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THE 1981-82 VELOCITY DECLINE:
A STRUCTURAL SHIFT IN INCOME OR MONEY DEMAND?

Robert J. Gordon

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ABSTRACT

The velocity of both M1 and M2 appears to have experienced a sharp and persistent downward shift during 1981 and 1982. The implications of this shift are reexamined within the context of the previous literature on quarterly econometric equations explaining the demand for money.

The traditional specification of money demand equations popularized by Chow and Goldfeld relates real balances to output, interest rates, and lagged real balances, all expressed as log levels. A consistent finding has been a large coefficient on the lagged dependent variable. While this has been interpreted as indicating substantial adjustment costs in portfolio behavior, it is also consistent with lags or "inertia" in price adjustment due to the presence of long-term wage and price contracts. The fact that the traditional Chow-Goldfeld money demand specification encountered large post-sample prediction errors at the time of the first oil shock in 1973-75 may suggest that a new interpretation of adjustment costs is required. It may be costly to adjust nominal balances by shifting to alternative assets, but it is costless for agents to allow real balances to shrink in response to an unanticipated price shock, as in 1973-75.

A substantial amount of evidence is provided on the relationship between money, income, and interest rates, using alternative dynamic specifications. The post-1973 prediction error in a demand equation for M1 is reduced by three-quarters when the equation is specified in nominal first-difference form rather than in the form of real levels in logs. Results indicate much smaller post-1979 prediction errors for equations describing "simple-sum" M2 than for simple-sum M1, Divisia M1, or for Divisia M2 measures of the money supply.

Robert J. Gordon
Department of Economics
Northwestern University
Evanston, IL 60201
(312) 492-3616

I. INTRODUCTION

Monetary Policy and the 1981-82 Decline in Velocity

The behavior of M1 velocity during the period 1981-82 has set off a new debate about monetary policy in general and monetary targeting in particular. Between 1953:Q1 and 1979:Q3 the velocity of M1 grew on average at 3.0 percent per year, but then slowed to a rate of 0.4 percent between 1979:Q4 and 1983:Q2. Over the shorter five-quarter interval between 1981:Q3 and 1982:Q4, the velocity of M1 fell absolutely by 5.5 percent. This episode calls into the question the case for Federal Reserve targeting on the growth rate of M1, long espoused by leading monetarists and adopted by the Fed as a central component of policy during the three years following October, 1979. Because it focussed its monetary policy during this period on M1 growth, the Federal Reserve has been accused of allowing the 1981-82 velocity decline to be transmitted directly into a dramatic drop in the growth rate of nominal GNP, from an average annual rate of 10.4 percent in the three years before 1981:Q3, to an average annual rate of only 2.7 percent between 1981:Q3 and 1982:Q4. This nominal GNP growth rate collapse was the proximate cause of double-digit unemployment in late 1982 and spurred proposals that the Fed shift from targeting on monetary aggregates to direct targeting on the growth rate of nominal GNP.[1]

The implications of the 1981-82 velocity decline for monetary

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[1] Previous discussions include Gordon (1984b, 1984c).

policy depend on its origin. The familiar undergraduate textbook exposition of the IS-LM model shows that shifts in velocity can originate in either the commodity (IS) or money (LM) markets. As Poole demonstrated in his classic (1970) analysis, for any given variance of IS shifts, targeting on the money supply rather than the interest rate reduces the variance of total spending if the demand for money is a stable function of spending and the interest rate, while targeting on the interest rate is more desirable and on the money supply less desirable, the more the money demand function exhibits instability. Thus the behavior of velocity in 1981-82 appears to reopen the debate over the stability of the money demand function that is already treated in the large literature on the "Goldfeld money demand puzzle" (Goldfeld 1973, 1976; Judd-Scadding 1982). If a well-specified money demand equation estimated through 1979 or 1980 proves to be unstable in 1981 and 1982, in the same way that many equations estimated through 1972 proved to be unstable in 1973-76, this would further undermine the case for monetary targeting.

Alternative Approaches

Any attempt to design econometric tests that quantify the extent of instability (if any) in the 1981-82 episode immediately confronts difficult conceptual issues. These arise because the behavior of velocity, i.e., the ratio of nominal spending (PQ) to money (M), is addressed by several hitherto unrelated strands of literature. Clearly the enormous literature on "structural" money demand equations, including that on the Goldfeld puzzle, has implications for velocity behavior. But so also does the literature on St. Louis-type reduced-form equations in which the change in nominal spending is the dependent variable, explained mainly by current and lagged changes in money. Equally relevant are equations explaining money and/or spending in Sims-type vector auto-regressive models (e.g., Sims 1980a, 1980b). More recently Tatom (1983), the first to address the 1981-82 velocity episode quantitatively, has estimated equations that directly specify the rate of change of velocity as the dependent variable.

The relation between the money demand and St. Louis approaches can be discussed initially in terms of a simple money demand equation of the Goldfeld type. The money demand approach involves variables expressed in log levels--the quantity of real balances ($M_t - P_t$), real income (Q_t), one or more interest rates (R_t), and the lagged dependent variable:

$$M_t - P_t = a_0 + a_1Q_t - a_2R_t + a_3(M_{t-1} - P_{t-1}) + e_t^M, \tag{1}$$

where E_t^M is an error term. Taking the derivative of each term with respect to time, we can write the implied evolution of velocity growth as follows, where lower-case letters indicate growth rates:

$$v_t = p_t + q_t - m_t = (1-a_1)q_t + a_2r_t - a_3(m_{t-1}-p_{t-1}) - e_t^M. \tag{2}$$

In this framework the velocity decline of 1981-82 might be explained by a decline in real income growth (if $a_1 < 1$), by negative growth in the interest rate, by rapid growth in real balances last period, or by positive realizations of the growth-rate error term e_t^M--i.e., a continuous increase in the log-level error term E_t^M.

Some of the issues to be addressed in this paper can be introduced by writing an equation that explains nominal GNP growth ($p_t + q_t$) as depending on current and lagged money growth (m_t), changes in the interest rate (r_t), and possible changes in another variable (x_t), e.g., high-employment expenditures in the St. Louis model:

$$p_t + q_t = \beta_0 + \beta_1(L)m_t + \beta_2(L)r_t + \beta_3(L)x_t + e_t^y, \tag{3}$$

where the coefficients are allowed to be polynomials in the lag operator. The path of velocity growth implied by (3) is:

$$v_t = p_t + q_t - m_t = \beta_0 + [\beta_1(L)-1]m_t + \beta_2(L)r_t + \beta_3(L)x_t + e_t^y. \tag{4}$$

It is evident that (2) and (4) differ in numerous ways, yet each purports to describe the evolution of velocity changes. Specification differences may yield differing conclusions regarding the significance, magnitude, and even the sign of shifts in the error terms e_t^M and e_t^y. This paper develops a parallel analysis of the 1981-82 period of velocity decline, and of the 1973-79 period previously identified as involving shifts in the money demand function (1). After an initial discussion of specification and estimation issues, it turns to estimation of equations in which levels and changes in various monetary aggregates, and changes in nominal spending, are alternative dependent variables.

