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THE SHORT-RUN DEMAND FOR MONEY: A RECONSIDERATION

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ABSTRACT

The partial-adjustment approach to the specification of the short-run demand for money has dominated the literature for more than a decade. There are three basic problems with this approach. First, the same lag structure is imposed on all variables, and each independent variable enters only as a current value. In contrast a rational individual would respond to different variables (income, interest rates, prices) with quite different lags. Second, when the general price level is subject to gradual adjustment but can move quickly in response to supply shocks, the influence of these supply shocks should enter with a negative sign. Third, the estimated equation for real balances may not be a money demand equation at all, but rather its coefficients may represent a shifting mixture of demand and supply responses.

The empirical work examines several alternative dynamic specifications, including a generalized partial adjustment framework and the error-correction model. Both of the latter specifications exhibit greater structural stability after 1973 than the standard partial adjustment model, and the generalized partial adjustment model also yields relatively small errors in post-sample dynamic simulations. Shifts in coefficients as the sample period is extended after 1973 are consistent with the interpretation that the real balance equation no longer traces out structural demand parameters, but rather a mixture of demand and supply responses.

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I. INTRODUCTION

Slightly more than a decade ago, the demand for money was one of the least controversial topics in macroeconomics, both in its underlying theory and in the stability and plausibility of empirical coefficient estimates. Conference sessions on the demand for money were an oasis of tranquility when compared to the controversial state of Phillips curves and aggregate supply macroeconomics in general. While the theory of the long-run demand for money remains essentially intact, a cloud of uncertainty now hangs over the entire subject of the short-run demand for money. This general air of discomfort originates partly in the much-researched "Goldfeld puzzle" (1976) of too little money and too much velocity in the mid-1970s and has been reinforced by the more recent puzzle of too much money and too little velocity in 1981-83.

But there are deeper issues at stake as well. The empirical relationships estimated under the heading of "short-run money demand" even on pre-1973 data yielded a large coefficient on the lagged dependent variable and were plagued by substantial residual autocorrelation. While "inertia" in the adjustment of real money balances was usually explained as resulting from portfolio adjustment costs, Laidler (1982) and Gordon (1984a) have suggested that the short-run money demand function may be partly a Phillips curve in disguise. Sluggish adjustment of real balances may reflect inertia in aggregate price adjustment as well as inertia in portfolio adjustment, and some of the post-1973 instability in the short-run money demand function may be a side effect of shifts in the Phillips curve that occurred as a result of supply shocks in 1973-75.

The recognition of inertia in the inflation process leads to other

reasons for doubt that a short-run structural demand for money function can be identified (Cooley-Leroy, 1981; Coats, 1982). The usual function explains real balances as depending on current output and interest rates and lagged real balances. If prices are sticky, then the burden of achieving short-run adjustment to changing output and interest rates must be carried by the nominal money supply. If the central bank in an attempt to stabilize interest rates allows the money supply to respond instantly and fully to changes in output and interest rates, then these passive shifts in the money supply function will trace out the desired short-run money demand function. But if the central bank abandons interest rate stabilization and instead targets the growth rate of the nominal money supply, then roles are reversed and output and interest rates become endogenous variables responding to money. Although the Federal Reserve neither completely stabilized short-term interest rates nor monetary growth for any substantial interval during the post-Accord period, nevertheless there is widespread agreement that over time the Fed shifted its emphasis from interest rate stabilization to monetary aggregate targeting. If this shift did take place, then coefficients in conventional equations in journal articles on the "demand for money" may actually represent a shifting mixture of demand and supply responses.

This paper attempts to provide a new interpretation of the short-run demand for money that emphasizes the multiple relations among the four major variables that enter the standard money demand function--the nominal money supply, real output, the price level, and the interest rate. Even the most recent investigations and literature surveys on the "Goldfeld money demand puzzle" give little attention to the other functional relations that involve the four variables. These include the

short-run Phillips curve that explains price changes as depending on the level and change in output and (at least implicitly) past changes in money; the short-run money supply function that relates the money supply to the monetary base, interest rates, reserve requirements, and the discount rate; the money reaction function that relates the monetary base to one or more determinants of money demand, including output, prices, and interest rates; and the closely related equations describing the evolution of the rate of change of money as depending on past monetary changes and unemployment, used for the purpose of proxying the concept of "anticipated monetary change" in the work of Barro (1977), Barro-Rush (1980) and their followers. The existence of these "other" relationships linking money, output, the price level, and the interest rate suggests that the short-run money demand functions estimated heretofore may be better viewed as "interesting reduced forms" rather than as structural equations that provide estimates of coefficients corresponding to structural parameters derived from the theory of portfolio behavior. Shifts in coefficients in these reduced forms may not reflect changes in portfolio behavior but rather (a) movements of variables in the "other" equations that are incorrectly omitted from the equation explaining real balances (e.g., supply shocks and price controls in the Phillips curve equation), (b) instability in the coefficients in the "other" equations, or (c) a shift in control regimes by the central bank.

