or rise with the level of rates. Perhaps the most interesting and appealing model, the nonlinear quarterly model, shows a range of the interest elasticity of M1 from -0.059 to -0.164 for interest rates from 5.5 percent to 20 percent.

15/See John A. Tatom, "Was The 1982 Velocity Decline Unusual?" Federal Reserve Bank of St. Louis Review, 65 (August/September 1983), pp. 5-15.

16/This is not a new discovery, only one that seems to have had little attention. The literature on the cyclical behavior of velocity extends at least back to Henry Thornton, An Inquiry into the Nature and Effects of the Paper Credit of Great Britian, 1802, F.A. v. Hayek, editor, Augustus M. Kelley, 1939, reprinted 1962, especially pp. 96-99.

17/The CEA potential output series breaks in 1953, when the potential output growth rate declines from a 4.5 percent rate for the period 1947-53 to a 3.5 percent rate for 1953-62. See Council of Economic Advisers, Economic Report of the President, 1962, pp. 49-56. My recent estimates show a pronounced break after I/1952. From III/1948 to I/1952, the trend of potential growth is 4.9 percent; from I/1952 to I/1963 or II/1983, the trend is 3.2 or 3.3 percent, respectively.

18/A second degree polynomial was used to estimate these coefficients, an F-test of this restriction failed to reject it at a 5 percent significance level ($F_{3, 112} = 0.97$).

19/Brayton-Farr-Porter indicate that such a level is toward the higher end of the range they observe; see footnote 14 above. Also, note that the lags in quarterly models extend back only three quarters instead of the five used here. This difference may account for the diminished role of interest rates here as compared with their results. On the other hand, with ordinary distributed lags here, using only three lags results in their all being insignificant.

[20]The estimation of this velocity model, like most money demand functions, should presumably employ the use of instrumental variables for several right-hand-side variables. Also, some of the key variables, especially inflation, are expectational so that expected series should be used. These shortcomings are not likely to pose serious problems here, however. For example, the rate of change of the money growth rate, the rate of change in inflation, the change in the GNP gap, and the growth rate of interest rates are not correlated. In the case of expected inflation, most time series models show changes in inflation to follow an MA1 process, so that the use of actual accelerations or decelerations in inflation does not appear to be an important misspecification.

[21]The simulation reported in Table 3 is dynamic; lagged errors are assumed to equal zero. A static simulation of the equation results in a mean error of -1.23 percent for the same period and an RMSE of 2.15.

[22]Milton Friedman, "Why a Surge of Inflation is Likely Next Year," Wall Street Journal, September 1, 1983, presents an analysis of "leading velocity" that includes a major cyclical component (-3 percentage points). His decomposition attributes more of the recent velocity decline to lower interest rates. It should be noted, however, that his cyclical estimate is based on the previous average postwar recession experience. Accounting for the larger than average cyclical decline in

output and employment would reverse Friedman's decomposition. Moreover, this adjustment would eliminate his implausibly high implicit estimates of the cyclically-adjusted own-rate elasticity of money demand of 2.2 and interest rate elasticity of 0.8.

23/See Robert J. Gordon, "Price Inertia and Policy Ineffectiveness in the United States, 1890-1980," Journal of Political Economy (December 1982), pp. 1087-117; and Milton Friedman and Anna Jacobson Schwartz, A Monetary History of the United States, 1867-1960 (Princeton University Press, 1963).

24/When coefficients of the interest rate variables are not constrained by a second degree polynomial, the interest elasticity estimate for the period III/1948 to III/1981 is 0.134 (t = 4.29). A 95 percent confidence interval comfortably includes the interest elasticity (similarly estimated) estimate for the III/1948 to II/1983 period of 0.140 (t = 5.14). This change, or the rise in the estimated interest elasticity from 0.125 to 0.140, when the coefficients are constrained, does not support the hypothesis that the interest elasticity has risen significantly.

25/Another shortcoming of this view is that increases in the exchange value of the dollar do not unambiguously indicate an increase in foreign demand for dollar denominated assets or for money. They could be associated, instead, with reductions in U.S. demand for foreign assets, including currency.

26/ Data for the trade-weighted exchange rate begin in 1967. A (0, 1) dummy variable for the beginning quarter of this variable was insignificant and so omitted.

27/ Out-of-sample static simulations of the equation containing these exchange rate variations are equally impressive. The mean error for the seven quarters (IV/1981 to II/1983) is reduced to -0.44 percent and the RMSE is only 1.37 percent. The seven residuals from IV/1981 to II/1983 are 0.03, -0.11, 2.00, -2.00, 0.11, -2.45, and -0.69 percent, respectively.

28/ Note that if "true money," M*, is M1 less some fraction of other checkable deposits, then dln M* equals dln M + dln (1-fs), where f is the fraction of other checkable deposits that is not in M* and s is the ratio of other checkable deposits to M1. It can easily be shown that the appropriate growth rate of money, $\Delta \ln M^*_t$, equals dln M less $f/(1-fs)\ \Delta s_t$. For a given f and s, the addition of $\Delta s_t$ to equations containing $\Delta \ln M1$ is a test of whether f is zero.

29/ The charge that the data are too limited to test this hypothesis is sometimes encountered. The ratio OCDR has nearly doubled over the past two years (I/1981 to II/1983), but it rose from about 0.5 percent in II/1976 to 1.3 percent in I/1978, and to 6.4 percent in IV/1980. There are at least 7 years of experience that can be used to evaluate the hypothesis. Admittedly, there is a difference between Super-NOWs and other OCD, in that the former do not have interest rate restrictions, but have more substantial minimum and average balance restrictions.