Plan of the Paper

Part II contains a discussion of specification and estimation issues, some of which are summarized in the differences between (2) and (4) above. Among these are the questions of levels vs. changes, real vs. nominal variables, specification of lag distributions, and exogeneity. These issues apply to the interrelated literatures on money demand, money supply, and money reaction functions, as well as to reduced form equations of the St. Louis and Sims types. Then in Part III we turn to the basic characteristics of postwar U. S. data on income, money, velocity, and interest rates. Unique features of the post-1979 period are highlighted, including the differing behavior of simple-sum and Divisia monetary aggregates. The estimated equations for levels and changes in monetary aggregates are contained in Part IV, and for changes in nominal spending in Part V. Considerable attention is paid to the reasons for the differing performance of log level and rate of change specifications, and to the relation between money demand functions and reduced-form income change specifications. The paper concludes in Part VI with a summary of the main results on the nature of velocity shifts, and with some general recommendations for future research on money demand.

II. NEW PERSPECTIVES ON THE ECONOMETRICS OF MONEY DEMAND

Simultaneity and Exogeneity

Equation (1) above is written in exactly the form estimated by Goldfeld (1973). When estimated for 1953:Q1-1972:Q4, a sample period close to that in his original article, the estimated parameters and t ratios are as follows:[2]

$$M_t - P_t = \underset{[0.34]}{0.032} + \underset{[6.28]}{0.045Q_t} - \underset{[-6.03]}{0.013R_t} + \underset{[41.4]}{0.941(M_{t-1} - P_{t-1})}; \qquad (5)$$

$$R^2 = 0.990, \text{ S.E.E.} = 0.00505$$

[2]The only important differences between (5) and Goldfeld's basic equation are that to simplify the subsequent exposition we use only the Treasury bill rate to represent R_t and omit Goldfeld's second interest rate, that on time deposits, and also we do not perform the Cochrane-Orcutt correction for first-order serial correlation.

Without regard to the poor post-sample forecasting performance of (5), to be discussed subsequently, several features immediately stand out. First, the specification relates the current level of real balances to the lagged dependent variable and to two endogenous variables, real output and the nominal interest rate. The specification thus assumes away the questions of simultaneity and exogeneity that play a leading role in recent discussions (Sims, 1980a) of vector-autoregressive (VAR) models. In the specification of a VAR model, separate equations are provided to explain each endogenous variable, in this case real balances, real output, and the interest rate. The usual practice is to omit contemporary right-hand variables at the estimation stage, thus forcing any contemporaneous correlation between, say, real balances and real output, to show up as a correlation between current innovations (error terms) in the real balance and real output equations. Simulations of the effect of an exogenous shock require that some assumption be made about the causal ordering of the relation. As shown by Gordon and King (1982, p. 212-3), it is impossible to avoid making an arbitrary decision about the ordering, and any such choice amounts to a decision about admitting current variables into the estimating equation.

The necessity for this arbitrary choice is usually swept under the rug in the discussion of money demand equations, but it seems just as plausible to assume that money is exogenous in the short run as to assume as in (5) that output is exogenous. In fact the direction of contemporaneous influence may have shifted over time, since the Fed has moved from interest rates to monetary aggregates as its main target. As recognized in the recent surveys by Laidler (1980) and Judd-Scadding (1982), it seems plausible to explore as alternatives to (5) the possibilities that interest rates and/or real GNP adjust to exogenous changes in money. The St. Louis practice of estimating equations for nominal GNP change which include contemporaneous money change on the right-hand side involve an alternative assumption about the direction of short-run dynamic adjustment.

A plausible sequence of events can be illustrated in the IS-LM model. The initial exogenous event is a shift in money supply or demand that moves the LM curve. Because the financial market clears faster than the commodity market, the economy moves initially to the crossing point of the current output level with the new LM curve. Thus the monetary shift and the resulting change in the interest rate occur almost simultaneously (and are observed to be simultaneous in quarterly data). Subsequently the change in the interest rate and in money, through their respective substitution and wealth effects, induce a change in spending and cause the economy to move to the intersection of the IS curve with the new LM curve.[3]

Consider the implications of this sequence for equation (5). If the sequence is initiated by an exogenous increase in the money supply, the contemporaneous correlation between $M_t - P_t$ and R_t is negative. However, if initiated by a shift in the money demand function, that correlation is positive. Each episode of a money demand shift contributes a positive correlation that cancels out part or all of the negative correlation provided by the money supply shifts and thus biases toward zero the allegedly "structural" coefficient α_2. Worse yet, the

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[3]This adjustment process in the IS-LM model is applied to the 1981-82 recession in Gordon (1984), p. 151.

size of this bias depends on the mix of supply and demand shifts occurring in a particular sample period, and out-of-sample drift of the "Goldfeld puzzle" variety could result from a change in this mix. Similarly, the low estimated α_1 coefficient on current output could result simply from lags in the response of output to monetary change.

Serially Correlated Money Demand Shifts and the Effects of Supply Shocks

There remains the interpretation of the large α_3 coefficient on the lagged dependent variable, a universal feature of estimates of the Goldfeld specification, no matter which particular variables are used to represent Q_t and R_t (see Judd-Scadding, 1982, Table 1, pp. 996-7). Consider first the influence of demand shifts that exhibit positive serial correlation. Since there is no other variable on the right-hand side of (5) to explain this source of change in the dependent variable, all of the explanation is attributed to the lagged dependent variable. More generally, the omission from the specification of <u>any</u> relevant variable which happens to exhibit positive serial correlation causes an upward bias on the coefficient of the lagged dependent variable.

More generally the Goldfeld specification may in part represent a spurious relation in the sense of Granger-Newbold (1974), and it may be possible to improve the performance of post-sample dynamic simulations by differencing (Plosser-Schwert, 1978). The large coefficient on the lagged dependent variable may result mainly from a trend in the dependent variable that is not filtered out by prior detrending or by inclusion of a trend as an explanatory variable.

These factors, a downward bias in the coefficients on output and the interest rate, and an upward bias in the coefficient on the lagged dependent variable, help to explain the tendency of the post-1972 predicted values of (5) to drift in dynamic simulations, responding little to changes in output and interest rates and tracking little of the actual observed change in real balances. But there is another important feature of the post-1973 period which has received extensive attention in the literature on price changes (e.g., Gordon, 1977, 1982), but apparently none in the literature on money demand. Despite the much-discussed inertia in the U. S. inflation process, the rate of inflation exhibited a sharp increase in 1973-74. I have previously attributed this jump to the simultaneous effects of an increase in the relative prices of food and energy, of a depreciation in the dollar, and of the termination of the Nixon-era price controls.[4] Then again in 1979-80 there was another sharp acceleration in the inflation rate at the time of the second oil shock ("OPEC II") and following a substantial depreciation of the dollar in 1977-79.