In addition to its discussion of specification issues in this multi-equation context, the paper provides new econometric estimates of equations explaining nominal or real money balances. The primary emphasis in the empirical section is on loosening the constraints on

dynamic adjustment behavior that have been almost universally imposed in the short-run money demand literature. In particular, equations with otherwise identical sets of explanatory variables are estimated for several different classes of dynamic adjustment models, including the conventional "Koyck log level" approach, first-difference changes, and the "error-correction" model advocated by David Hendry (1980a, 1980b), James Davidson (1984a, 1984b), and their collaborators. Differences in results with the alternative dynamic models are discussed within the multi-equation context, and each model is subjected to dynamic post-sample simulations over the decade since 1973 and the four years after the shift in monetary control regimes in late 1979.

In light of the large literature on the conventional approach, including the recent surveys by Laidler (1977, 1980) and by Judd and Scadding (1982), no attempt is made here to review systematically the papers that address the issues under discussion. Instead, the emphasis in the theoretical section is on establishing links between the short-run demand for money function and related topics in time series macroeconometrics, and in the empirical section is on interpreting coefficients estimated for alternative models of the adjustment process in light of the foregoing theoretical analysis.

II. DISTINGUISHING THE SHORT-RUN AND LONG-RUN FUNCTIONS

The Standard Approach

The long-run and short-run concepts of the demand for money are distinguished by the absence of adjustment costs in the former and their presence in the latter. Allowing upper-case letters to stand for log

levels (and reserving lower-case letters subsequently for growth rates), the long-run demand for real balances in logs ($M_t^* - P_t$) depends on a vector of variables (X):

$$(1) \qquad M_t^* - P_t = f(X_t), \text{ or}$$

$$M_t^* = f(X_t) + P_t.$$

The long-run demand for money function assumes that tastes are constant and that individuals can adjust their holdings of money instantly and costlessly to any change in the vector of the variables (X) that determine money holdings. A universal feature of every theory of the long-run demand for money is homogeneity of degree one with respect to the price level. The demand for money is a demand for real balances, and in fact this distinction between real and nominal balances is sometimes invoked to support the feasibility of identifying a demand for money function that is separate from a money supply or money reaction function.

Because of adjustment costs, actual real money balances ($M_t - P_t$) are not always equal to the desired amount ($M_t^* - P_t$). Only a portion (η) of the gap between desired and actual real balances is closed in a single discrete time period (denoted by the subscript "t"), implying that the current level of real balances is a weighted average of the desired level and of lagged real balances:

$$(2) \qquad M_t - P_t = \eta(M_t^* - P_t) + (1-\eta)(M_{t-1} - P_{t-1}), \qquad 0 < \eta < 1.$$

When (1) and (2) are combined, the demand for real balances can be written:

$$(3) \qquad M_t - P_t = \eta f(X_t) + (1-\eta)(M_{t-1} - P_{t-1}).$$

When the vector "X" is made to include real output, a short-term market interest rate, and the interest rate on savings deposits, (3) is exactly the specification used in Goldfeld's original paper (1973) and that yields a post-1972 prediction puzzle.

The long-run function (1) asks how much money individuals would hold in hypothetical alternative circumstances in which the elements of the "X" vector take on different values. The short-run function attributes the sluggish adjustment of the observed values of real balances in response to the more volatile "X" changes to postulated portfolio adjustment costs, with unity minus the estimated coefficient on the lagged dependent variable $(1-(1-\eta)) = \eta$ interpreted as the portfolio adjustment coefficient, and $(1-\eta)/\eta$ as the average adjustment lag. The formulation (3) is not the only possible representation of adjustment costs. Below we examine the implications of several variations, including adjustment costs for nominal rather than real balances (as suggested by Goldfeld, 1976), and separate adjustment processes for nominal balances and prices.

The Short-run Demand for Money: Who Needs It?

The concept of the long-run demand for money plays such a central role in macroeconomic theory that it is difficult to imagine living without it. Numerous theoretical exercises in monetary theory, including the study of optimal inflation and other long-run issues, are based on the standard twin assumptions that the supply of money is exogenous and that the demand for money is stable. Often in such models the price level does the necessary quick maneuvering to equate the

demand for nominal balances to the exogenous supply. Similarly, stable long-run money demand functions, both at home and abroad, are key ingredients in the monetary theory of the balance of payments and the more recent monetary theory of exchange rate determination. In macroeconomic theory for the closed economy, it has become common to specify aggregate real demand (Q) as an inverted money demand function, e.g., $Q = \alpha(M-P) + v$, with interest rates omitted and v treated as white noise.