30/Some analysts conjectured that money market deposit accounts would draw idle funds out of M1 balances, especially to meet minimum balances on the new accounts, and thereby lead to a permanent rise in velocity. Also, limited checking availability with money market mutual funds led to the conjecture that MMMFs were a substitute for M1, raising its velocity.

31/See John A. Tatom, "Money Market Deposit Accounts, Super-NOWs, and Monetary Policy," Federal Reserve Bank of St. Louis Review (March 1983), p. 5-16.

32/For both periods, the two financial innovations hypotheses, shifts to money market accounts and other checkable deposits, were examined jointly. Testing the hypotheses jointly does not alter the conclusion that these innovations have had no significant effect on velocity.

33/The principal variable of concern in Angelo Mascaro and Allan H. Meltzer, "Long- and Short-Term Interest Rates in a Risky World," unpublished study for the U.S. Treasury Department (December 1982), is the rate of interest, but the theory is general. See also, Edward Bomhoff, Monetary Uncertainty (Amsterdam: Elsevier Publishers B.V., 1983), and

Milton Friedman, "What Could Reasonably Have Been Expected From Monetarism: The United States," The Mont Pelerin Society, 1983 Regional Meeting, Vancouver, Canada, August 1983.

34/The coefficients (t-statistics in parentheses) for ($\Delta\sigma_t$, . . ., $\Delta\sigma_{t-5}$) are -0.41 (-0.72), -0.76 (-1.19), -0.30 (-0.47), 0.46 (0.75), -0.15 (-0.26) and 0.21 (0.34), for the period III/1951 to III/1983.

35/See the first two references in footnote 33 above.

## APPENDIX
## Final Sales Velocity Growth

Another measure of velocity that has attracted some attention is final sales velocity, or GNP less inventory investment, measured relative to M1. Inventories are highly variable surrounding recessions so that GNP growth is more volatile than final sales; over long periods, however, final sales growth and GNP growth are virtually identical so that the growth of velocity using either measure is similar. Indeed, a primary reason for observed cyclical movements in velocity, measured as (GNP/M1), is that monetary policy actions induce sharp temporary swings in inventory investment.[1/] The purpose of this appendix is to apply the velocity model in the text to the final sales measure of velocity. The various hypotheses tests, beyond the cyclical hypothesis and shocks hypotheses embodied in the model in table 2 in the text, are not examined.

All of the important properties of the GNP velocity model hold for the final sales velocity equation, in particular, money growth has transitory but not permanent effects on velocity growth, with the optimal lag being five quarters, including the current quarter effect. Similarly, changes in relative energy prices, inflation expectations, and high-employment expenditures have transitory influences on final sales velocity growth. Final sales velocity is also cyclical, but not as strongly as GNP growth, since the latter also includes cyclical inventory investment behavior. A search of up to seven lags of long-term interest rate movements revealed that only the change two quarters earlier is significant, the interest elasticity is 0.066 for the III/1948 to II/1983 period, somewhat lower than the interest elasticity estimate for GNP velocity growth, again reflecting a transitory rise in inventory when interest rates depress final sales. The final sales velocity growth equation is given in the table for the period III/1948-II/1983.

The principal differences from the GNP estimate are that the model here excludes insignificant effects of strikes, contemporaneous energy price changes, and longer lags on interest rate movements. No constraints are employed in estimating lag coefficients. The standard error of the estimate is much larger than that of GNP velocity, indicating a buffering effect of inventory movements on GNP growth in response to random disturbances to final sales.

## FOOTNOTE TO APPENDIX

[1] See Tatom, "Was the 1982 Velocity Decline Unusual?" pp. 9-12.

Table
Final Sales Velocity Growth
III/1948-II/1983

$$
\begin{aligned}
\Delta \ln\left(\frac{FS}{MT}\right) = {} & \underset{(10.62)}{2.721} + \underset{(4.86)}{3.032}\,D - \underset{(-9.09)}{0.785}\,\Delta\dot{M}_t - \underset{(-4.52)}{0.453}\,\dot{M}_{t-1} \\
& - \underset{(-3.39)}{0.339}\,\Delta\dot{M}_{t-2} - \underset{(-3.59)}{0.333}\,\Delta\dot{M}_{t-3} - \underset{(-3.28)}{0.306}\,\Delta\dot{M}_{t-4} \\
& + \underset{(4.08)}{0.066}\,\dot{r}_{t-2} - \underset{(-1.64)}{0.038}\,\dot{p}^e_{t-1} + \underset{(2.75)}{0.064}\,\dot{p}^e_{t-2} \\
& + \underset{(3.48)}{0.054}\,\dot{E}_t - \underset{(-0.97)}{0.017}\,\dot{E}_{t-1} + \underset{(1.50)}{0.025}\,\dot{E}_{t-2} \\
& - \underset{(-5.06)}{0.074}\,\dot{E}_{t-3} - \underset{(-9.06)}{0.519}\,\Delta G + \underset{(4.27)}{0.453}\,\Delta\dot{P}_t
\end{aligned}
$$

$\bar{R}^2 = 0.56$ S.E. $= 2.56$ D.W. $= 1.94$ $\hat{p} = \underset{(-3.32)}{-0.27}$