Now consider the response of the real demand for money implied by specification (1) and (5). Goldfeld's inclusion of the lagged dependent variable is based on the partial adjustment scheme of Chow (1966), in which real money balances adjust with a lag to changes in money demand caused by changes in real output and the interest rate. Presumably the reason for the gradual adjustment is the existence of transaction costs which cause optimizing individual agents to choose voluntarily to delay full and instantaneous adjustment to every change in output and the interest rate. What is the impact on individuals of a supply shock that causes a sudden 10 percent jump in the price level? Because transaction

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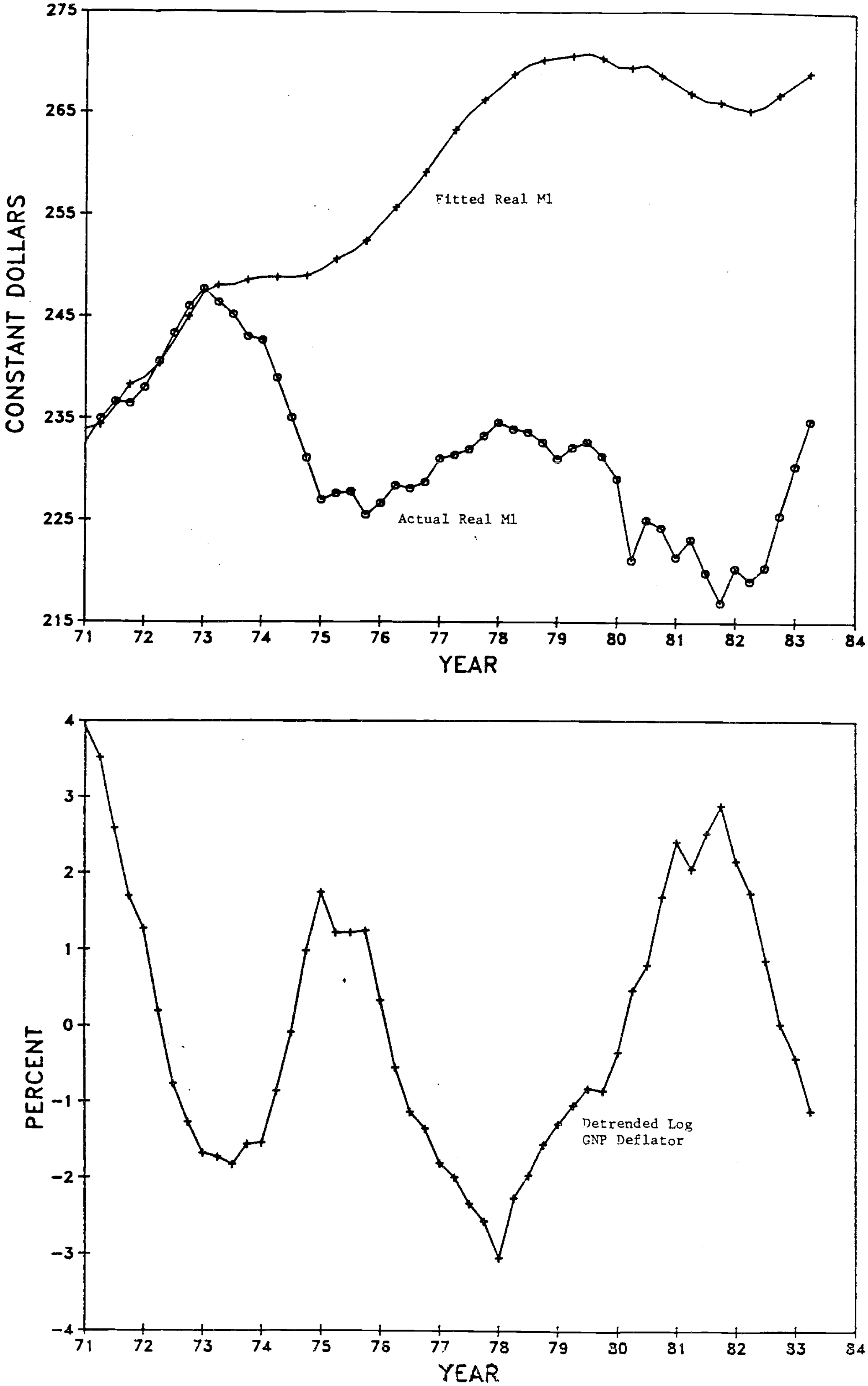
[4]A similar verdict is reached in Eckstein (1980).

costs depend on transfers of nominal balances among currency, demand deposits, and alternative forms of asset holding, each agent minimizes transaction cost by allowing a full 10 percent decline in real balances. There is no lagged adjustment at all in the response of real balances to the supply shock, erroneously labelled in the Goldfeld literature as a "money demand shift."

Thus, in aggregating from the individual to the entire economy, Chow, Goldfeld, and their followers have neglected the fundamentally different ways in which the numerator (M) and denominator (P) of real balances influence individual agents. The adjustment costs affecting nominal balances (M) depend on a set of considerations other than the factors (e.g., length and degree of indexation of wage contracts) that influence the degree of inertia in the adjustment of the price level. The fact that the Goldfeld equation and conventional Phillips-curve wage and price equations went off the track after 1972 does not appear to be mere coincidence. Before 1973, both nominal money growth and inflation were inertia prone, whereas after 1973 the variance of inflation increased dramatically relative to that of money growth. To make this point, Figure 1 displays the actual values of $M_t - P_t$ plotted against the fitted values when (5) is simulated dynamically for the ten years following the end of the 1953:Q1-1972:Q4 sample period. The bottom frame exhibits the detrended log level of the GNP deflator. We note that sharp drops in actual real balances occur precisely at the time of the two major supply shock episodes, 1973-early 1975 and 1979-80.

What seems to have occurred is that Goldfeld estimated his original demand for money equation over the same quiescent 1953-72 period which misled Fama (1975) into claiming that the real interest rate was con-



CONSTANT DOLLARS
275
265
255
245
235
225
215
Fitted Real M1
Actual Real M1
71
72
73
74
75
76
77
78
79
80
81
82
83
84
YEAR
PERCENT
4
3
2
1
0
-1
-2
-3
-4
Detrended Log
GNP Deflator
YEAR

FIGURE 1

stant, and that misled numerous investigators into thinking that the Phillips curve was a stable function of unemployment and lagged wages or prices. The resemblance between Goldfeld's equation and a Phillips curve is evident when we rearrange (1) as follows:

$$P_t - a_3P_{t-1} = -a_0 - a_1Q_t + a_2R_t + M_t - a_3M_{t-1} - e_t^M. \tag{6}$$

Let us assume that the interest rate can be decomposed into a real interest rate, which can be written as a constant plus a linear function of real output, and an expected inflation term, which is simply equal to last period's actual rate of inflation:

$$R_t = p_0 + p_1Q_t + p_{t-1} + e_t^R.$$

We now rewrite (6) with this expression for the interest rate substituted for R_t, and with the additional assumption that, because of the values close to unity for a_3, found in most empirical research, a_3 in (6) can be approximated by 1.0:

$$p_t = a_2p_0 + (a_2p_1 - a_1)Q_t + a_2p_{t-1} + m_t + a_2e_t^R - e_t^M. \tag{7}$$

(Recall that lower-case letters represent rates of change, and so $p_t = P_t - P_{t-1}$, and $m_t = M_t - M_{t-1}$.)

If we can view (7) as an approximation to the reduced-form inflation equation implied by most pre-1973 Phillips curve research, then we can interpret post-1973 prediction errors as caused by the omission of variables to represent the effects of supply shocks and flexible exchange rates. These factors caused the rate of inflation to accelerate relative to the prediction of an equation like (7). Converted back into its "dual," the money demand equation (1), the supply shocks had the effect of introducing a serially correlated negative error term that has been misinterpreted as a "money demand puzzle."