What seems less clear is the need for a short-run money demand function. This startling assertion may seem even more preposterous to the large number of economists who have struggled to find a stable empirical function. But there are good reasons to doubt the need for this concept, from both a monetarist and a Keynesian perspective.

Monetarists, while providing the intellectual underpinnings for central bank monetary targets, usually show disdain for and disinterest in short-run relationships, reflecting their long time horizon in interpreting economic behavior (M. Friedman, 1968). Thus there was little consternation in the monetarist camp at the velocity collapse of 1981-83. Even though this velocity shift implied that nominal GNP in late 1983 was about 10 percent lower than would have been predicted in mid-1981 based on the historical growth of velocity, most monetarists seemed unperturbed by this shift, and none were observed to confess the need to abandon monetary targets under such circumstances.[1] This indifference to drift in the predictions of short-run money-demand

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[1]The 10 percent figure is the cumulative shortfall of M1 velocity in the eight quarters of 1982 and 1983 from the 1969-80 trend. The corresponding figure for M2 is 9 percent.

functions may reflect the general monetarist belief that any deflection of nominal GNP from the previously anticipated path will be reflected mainly in prices rather than output over any but the shortest time perspective.[2]

Keynesians also have good reasons to be unperturbed by instability in the short-run demand for money function. Some economists, mostly of the Keynesian persuasion, have examined the possibility that the central bank might target nominal GNP rather than one or more monetary aggregates.[3] In one version of nominal GNP targeting, a desired growth path of nominal GNP is chosen that yields the socially optimal combination of inflation (p) and detrended output ($\hat{Q}$), given the constraint imposed by the economy's reduced-form Phillips curve:

$$(4) \qquad p_t = p_{t-1} + \gamma_2 \hat{Q}_t + \gamma_3 z_t + \varepsilon_t^p.$$

Here for convenience only one lagged value of inflation is entered, z_t represents a vector of "supply shock" variables, and ε_t^p is an error term. (4) can be combined with the identity:

$$(5) \qquad \hat{Q}_t \equiv \hat{Q}_{t-1} + y_t - q_t^* - p_t,$$

where $y_t - q_t^*$ is excess nominal GNP growth, i.e., the excess of actual nominal GNP growth (y_t) over the trend or "natural" growth rate of

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[2]Ironically, in light of his earlier writings that stress the long run, M. Friedman has recently made widely publicized forecasts based on extreme short-run quarter-to-quarter relationships. See Guzzardi (1984) and M. Friedman (1984).

[3]Support and analysis can be found in Bean (1983), Feldstein (1984), Gordon (1983), Hall (1983), Meade (1978), and Tobin (1980, 1983).

output (q_t^*). This creates a two-equation model of the dynamic response of output and inflation, that explains the behavior of p_t and $\hat{Q}_t$, given the exogenous variables z_t, y_t and q_t^*. When an empirical estimate of (4) is combined with (5), an optimal path of nominal GNP growth can be determined that minimizes the policymakers' loss function.

If the primary short-run links between the policy instruments under the Fed's immediate control and the nominal GNP target are short-term interest rates, then there is little reason for concern with the short-run demand for money function. Once a nominal GNP target path is chosen from simulations of (4) and (5), the central bank would use its influence on short-term nominal interest rates to "lean against" deviations of forecast nominal GNP growth from the target path without any reference to the money supply.[4] In the context of nominal GNP targeting, then, the supply of one or more arbitrarily defined monetary aggregates would be shifted from central stage to backstage.[5]

It may require some mental readjustment for the economics profession to demote the money supply to a second-order economic

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[4]The scope for stabilizing nominal GNP through an interest-rate feedback rule is demonstrated in Gordon (1984c).

[5]In this sentence the phrase "arbitrarily defined" refers to the meaninglessness of the current distinction between M1 and M2. The balances that I use for all my transactions in a "Fidelity USA" account are included in M2, not M1, whereas the "NOW" and "Super NOW" accounts that provide inferior services at greater cost are included in both M1 and M2. The distinction between M1 and M2 tells us more about the distribution of income and wealth than about the transaction motive for holding money balances, since the only barrier to establishing a multi-purpose interest-paying account like the Merrill-Lynch CMA or Fidelity USA is a purely transitory entry deposit of $10,000 or $20,000. This entry fee is transitory, because one can write a check against it the instant the account is established and thereafter maintain an average balance of close to zero.