The Case for Spending Changes as the Dependent Variable

The two preceding sections develop two independent sets of reasons to reject (1) as a plausible formulation of the relation between money and spending. First, because the financial market is likely to clear faster than the commodity market, it is likely that money and interest rates are simultaneously determined, and that output experiences its major adjustment in a subsequent period. While all three variables are endogenous, the postulated timing relationship, if true, suggests that treating output rather than money as the dependent variable is more sensible in studies of quarterly dynamics. Second, the role of supply shocks in raising the growth rates of prices and reducing the growth rate of output, while leaving the growth rate of nominal GNP relatively unaffected, suggests that the study of reduced-form macroeconomic relationships may be usefully dichotomized into questions involving (a) the response of nominal GNP changes to changes in nominal money and interest rates, and (b) the division of those nominal GNP changes between inflation and real GNP changes. If we write nominal GNP changes as depending on past changes in money and interest rates, and the inflation rate as depending on its own lagged value, on the level and change in (detrended) output and on the influence of supply shocks (z_t), we can determine output change as a residual. Thus:

$$p_t + q_t = f(m_{t-1}, r_{t-1}); \tag{8}$$

$$p_t = g(p_{t-1}, q_t, Q_{t-1}, z_t); \quad \text{implying} \tag{9}$$

$$q_t = h(m_{t-1}, r_{t-1}, p_{t-1}, Q_{t-1}, z_t). \tag{10}$$

If this dichotomy is valid, then velocity changes are determined completely by (8) and are entirely independent of supply shocks and other factors determining the rate of inflation:

$$v_t = p_t + q_t - m_t = f(m_{t-1}, r_{t-1}) - m_t. \tag{11}$$

We conclude, then, that the topic of this paper is best studied in the framework of (8). One possible econometric specification of (8) is the VAR equation (3) written above in Part I. The conventional Goldfeld money demand specification is rejected, because it mixes up the consequences of supply shocks, portfolio shifts, and lags in the response of spending to financial market events, under the misleading rubric of the "structural money demand equation."

III. BASIC FEATURES OF THE DATA

This section presents descriptive statistics on the growth rates of spending, money, and velocity, as well as on the level of short-term and long-term interest rates. The period between 1953:Q1 and 1979:Q3 is divided into three roughly equal intervals of nine years each. The period after 1979:Q3 is treated as a separate interval, reflecting the widespread interest in the impact, if any, of the change in Federal Reserve targeting procedures that took place in October, 1979. Variables examined in the tables in this section are nominal GNP, nominal final sales, the Treasury bill rate, the corporate bond rate, and six different monetary aggregates. These include the monetary base, simple-sum M1 and M2, and the Divisia growth rates of M1, M2, and M3. In addition six velocity change measures are examined, expressed as the change in nominal final sales minus, respectively, the change in the six monetary aggregates.

Changes in Spending and in Monetary Aggregates

The top half of Table 1 exhibits mean rates of change, and the bottom half displays standard deviations of rates of change, expressed alternatively as one-quarter and four-quarter changes. There are five columns in the table, corresponding to the three nine-year intervals (1953-61, 1962-70, and 1971-79), and two alternative measures for the period extending form 1979:Q4 to 1983:Q2. The straightforward calculation in the fourth column is supplemented by an additional figure in the fifth column that excludes the two quarters most affected by the Carter credit controls (1980:Q2 and 1980:Q3).

The collection of mean rates of change in the upper section of Table 1 confirms the well-known fact that nominal spending and monetary growth accelerated together from the decade of the 1950s to the 1960s and the 1970s. The slowdown in spending growth after 1979 contrasts with an unchanged growth rate for the monetary base and a slight acceleration for the conventional M1 measure; this is the counterpart of the decline in M1 velocity growth that occurred in 1981-82. There is considerable diversity among the six monetary aggregates, with a slight deceleration after 1979 for the conventional M2 measure and a sharp deceleration for the Divisia M2 and M3 aggregates.

A central feature of the recent debate is the differing interpretation by monetarists and nonmonetarists of the Fed's monetary policy between 1979 and 1982. Nonmonetarists claim that the Fed aggravated the

TABLE I

Means and Standard Deviations
of Nominal Spending and Monetary Variables,
Selected Intervals, 1953-83

(All Changes are at Annual Rates)

	1953:Q1 -1961:Q4	1962:Q1 -1970:Q4	1971:Q1 -1979:Q3	1979:Q4 - 1983:Q2 All Quarters	1979:Q4 - 1983:Q2 1980:Q2-3 Omitted
Means (One-Quarter Changes)					
Nominal GNP	4.6	6.9	10.2	7.7	8.3
Nominal Final Sales	4.6	6.9	10.3	7.9	8.4
Monetary Base	1.4	5.3	7.8	7.4	7.4
M1	1.7	4.3	6.6	7.3	7.5
M2	4.0	6.9	10.0	9.1	8.8
Divisia M1	---	---	6.5	7.6	7.3
Divisia M2	---	---	8.4	4.2	3.1
Divisia M3	---	---	8.6	4.1	3.3
Standard Deviations (One-quarter/four-quarter changes)					
Nominal GNP	5.2/3.3	2.6/1.6	3.9/2.0	5.4/3.2	5 1/3.3
Nominal Final Sales	3.6/2.3	2.2/1.4	4.0/1.7	4.3/2.6	3.6/2.6
Monetary Base					
M1	2.0/1.4	2.3/1.6	2.0/1.3	5.2/2.0	3.6/1.7
M2	2.2/1.6	2.3/1.6	3.1/2.4	4.3/1.8	3.9/1.5
Divisia M1	---	---	2.8/1.4	4.4/1.3	3.3/1.0
Divisia M2	---	---	3.5/2.6	5.1/2.1	3.6/1.9
Divisia M3	---	---	3.1/2.4	4.9/1.9	3.6/1.7

Note: Data and calculations for Divisia indexes of monetary change end in 1983:Q1.

1981-82 recession by adhering too closely to the longstanding monetarist recommendation of M1 targeting and thus ignored the consequences of the persistent decline in M1 velocity. Monetarists counter that the Fed's actions bore no resemblance to monetarist recommendations for a constant growth rate monetary rule, since the quarter-to-quarter variance of monetary growth increased markedly after 1979. In fact monetarists have tended to blame several of the unusual features of the 1979-82 period, including high interest rates and an increase in the demand for money, on the high variance of M1 growth.

The bottom half of Table 1 exhibits several measures of the standard deviation of spending and monetary growth. Each cell contains two figures separated by a slanted line; the first represents the standard deviation of successive one-quarter rates of change, and the second represents the standard deviation in quarterly data of overlapping four-quarter rates of change. The four-quarter variance is emphasized here to reflect the finding of previous research on St. Louis-type equations that nominal spending growth responds to a four-quarter moving average of monetary change, not just to a single quarter. When the standard deviation of one-quarter changes of M1 is examined, we find a marked increase from 2.0 percentage points in 1971-79 to 5.2 points in 1979-83. The latter figure is reduced to 3.6 points when the credit control quarters (1980:Q2-3) are omitted, but this still represents almost a doubling of the standard deviation. Much of this increase in M1 variance, however, appears to represent quarter-to-quarter movements that are not sustained over a full year, since the post-1979 increase in the standard deviation of overlapping four-quarter changes is less marked. For conventional M2 and for all three of the Divisia measures, the standard deviation of four-quarter overlapping changes actually decreased after 1979, and this is true even if the middle 1980 quarters are not excluded.