variable for short-run analysis. But events have now shown to be obsolete the major reason to pay attention to money, that is, its presumed causal connection with inflation. When the two years 1981-83 are compared with the decade average for 1970-80, the growth rate of M1 accelerated by 2.6 percentage points and that of M2 by 0.7 percentage points. If most economists had been told in 1980 that this acceleration of monetary growth was about to occur, they would have predicted that there would be a further acceleration in inflation. Yet, as everyone knows, the actual outcome was a sharp reduction in the inflation rate, from 9.2 percent in 1980 to 4.2 percent in 1983 for the GNP implicit deflator.[6] The recent experience conflicts with the much-quoted maxim that "inflation is always and everywhere a monetary phenomenon" and suggests its replacement with a new truism that (at least in the long run) "inflation is always and everywhere an excess nominal GNP growth phenomenon." That is, when output is growing at its long-run trend rate and the output ratio $\hat{Q}_t$ is zero, (5) becomes:

$$(5') \qquad p_t = y_t - q_t^*.$$

The foregoing argument can be related to the role of money in the simple IS-LM model of undergraduate macroeconomics textbooks. Once the IS and LM curves are combined to form the economy's aggregate demand schedule, there is no reason for special attention to the money supply. If the supply of money is determined by the central bank

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[6]The growth rate figures for M1 and M2 are quarterly rates expressed on an annual basis for the eight quarters 1981:Q1 through 1983:Q4 compared with the average for the 44 quarters between 1970:Q1 and 1980:Q4. Inflation figures are annual averages.

through its conduct of open market operations and discount rate policy, those instruments (together with fiscal policy) are then the arguments of the aggregate demand function. Most of the "big issues" in macroeconomics, particularly the determinants of output fluctuations and inflation, can be stated in terms of the interaction of this aggregate demand schedule with an aggregate supply function, without need for separate reference to the IS or LM curves. The one important topic that requires the IS-LM apparatus, rather than the aggregate demand curve, is the dependence of the interest rate on the mix of monetary and fiscal policy. But even here the money supply is unimportant once the central bank targets on nominal GNP, since now the "mix" issue can be translated into a positive dependence of the natural rate of interest on the fiscal deficit for any given level of nominal GNP.

These questions about the need for the short-run money demand concept are related to Benjamin Friedman's (1977) critique of short-run monetary targets. Friedman argued that an intermediate target procedure based on the money stock hinders policymakers from making optimal use of available information, but nevertheless money may still be an important information variable. We argue that in a short-run context there is no need for one or more monetary aggregate concepts to intervene between the central bank's direct operating instruments and its ultimate objective of controlling nominal GNP. The money stock continues to be interesting only to the extent that its past values help the central bank forecast deviations of nominal GNP growth from target, or to the extent that money directly determines nominal GNP over and above the contributions of the primary operating instruments of the central bank--unborrowed reserves and short-term interest rates.

III. ADJUSTMENT AT THE INDIVIDUAL LEVEL

Portfolio Adjustment Costs for an Individual

Equation (2) above is the standard approach to modelling the short-run adjustment of real money balances for an individual. This approach, which goes back to Eisner-Strotz (1963) and Griliches (1967), views an agent as facing a tradeoff between the costs of being off his long-run money-demand function (1), and transactions costs that are incurred in proportion to the change per period in real balances. If we write the two types of costs (K_1 and K_2) in quadratic form, and use the i subscript to denote individual variables, we have:

$$(6) \qquad K_1 = k_1[(M^*_{it}-P_t)-(M_{it}-P_t)]^2$$

$$(7) \qquad K_2 = k_2[(M_{it}-P_t)-(M_{i,t-1}-P_{t-1})]^2.$$

The cost-minimizing adjustment will take place according to (2), with the adjustment parameter $\eta = k_1/(k_1+k_2)$.

However, doubt about the appropriateness of this adjustment formulation arises from a consideration of alternative shocks to which our representative agent may be subjected. Let desired holdings of real balances in time period t depend on the expected level of the individual's real income (Q^e_{it}) and of the opportunity cost of holding money (R^e_t), where R_t is properly interpreted as the difference between the interest paid on alternatives to money and the own-interest on money:

$$(8) \qquad f(X_t) = \alpha_0 + \alpha_1 Q^e_{it} + \alpha_2 R^e_t.$$

The standard approach to the specification of the short-run demand for

money assumes that we can maintain the individual adjustment equation for analysis with aggregate data. Thus, dropping the "i" subscript, when Q_t^e and R_t^e are replaced by their own current values, and (6) is substituted into (3), and we allow for an error term, we have the standard Goldfeld specification:

$$(9) \qquad M_t - P_t = \eta[\alpha_o + \alpha_1 Q_t + \alpha_2 R_t] + (1-\eta)(M_{t-1} - P_{t-1}) + u_t.$$

This formulation implies that actual money holdings adjust with the same coefficient (η) to changes in either output or interest rates. Yet a consideration of individual portfolio behavior suggests that in general the adjustment to income and interest rate changes should be quite different.

Let us examine an agent's reaction to the following hypothetical events:

A. An anticipated increase in real income due, say, to a scheduled wage increase occurs on January 1. There is clearly no adjustment cost in raising real balances if wages are paid in the form of money. When income is paid in the form of money, as still occurs for most labor income, dividends, and some kinds of proprietors' income, the relevant portfolio adjustment cost is not in raising real money balances in response to higher income, but rather in reducing the initial receipt through reallocation to other forms of assets, e.g., savings accounts, bonds, and equities.[7]

B. An unanticipated increase in real income causes no more

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[7]The major type of income paid in a form other than M1 is accrued interest on assets not included in M1, where interest is credited to the account rather than paid by check.

adjustment cost in raising real balances than a fully anticipated increase, as long as income is paid in the form of money. The main difference in the case of an income "surprise" is the presumed greater magnitude of portfolio reallocation costs. For an individual managing a portfolio consisting only of M1 and a savings account, when higher income is expected in advance, M1 can be temporarily depleted in anticipation of the forthcoming payment (thus reducing the excess to be transferred to savings), whereas this advance depletion cannot occur in the case of an income surprise.

C. A government transfer payment distributed in the form of money, the classroom example of "helicopter money" or "money rain," is identical to any other form of income surprise received in the form of money. There is no portfolio adjustment cost in raising real balances, but only in reducing them as part of the process of portfolio reallocation.

D. If financial markets operate efficiently, then changes in interest rates are unanticipated. Real money balances adjust slowly to changes in interest rates for two reasons, both the delay in adjusting expectations of the interest rate level in the determination of M_t^*, and the partial closing of any gap between M_t^* and M_t due to transaction costs. Thus at the individual level gradual adjustment of real balances makes sense for interest rates but not for real income, leading us to question the specification in (3) that forces an identical adjustment speed on each component of the "X" vector of independent variables.

E. From the individual point of view, an open-market operation is like any other cause of a change in interest rates. The government bond purchase changes interest rates enough to induce sufficient

portfolio holders to shift from bonds to money. A government transfer financed by bond issue can be viewed as a combination of cases C and E, with the recipients of the transfer payment actually paid in money, while a concurrent open-market purchase shifts the portfolio of other individuals by enough to leave the money supply constant.

F. Finally, consider a "price surprise" due to a higher price of energy. Real income and real balances decline simultaneously. There is no adjustment cost, because the individual does not control the price level. The decline in real balances occurs effortlessly, without any transactions taking place. Once again, as in the cases A, B, and C, the change in real balances is observed to occur simultaneously with the occurrence of the shock, with no adjustment lag or transaction cost incurred.

Revision of the Standard Formulation of Short-run Dynamics

Two changes are suggested by this discussion for the standard dynamic adjustment formulation in equations (2) and (3) above. First, the absence of adjustment costs in response to a price surprise suggests that it is costly to adjust nominal rather than real balances, so that equation (2) should be rewritten in nominal form:

$$(2') \qquad M_t = \lambda M_t^* + (1-\lambda)M_{t-1}, \text{ implying}$$

$$(3') \qquad M_t = \lambda f(X_t) + \lambda P_t + (1-\lambda)M_{t-1}.$$

For estimation purposes (3') can be rewritten

$$(10) \qquad M_t - P_t = \lambda f(X_t) + (1-\lambda)(M_{t-1}-P_t).$$

We can see that (10) is equivalent to the original "real" adjustment

formulation (3), with the addition of a previously omitted variable, the rate of inflation:

$$(10') \qquad M_t - P_t = \lambda f(X_t) + (1-\lambda)(M_{t-1}-P_{t-1}) - (1-\lambda)(P_t-P_{t-1}).$$

In Goldfeld's classic paper (1973) that later yielded the "Goldfeld puzzle," the real adjustment hypothesis was used as in (9). But in his reexamination of the puzzle, Goldfeld (1976) shifted to the nominal adjustment hypothesis. That this switch occurred after the 1973-75 "price surprises" is understandable, although Goldfeld (1976) did not explicitly discuss the implausibility of (2) nor give more than cursory attention to "price effects" (pp. 702-4).

The nominal adjustment scheme of (2') is more plausible than the real adjustment hypothesis of (2), but it still constrains the adjustment of real balances to all the components of the X vector to be identical. An interesting point to note about (10) is that $dP_t/dM_t = 1/\lambda > 1$, whereas in the long run $dP_t/dM_t = 1$. This implausible structure is another symptom of the more general problem that the reasons given for gradual adjustment of nominal or real money balances in the case of an individual actually imply overshooting and non-gradually-adjusting price behavior in the aggregate.[8]

The basic problem encountered in cases A, B, and C, the fact that income is paid in the form of money, can be surmounted by distinguishing between money holdings at the end of the last period and at the beginning of this period. If we denote money holdings at the beginning of a period as M'_t and at the end of a period as M_t, and if we designate

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[8] I am grateful to Jim Clouse for this point.

m'_t as the receipt of money at the beginning of the period in the form of expected or unexpected income or a government transfer payment, then $M'_t = M_{t-1} + m'_t$.