Table 2 uses the same format as Table 1 to summarize the recent behavior of the rate of change of six different velocity measures and of the level of the nominal Treasury bill and corporate bond rates. In the top section the sharp slowdown in velocity growth for the monetary base and M1 is a familiar result, but less well known is the reverse phenomenon--a sharp acceleration in velocity growth for Divisia M2 and M3. The Divisia calculation seems to make no appreciable difference for M1 but converts a mild slowdown in M2 velocity into a marked increase.

The array of standard deviations in the bottom half of Table 2 tells a consistent story of more variable velocity and interest rates after 1979 by every measure shown. It is interesting to note that, when the middle quarters of 1980 are omitted, the standard deviation of velocity growth is lowest for the monetary base on a one-quarter change basis, and lowest for the base and for divisia M1 on a four-quarter change basis. Despite the widespread attention paid to the unstable behavior of M1 velocity in 1981-82, the variance of M2 velocity is actually higher than that of M1 velocity during 1979-83 by both the conventional and Divisia measures.

Table 3 summarizes the changes between the 1971-79 and 1979-83 intervals (with 1980:Q2-3 omitted) for both means and standard deviations. Here again we see that there is a marked slowdown in monetary growth and acceleration in velocity growth for Divisia M2 and M3, but the reverse for conventional M1 and Divisia M1. The ratios of standard deviations demonstrate the familiar increase in M1 variance on a one-

TABLE 2

Means and Standard Deviations
of Nominal Final Sales Velocity Changes
and of Interest Rate Levels,
Selected Intervals, 1953-83

	1952:Q1 -1961:Q4	1962:Q1 -1970:Q4	1971:Q1 -1979:Q3	1979:Q4 - 1983:Q2 All Quarters	1979:Q4 - 1983:Q2 1980:Q2-3 Omitted
Means					
Velocity (One-Quarter Changes)					
Monetary Base	3.2	1.6	2.4	0.3	1.0
M1	2.9	2.5	3.7	0.6	0.9
M2	0.6	-0.1	0.3	-1.2	-0.4
Divisia M1	---	---	3.8	0.2	1.0
Divisia M2	---	---	1.9	3.7	5.2
Divisia M3	---	---	1.6	3.7	5.1
Interest Rate Levels					
Treasury Bill Rate	2.3	4.6	6.1	11.6	11.8
Corporate Bond Rate	4.0	5.9	8.6	13.8	13.6
Standard Deviations					
Velocity (One-Quarter/Four-Quarter Changes)					
Monetary Base	5.2/3.2	2.8/1.5	4.1/2.0	6.0/3.6	4.7/2.9
M1	3.2/2.1	2.8/1.3	3.9/1.3	5.4/3.4	5.4/3.1
M2	4.0/2.8	3.0/1.8	4.8/2.9	6.1/3.7	6.3/3.5
Divisia M1	---	---	4.6/1.6	5.2/3.1	5.2/2.9
Divisia M2	---	---	5.2/3.2	7.0/4.3	6.7/4.3
Divisia M3	---	---	4.7/3.0	6.7/4.2	6.5/4.0
Interest Rate Levels					
Treasury Bill Rate	0.9	1.4	1.7	2.5	2.4
Corporate Bond Rate	0.8	1.7	0.8	1.8	2.0

TABLE 3

Comparison of Means and Standard Deviations
of Spending, Monetary, Velocity, and Interest Rate Variables,
1979:Q4-1983:Q2 vs. 1971:Q1-1979:Q3

	Difference in Means	Ratio of Standard Deviations: One-Quarter Changes	Ratio of Standard Deviations: Four-Quarter Changes
Spending Growth			
Nominal GNP	-1.9	1.3	1.7
Nominal Final Sales	-0.9	0.9	1.5
Monetary Growth			
Monetary Base	-0.4	1.6	1.6
M1	1.1	1.8	1.3
M2	-1.2	1.3	0.6
Divisia M1	0.8	1.2	0.7
Divisia M2	-5.3	1.0	0.7
Divisia M3	-5.3	1.2	0.7
Nominal Final Sales Velocity Growth			
Monetary Base	-1.4	1.1	1.5
M1	-2.8	1.4	2.4
M2	-0.7	1.3	1.2
Divisia M1	-2.8	1.1	1.8
Divisia M2	3.3	1.3	1.3
Divisia M3	3.5	1.4	1.3
Interest Rate Levels		Levels	
Treasury Bill Rate	5.7	1.4	
Corporate Bond Rate	5.0	2.5	

Notes: 1979:Q4-1983:Q2 means and standard deviations exclude 1980:Q2-3. Data for Divisia monetary and velocity growth end in 1983:Q1.

quarter basis, much emphasized by the monetarists, but the less familiar decline in the variance of M2 and all three Divisia indexes on a four-quarter change basis. The standard deviation of velocity increases after 1979 for all monetary measures and does so more on the four-quarter change basis than the one-quarter change basis. This indicates that, while the extra variance of money after 1979 took the form of quarter-to-quarter wiggles that did not persist for a year, the increased variance of velocity took the form of persistent shifts lasting a year or longer.

The apparent persistence of post-1979 velocity shifts has an important implication for policy. While the Fed cannot act rapidly enough to offset velocity movements lasting only a single quarter, it may be able to offset at least part of serially correlated velocity movements lasting a year or more. This is the essence of the case I have made elsewhere in support of a nominal spending growth target for the Fed and it renders ineffective the recent attack by Karl Brunner (1983) on my nominal GNP targeting proposal, since his demonstration is valid only if velocity "is controlled approximately by a white noise process."

IV. ALTERNATIVE EQUATIONS EXPLAINING REAL AND NOMINAL MONETARY AGGREGATES

The Goldfeld Specification

Figure 1 has already exhibited the pattern of persistent serially correlated errors that typically result when a Goldfeld-type demand for money equation is subjected to a post-sample dynamic simulation. In Table 4 we examine the post-sample tracking ability of several versions of the Goldfeld specification and compare these to an alternative arrangement of the same variables. The first line displays the basic result written above as equation (5). Here the dependent variable is the log level of real M1, and the explanatory variables are the logs of real GNP and of the Treasury bill rate, and the lagged dependent variable. The equation is estimated for 1953:Q1 through 1972:Q4, yielding a sample-period standard error of estimate of .00505, or roughly half a percentage point. However, in a dynamic simulation for the period 1973:Q1 through 1979:Q3, the root-mean-squared error (RMSE) is .110, or eleven percent, and the mean error is -.099. Thus on average the actual value of real balances during 1973-79 is ten percent below the predicted value. The three right-hand columns of Table 4 exhibit the standard error when the sample period is extended to 1979:Q3 (.00627), and the performance of the extended equation in a dynamic simulation for 1979:Q4 through 1983:Q2. The 1979-83 RMSE is .03 and mean error is -.023, so that the equation has the same tendency to overpredict real M1, albeit with a smaller error than during 1973-79.