Thus (2') is replaced as the adjustment equation by:[9]

$$(2'') \qquad M_t = \lambda M_t^* + (1-\lambda)(M_{t-1}+m'_t).$$

To provide a specific example of the implications of (2") for empirically estimated money demand equations, let us adopt as a hypothesis about expectations that the income concept relevant for money demand (Q_t^e) is Friedman's "permanent income" (1959), estimated from a geometrically declining distributed lag, and that the interest rate is expected to follow a random walk:

$$(11) \qquad Q_t^e = (1-\beta)\sum_{j=0}^{\infty}\beta^j Q_{t-j}$$

$$(12) \qquad R_t^e = R_{t-1}.$$

When (11) and (12) substituted into (8), and then into (2"), we have:

$$(13) \quad M_t = \lambda[\alpha_0 + \alpha_1(1-\beta)\sum_{j=0}^{\infty}\beta^j Q_{t-j} + \alpha_2 R_{t-1} + P_t] + (1-\lambda)(M_{t-1} + m'_t).$$

Now let us assume that a windfall gain in real income occurs (ε_t^Q), and that it is paid out in money at the beginning of the period ($\varepsilon_t^Q = m'_t$). Then with the additional simplifying assumption that income

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[9] Coats (1982) derives an equation in the form (2") but does not pursue its implications as in (13) - (15) below. Laidler (1982) also introduces the distinction between individual money holdings at the end of last period and at the beginning of this period.

in all previous periods has been a constant equal to Q_0, so $Q_t = Q_0 + \varepsilon_Q$,

we obtain from (13):

$$(14)\quad M_t = \lambda[\alpha_0 + \alpha_1 Q_0 + \alpha_2 R_{t-1} + P_t] + [1-\lambda(1-\alpha_1(1-\beta))]\varepsilon_t^Q + (1-\lambda)M_{t-1}.$$

The second term in brackets is the coefficient on the current innovation in income, and this is quite different from the coefficient ($\lambda\alpha_1$) that is implied by the conventional approach (7). More generally, allowing a separate innovation over each period in the past, (14) can be generalized to:

$$(15)\quad M_t = \lambda[\alpha_0 + \alpha_1(Q_0 + (1-\beta)\sum_{j=1}^{\infty}\beta^j\varepsilon_{t-j}^Q) + \alpha_2 R_{t-1} + P_t] + [1-\lambda(1-\alpha_1(1-\beta))]\varepsilon_t^Q + (1-\lambda)M_{t-1}.$$

An inspection of (15) reveals three aspects of dynamic adjustment that are ignored in the conventional specification (9). These are (a) the inclusion of lagged terms as well as the current term for real output, (b) the difference in the coefficient on the current output innovation from the geometric structure of the coefficients on lagged output innovations, and (c) the different adjustment lag for output changes than for interest rate changes. A further feature of this analysis is the dependence of the coefficient on current output on the assumption that all of the current income innovation is paid in the form of money. If only a fraction is paid as money, the coefficient would be different, and in an aggregate time series context the coefficient on income might change over time with shifts in payment practices and technology.

IV. THE AGGREGATE LEVEL

The preceding analysis follows the usual practice of making no distinction between the individual and aggregate level. The "i" subscript was introduced in the statement of adjustment costs perceived by an individual in equations (6) and (7), but otherwise variables were written without the "i" subscript, as if the reference agent's behavior could be treated without qualification as identical to that of the aggregate economy. Laidler (1982) has also examined the distinction between the individual and aggregate levels, and has developed alternative interpretations of the coefficient on the lagged dependent variable appearing in equations like (3) or (10). We shall not repeat here his analysis of the distinction between portfolio adjustment costs and the formation of expectations about permanent income. Rather, we provide here a further analysis of two other issues that arise at the aggregate level. Individuals are price takers and are not concerned with price adjustment, but prices must somehow adjust at the aggregate level; problems introduced by gradual price adjustment are examined in the next section. Subsequently we examine problems introduced by the possibility that nominal money is partly or completely exogenous at the aggregate level.

The Gradual Adjustment of Prices

Much of my recent research has emphasized an approach to macroeconomic analysis that combines the long-run neutrality aspects of the natural rate hypothesis with the short-run gradual adjustment of prices ("NRH-GAP"). In Gordon (1982a) I showed that this approach could make sense of the behavior of output and price changes in quarterly data back

to 1890 and could explain postwar observations with a standard error several orders of magnitude smaller than the parallel research of Barro and Rush (1980). Some of the implications of gradual price adjustment, together with proposed explanations of sticky price behavior in product markets, are provided in Gordon (1981) and Okun (1981). Here we examine the main implications for the dynamic specification of short-run money demand equations.

Laidler (1982) derives an adjustment equation in which agents are always on their demand function for nominal balances, but in contrast the aggregate price level adjusts slowly to its equilibrium level. Here we allow gradual adjustment of both nominal balances and the price level, and derive a more general dynamic specification of which Laidler's is a special case. To make this more general analysis possible, it is necessary to assume that current nominal GNP (Y_t) is predetermined. Implicitly we assume that nominal GNP evolves as a function of a set of past variables, including bank reserves, interest rates, government spending, and tax rates.

Then, given the current value of nominal GNP, we define two equilibrium concepts, the equilibrium price level and the equilibrium money stock as follows:

$$(16) \qquad P_t^* = Y_t - Q_t^*, \text{ and}$$

$$(16') \qquad M_t^* = Y_t - V(X_t).$$

Here in (16) the equilibrium price level (P_t^*) is defined as that which will make the predetermined current level of nominal GNP (Y_t) compatible with the "natural" level of real GNP (Q_t^*), which is assumed to be exogenous. In (16') the equilibrium money supply (M_t^*) is defined as

that which will be demanded at the current level of nominal GNP, given the velocity of money, which is written as a function of the explanatory variables in the long-run money demand function [$V(X_t)$]. Since nominal GNP can be decomposed into the current price level and current real GNP ($Y_t = P_t + Q_t$), (16') is identical to the long run demand for money function (1) above, with $f(X_t) = Q_t - V(X_t)$. Nominal balances adjust in the standard way, from (2'), with an error term now added:

$$(17) \qquad M_t = \lambda M_t^* + (1-\lambda)M_{t-1} + \varepsilon_t^M.$$

In this section we simplify the exposition by ignoring the distinction in (2") between money at the end of one period and the beginning of the next.

Now let us assume that the price level (P_t) adjusts gradually to its equilibrium level (P_t^*), except when there is a "price shock" (ε_t^P):

$$(18) \qquad P_t = \mu P_t^* + (1-\mu)P_{t-1} + \varepsilon_t^P.$$

We can add more substance to (18) by replacing the ε_t^P term with a coefficient times the supply shock vector from (4) plus a serially uncorrelated error term ξ_t^P,

$$(18') \qquad P_t = \mu P_t^* + (1-\mu)P_{t-1} + \gamma_3 z_t + \xi_t^P.$$

This formulation implies that supply shocks are ignored in the determination of P_t^*.[10]

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[10]This is consistent with the idea that adverse supply shocks have an inflationary impact only to the extent that nominal wages fail to decline to their lower equilibrium level. In this context Q_t^* is interpreted as the "no shock natural output level" that ignores the transitory decline in output after a supply shock that occurs as a

To derive the implications of these assumptions for the behavior of real balances, we first combine (16) and (16') to eliminate Y_t, then substitute the resulting relation between M_t^* and P_t^* into (17), and then use the resulting expression to substitute for P_t^* in (18'), yielding:

$$(19) \qquad P_t = (1-\mu)P_{t-1} - \mu[Q_t^* - V(X_t)] + \frac{1}{\lambda}[\mu(M_t - (1-\lambda)M_{t-1} - \varepsilon_t^M)] + \gamma_3 z_t + \xi_t^P.$$

With some further manipulation, we can write the implied equation for real balances:

$$(20) \qquad M_t - P_t = \mu[Q_t^* - V(X_t)] + \frac{1}{\lambda}[(\lambda-\mu)(M_t - P_{t-1}) + \mu(1-\lambda)(M_{t-1} - P_{t-1})] + \frac{\mu}{\lambda}\varepsilon_t^M - \gamma_3 z_t - \xi_t^P.$$

This form (20) is a convenient one for discussing the implications of gradual price adjustment. First, we note that if agents are always on their money demand function, then $\lambda = 1$. If we neglect the supply shock and error terms, and if we recall that $Q_t^* - V(X_t) = f(X_t)$, then (20) reduces to:

$$(21) \qquad M_t - P_t = \mu f(X_t) + (1-\mu)(M_t - P_{t-1}),$$

which is Laidler's result (1982, equation 23).[11] Laidler claims that lags in price adjustment ($\mu < 1$) provide the "best available explana-

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[11]This result is also repeated in equation (9) in Laidler's comment on Gordon (1984a).

tion" of the presence of the lagged dependent variable in an equation like (21), although from (20) we can see that the matter is more involved if $\lambda \neq 1$, in which case there are two lagged dependent variables ($M_t - P_{t-1}$ and $M_{t-1} - P_{t-1}$), each with coefficients that depend on both the speed of price adjustment (μ) and of portfolio adjustment (λ).

Another implication of the analysis, omitted from (21) but present in (20), is that the supply shock variables (z_t) belong in the money demand equation with a negative sign. The supply shock variables that turn out to be relevant in the Phillips curve (4) are serially correlated and have, taken together, a uniformly positive influence on inflation during almost every quarter between 1973:Q1 and 1975:Q4.