Additional variants of the Goldfeld specification are shown on the next three lines of Table 4. Because a notable feature of the 1981-82 episode is the decline in nominal GNP relative to nominal personal consumption expenditures (PCE), it has been suggested that the velocity puzzle could be partly explained if money demand depended more on consumption than on total spending. However, Table 4 shows that when real PCE is substituted for real GNP in the Goldfeld specification, the in-sample and out-of-sample performance of the equation is uniformly inferior. Versions are also shown with real M2 as the dependent variable, and real GNP and real PCE as alternative income variables, with results that are quite similar to those for M1. Perhaps the only en-

TABLE 4

Equations Explaining Real Monev
and changes in Nominal Money,
Selected Sample Periods

(* indicates significance at the 5 percent level, ** at the 1 percent level)

		Sample Period 1953:Q1-1972:Q4						Sample Period 1953:01-1979:03		
		Coefficients on				Dynamic Simulation 1973:Q1-1979:Q3			Dynamic Simulation 1979:Q4-1983:02	
Dependent Variable	Income Variable	Income Variable	Treasury Bill Rate	Lagged Dependent Variable	S.E.E.	Mean Error	R.M.S.E.	S.E.E.	Mean Error	R.M.S.E.
Log Level of Real Balances										
M1	Real GNP	.045**	-.013**	.941**	.00505	-.099	.110	.00627	-.023	.030
M1	Real PCE	.041**	-.012**	.954**	.00516	-.109	.123	.00634	-.027	.032
M2	Real GNP	.157**	-.023**	.897**	.00651	-.065	.071	.00770	-.016	.027
M2	Real PCE	.115**	-.019**	.937**	.00653	-.100	.110	.00796	-.041	.044
One-Quarter Nominal Changes										
M1	Nom. GNP	.565**	-.038**	.357*	.00459	-.018	.025	.00456	.010	.025
M1	Nom. PCE	.595**	-.030**	.341	.00440	-.027	.036	.00448	-.020	.026
M2	Nom. GNP	.377**	-.037**	.673**	.00360	-.034	.039	.00400	-.007	.014
M2	Nom. PCE	.211	-.024**	.776**	.00370	-.030	.033	.00407	-.034	.036

couraging feature of these results is the relatively small post-sample error for the M2/GNP equation when simulated over the 1979-83 period.

An Alternative Specification

Our discussion above in Part II criticized the Goldfeld specification for applying the Chow gradual adjustment approach to real balances, on the grounds that individual agents face different sets of transaction costs to achieve changes in nominal balances than in response to externally-imposed changes in the price level. Another potential weakness in that specification is the possibility of a spurious regression when a lagged dependent variable is allowed to enter an equation for a variable that is not detrended yet contains a pronounced trend.

The bottom half of Table 4 exhibits equations which alter both of these features of the Goldfeld approach. In place of log levels all variables are defined as first differences. And both the monetary and income variables are expressed in nominal rather than real form. Finally, a series of lagged terms is allowed to enter, rather than just one. Thus the specification can be written as:

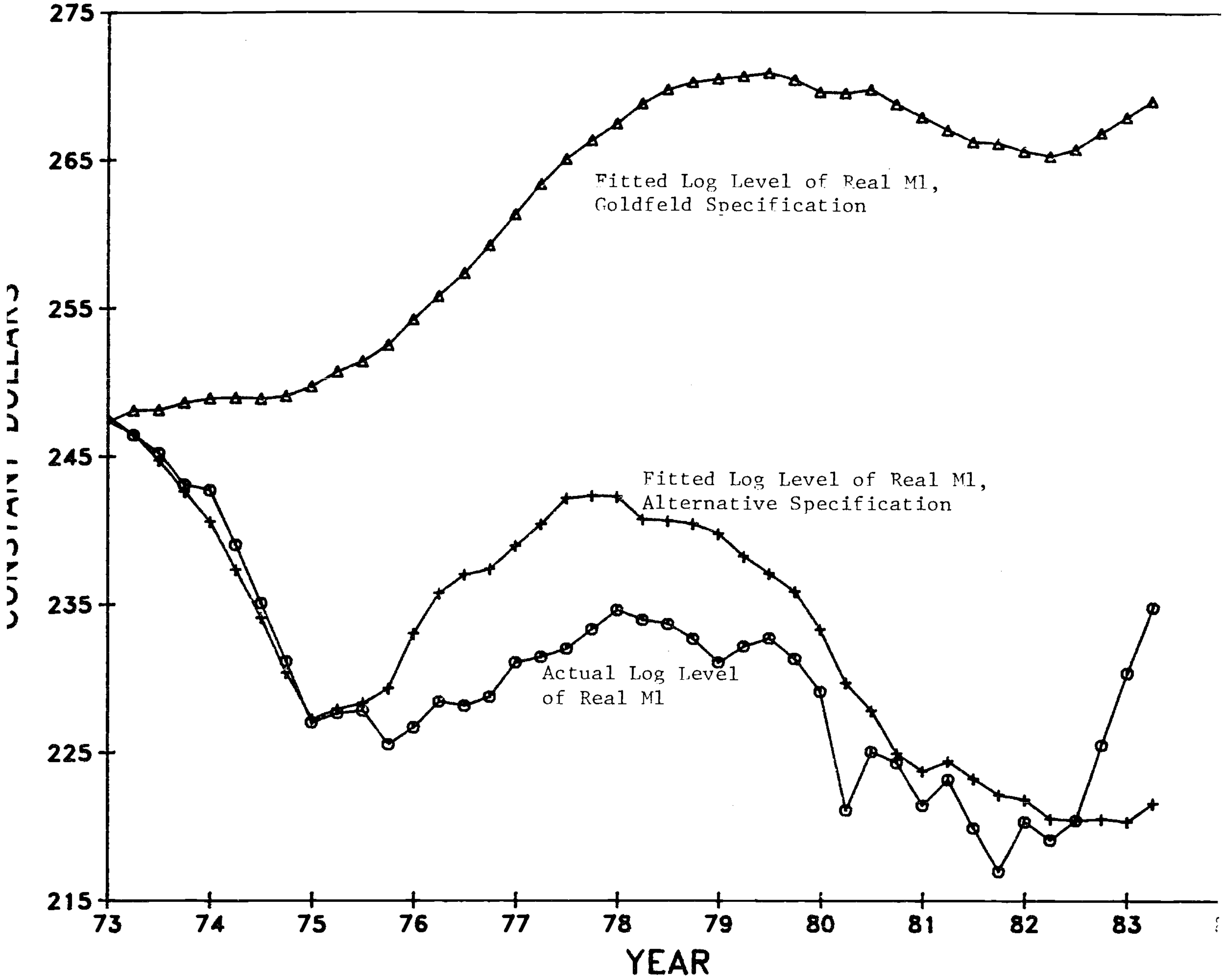
$$m_t = \sigma_0 + \sigma_1(L)(p_t+q_t) + \sigma_2(L)r_t + \sigma_3(L)m_{t-1} + e_t^m, \qquad (12)$$

where the L notation as before indicates a polynomial in the lag operator.

The first line in the bottom half of Table 4 exhibits results when (12) is estimated with the quarterly rate of change of M1 as the dependent variable, and the current and three lagged values of quarterly real GNP changes is the explanatory income variable. Also included are the current and three lagged changes in the Treasury bill rate, and four successive lags of the dependent variable. The coefficients shown in Table 4 are sums of coefficients, and it is evident that the alternative specification yields higher coefficients for income and lower coefficients for the lagged dependent variable than the Goldfeld specification. The standard error of estimate is also lower, and this is particularly true for the extended 1953-79 sample period (units of measurement are comparable across the two specifications when the rate of change is calculated as the first difference in the log). Also impressive is the fact that the standard error does not increase at all when the end of the sample period is extended from 1973 to 1979. Corresponding to this evidence of stability is the important result that the post-sample dynamic simulation for 1973-79 yields a RMSE of only .025 as compared to .110 in the Goldfeld specification, and a mean error of only -.018 as compared to -.099. These measures of simulation performance are made comparable for the one-quarter change specification by calculating the fitted log level of M1 as the 1972:Q4 actual value plus the cumulated one-quarter-change errors.

Figure 2 compares the actual and fitted values from the log-level specification for real balances with implied fitted values from the alternative approach (the latter is the cumulated fitted log level series for nominal M1 minus the actual log GNP deflator). While the alternative specification yields a much improved prediction performance for 1973-83, it still indicates the existence of money demand puzzles in 1976-78 (when there was too little money) and in 1982 (when there was a sharp unexplained increase in the level of real balances).

It is possible to allocate the source of the improvement in


275
265
255
245
235
225
215
73
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77
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79
80
81
82
83
YEAR
Fitted Log Level of Real M1,
Goldfeld Specification
Fitted Log Level of Real M1,
Alternative Specification
Actual Log Level
of Real M1

FIGURE 2

prediction performance for the alternative fitted series in Figure 2 between the two major differences in specification--nominal vs. real and changes vs. log levels. This can be done by calculating 1973-79 post-sample dynamic simulations for four versions: log level real, log level nominal, one-quarter-change real, and one-quarter-change nominal. In each case the sample period is 1953:Q1-1972:Q4, and the errors for the one-quarter-change versions are calculated by cumulating errors into the implied fitted log level series, as described above:

	Prediction Record, 1973:Q1-1979:Q3	
	Mean Error	RMSE
Log Level Real	-.0985	.1101
Log Level Nominal	-.0772	.0919
Change Real	-.0440	.0514
Change Nominal	-.0179	.0252

Thus it appears that both aspects of the change in specification make a major contribution to the improved post-sample predictive performance of the nominal change version. In terms of the absolute reduction in the prediction error, the shift from log levels to rates of change is more important than the shift from a real to a nominal specification.

V. ALTERNATIVE EQUATIONS EXPLAINING CHANGES IN NOMINAL SPENDING

The introduction to this paper contrasted explanations of velocity changes based on equations explaining the evolution of money and alternative equations in which nominal spending is the dependent variable. This section describes results obtained when specification (3) above is estimated for postwar quarterly data on nominal spending, nominal money, and the Treasury bill rate. As summarized in Table 5, the results are identical in all details to those shown in the bottom half of Table 4, except that the roles of the dependent and first independent variable are switched. Now the dependent variable is the one-quarter rate of change of spending, and the list of independent variables includes the current and three lagged changes in money and in the Treasury bill rate, as well as four values of the lagged dependent variable. Table 5 shares with Table 4 its display of results for an "early" sample period (1953:Q1-1972:Q4) and corresponding post-sample dynamic simulation interval (1973:Q1-1979:Q3) and an "extended" sample period (1953:Q1-1979:Q3) and corresponding post-sample dynamic simulation interval (1979:Q4-1983:Q2). The only difference between nominal GNP and final sales is the inclusion of inventory change in the former and its omission from the latter. By including the nominal final sales version of spending, we are interested in whether the inclusion or exclusion of inventory changes makes any difference in the study of shifts in velocity and money demand.

The first few columms of Table 5 display the sums of coefficients in the 1953-72 versions of the equations. In all six versions the current and lagged changes in money are strongly significant, and the current and lagged changes in the Treasury bill rate are significant in all versions but the last one listed. The sum of coefficients on the lagged dependent variable is negative in most versions, highlighting an interesting difference between positive serial correlation of money changes and negative serial correlation of income changes. The modest increase in the standard errors of estimate in all of the spending equations in Table 5, as contrasted with the money change equations in the bottom half of Table 4, is consistent with the higher standard deviations for spending changes observed for the 1950s and 1970s in the statistical summary of Table 1.

The post-sample dynamic simulation performance of all the 1953-72 nominal spending equations is quite poor. The mean errors and RMSE statistics are calculated in the same way as in Table 4, by cumulating one-quarter-change errors into implied fitted values of log levels. Each of the six equations for 1953-72 displays a tendency to drift, with the major error occurring in the form of a substantial underprediction of spending changes in 1976-78. Thus the Goldfeld money-demand puzzle emerges in a stronger form in Table 5 than in the bottom half of Table 4, albeit restated in a different way. The question now becomes, "why was the growth of nominal spending in 1976-78 more rapid than could have been explained by the earlier behavior of money growth and changes in interest rates?" A full resolution of this puzzle is beyond the scope of the paper. A fruitful avenue may lie in an exploration of the difference between nominal and real interest rates; we know that the 1970s were distinguished by low or negative values of real interest rates and by unprecedented increases in the real value of home prices, and these two factors could have contributed to the ebullience of nominal spending growth during the 1976-78 interval.

The post-sample prediction performance of the nominal spending equations in Table 5 is markedly superior when the sample period is extended to 1979:Q3, and dynamic simulations are performed for 1979:Q4-1983:Q2. Leaving aside the results for the nominal PCE variable in the last two lines of the table, it appears that M2 yields a relatively accurate forecasting performance. The mean error in the nominal GNP

TABLE 5

Equations Explaining One-Quarter Changes

Nominal Spending and Consumption,

Selected Sample Periods

(* indicates significance at the 5 percent level, ** at the 1 percent level)

		Sample Period 1953:Q1-1972:Q4						Sample Period 1953:Q1-1979:Q3		
		Coefficients on				Dynamic Simulation 1973:Q1-1979:Q3			Dynamic Simulation 1979:Q4-1983:Q2	
Dependent Variable	Monetary Variable	Monetary Variable	Treasury Bill Rate	Lagged Dependent Variable	S.E.E.	Mean Error	R.M.S.E.	S.E.E.	Mean Error	R.M.S.E.
Nom. GNP	M1	1.369**	0.054**	-0.690**	.00748	.0504	.0618	.00805	-.0214	.0359
Nom. GNP	M2	0.945**	0.067**	-0.550*	.00775	.0540	.0643	.00850	.0075	.0187
Nom. F.S.	M1	0.986**	0.026**	-0.233	.00650	.0514	.0616	.00775	-.0122	.0287
Nom. F.S.	M2	0.735**	0.037**	-0.136	.00663	.0471	.0561	.00815	.0119	.0196
Nom. PCE	M1	1.111**	0.022*	-0.506*	.00548	.0611	.0746	.00625	.0236	.0284
Nom. PCE	M2	0.505**	0.017	0.062	.00595	.0646	.0774	.00658	.0437	.0461

equations that use M2 as the explanatory monetary variable is only .0075, the lowest of any of the post-sample mean errors in Tables 4 or 5. At least in this limited way the results here support the verdict of Tatom (1983) that there was no velocity puzzle in 1981-82, at least in the form of sharp or unprecedented forecasting errors. The RMSE statistics indicate that the post-sample forecasting performance of M2 in both the nominal GNP and nominal final sales equations is superior to that of M1, despite a slightly higher in-sample standard error of estimate. However, M2 does very poorly in tracking the post-sample behavior of nominal personal consumption expenditures (PCE).

While much attention has recently been given to Divisia aggregates of monetary change, there appears to be little evidence in our results of a superior forecasting record of Divisia aggregates in the 1979-83 period. Because the available data on Divisia aggregates extends back only to 1969, we cannot repeat all of the tests displayed in Tables 4 and 5. Instead here we briefly summarize the results of analogous experiments in which changes in nominal spending are explained for the period 1970:Q1-1979:Q3 on the basis of alternative monetary change aggregates and of the other variables listed in Table 5. Then, based on these estimated coefficients, dynamic simulations are calculated for 1979:Q4 through 1983:Q2. Because the results are similar for nominal final sales and nominal PCE, the following table summarizes the results only for equations explaining quarterly changes in nominal GNP:

	1970:Q1-1979:Q3		1979:Q4-1983:Q2 Post-sample Dynamic Simulations			
	S.E.E.		Mean Error		RMSE	
	Simple-sum	Divisia	Simple-sum	Divisia	Simple-sum	Divisia
M1	.00978	.01050	-.0331	-.0565	.0516	.0733
M2	.01000	.00985	-.0116	.0260	.0239	.0313

The estimated equations for changes in nominal money and nominal spending represent alternative rearrangements of the same variables. However, the pattern of lag coefficients in the various equations provides an interesting interpretation of endogeneity-exogeneity relationships among changes in spending, monetary aggregates, and the Treasury bill rate. Because Table 4 includes three lagged values of monetary changes in equations explaining spending, it is possible to use the results already estimated to perform Granger exogeneity tests. This test would, for instance, describe money as exogenous with respect to nominal GNP if lagged values of nominal GNP do not make a significant contribution to equations in which money is the dependent variable.

An entire paper could be written on the nature of exogeneity relationships between money and spending. Here we take advantage of the symmetry between specifications (3) and (12) to provide a brief summary of the role of lagged money and spending variables for the 1953-79 sample period. In the following table each number is a significance level; as before asterisks are used to denote significance levels of 5 percent or better (*) and 1 percent or better (**). Each significance level describes an F test in which a particular set of lagged variables is respectively included and excluded from a particular equation:

Version	Money Equations: Lagged Spending	Money Equations: Lagged Interest Rate	Spending Equations: Lagged Money	Spending Equations: Lagged Interest Rate
M1, Nominal GNP	.376	.004**	.025*	.232
M2, Nominal GNP	.091	.001**	.320	.061
M1, Nominal PCE	.007**	.005**	.173	.923
M2, Nominal PCE	.616	.010*	.943	.164

The implications of this table are surprising, at least to me. The strongest feedback relationship is from the Treasury bill rate to money. This would be compatible with an interpretation of the money equations as describing the evolution of (a) money demand, or (b) a money reaction function when the Fed is trying to stabilize interest rates. The only equation in which there is strong evidence of feedback from spending to money is in the equation explaining changes in M1 as a function of current and lagged changes in nominal PCE. Contrary to the assumption of St. Louis-type equations, three out of the four variants reveal no significant feedback from money to spending. This occurs only in the version explaining changes in nominal GNP growth by current and past changes in M1 growth, but not in versions involving nominal PCE or M2. Equally important is the lack of any strong influence of past interest rate changes on nominal GNP or PCE.

The absence of a strong feedback from money to spending, except for the M1-nominal GNP equation, suggests that further research in this area might well follow the lead of King (1983), who shows that there is a weak influence of past changes in the monetary base on income but a strong influence of past changes in the money multiplier (i.e., M1 divided by the base). King's hypothesis is confirmed in my own preliminary explorations of the relations among the base, multiplier, and spending (Gordon, 1984c). The strong influence on interest rates on money exhibited above suggests the possibility of a channel running between interest rates and the money multiplier to measured monetary aggregates, and from there to spending.

VI. CONCLUSION

This paper took as its point of departure the puzzling decline of velocity in 1981-82. Along the way it examined and criticized the conventional approach to the estimation of money demand equations. Still remaining is a quantitative description of the 1981-82 episode. When the specification of Table 5 is estimated for the "extended" period 1953:Q1-1979:Q3, the following post-sample simulation errors result when nominal GNP changes are used as the dependent variables and M1 and M2 as alternative dependent variables. As before, errors in the one-quarter changes are cumulated to yield a fitted value of the log level of spending, starting from the actual value in 1979:Q3. The following shows the actual and fitted log levels of velocity, calculated as the actual and fitted log levels of nominal GNP minus the log levels of M1 and M2, respectively:

	Log of M1 Velocity			Log of M2 Velocity		
	Actual	Fitted	Error	Actual	Fitted	Error
1981:Q3	1.938	1.933	.005	.549	.518	.031
1981:Q4	1.939	1.933	.006	.534	.507	.027
1982:Q1	1.910	1.936	-.027	.509	.506	.003
1982:Q2	1.918	1.939	-.021	.508	.502	.006
1982:Q3	1.909	1.942	-.034	.488	.489	-.002
1982:Q4	1.883	1.944	-.061	.471	.481	-.010
1983:Q1	1.868	1.944	-.075	.442	.466	-.023
1983:Q2	1.870	1.953	-.083	.448	.464	-.017

The conclusion I reach from these results is that there was a major downward shift in the velocity of M1 in 1981-82, and that this shift displays a persistence over several quarters. Errors for M2 are much smaller, exceeding one percentage point only in 1980:Q4-1981:Q4 (actual velocity higher than predicted) and in 1982:Q4-1983:Q2 (actual velocity lower than predicted). The superior performance of M2 in these experiments does not necessarily mean that M2 can be used as a monetary target, because there seems to be little feedback from lagged M2 changes to current changes in nominal GNP or PCE, as shown in the above summary of exogeneity results.

The main conclusion of this paper is that the standard log-level-real specification used in most previous studies of the demand for money is deeply flawed. However, on the more substantive issue of velocity shifts in 1976-78 and 1981-82, this paper raises as many questions as it settles. By any measure there seems to have been a reduction in money demand and increase in velocity in the 1976-78 period which cannot be explained by any past behavior of changes in spending, money, or interest rates. There was a reverse shift toward higher money demand and lower velocity in 1981-82. The fact that the post-sample simulation errors are much larger for M1 than for M2 in 1981-82 suggests that the underlying explanation in that episode may lie in changing financial regulations that affected components of M1 more than those of M2. But the earlier 1976-78 episode still warrants further investigation, since it does not seem to be synchronized with the timing of financial innovations.

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