(Insert Figure 1 here)

Figure 1 plots the cumulative values of z_t against the prediction error of the Goldfeld money demand specification (6), and shows that the two move together with opposite signs.[12]

To summarize this section, we note that our basic equation (20) can be related to the standard Goldfeld specification (3) if we make just two changes. First, we must set the two adjustment coefficients equal

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[12]The inflation equation is that estimated in Gordon-King (1982), where the supply shock vector contains four variables, all of which are positive during most or all of the 1973-75 period, (a) the change in the personal consumption deflator minus the change in that deflator net of expenditures on food and energy, i.e., the effect on consumption prices of changes in the relative prices of food and energy, (b) the change in the relative price of imports, (c) the change in the effective exchange rate of the dollar, and (d) a dummy for the rebound after the Nixon price controls that is in effect during 1974:Q2 through 1975:Q1. The top frame plots the dynamic simulation forecasting error of the equation in this paper shown below in this paper in Table 1, column (1).

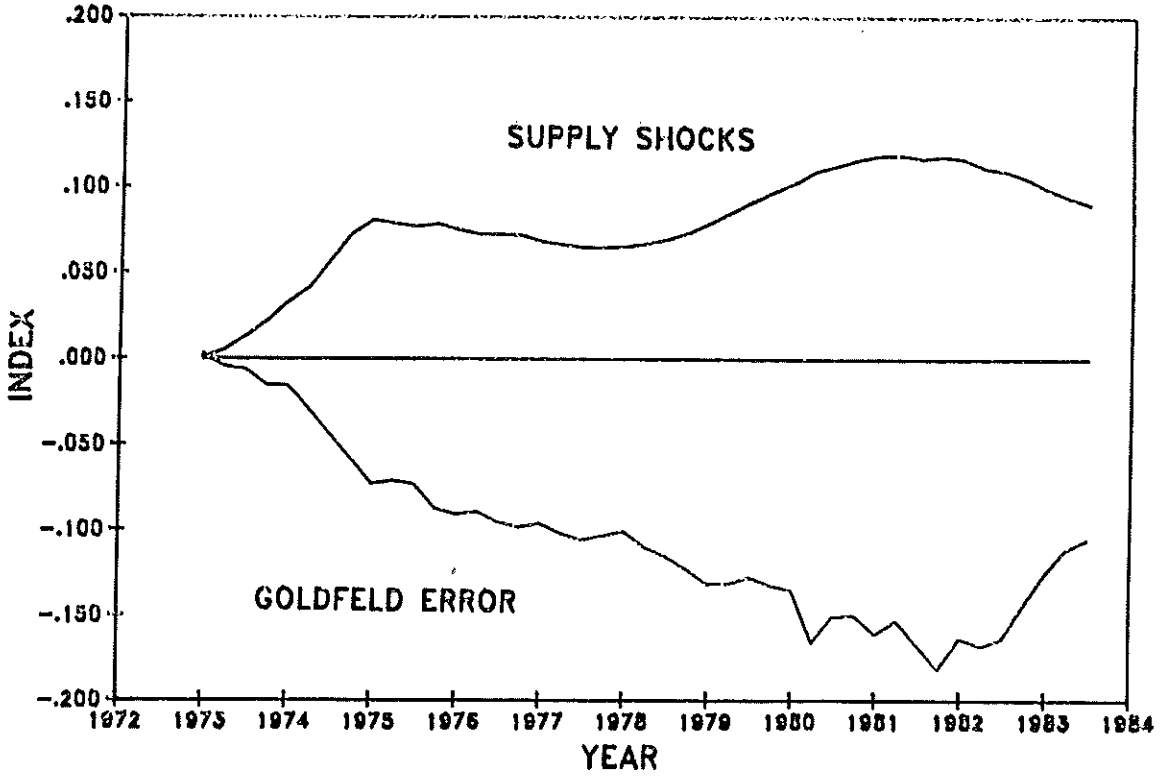
.200
.150
.100
.050
.000
-.050
-.100
-.150
-.200
INDEX
SUPPLY SHOCKS
GOLDFELD ERROR
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
YEAR

Figure 1

to each other ($\mu = \lambda$), and, second, we must drop the price innovation terms. This yields:

$$(22)\quad M_t - P_t = \lambda f(X_t^*) + (1-\lambda)(M_{t-1} - P_{t-1}) + \varepsilon_t^M.$$

Thus the Goldfeld specification is a special case that constrains the two adjustment speeds to be equal and ignores the presence of an error term in the price equation. Because that omitted error term is serially correlated, given the evidence produced by studies of inflation, it is not surprising that serial correlation has been present in estimated versions of (22).

Money Demand or Money Supply Function?

At the individual level, prices, income, and interest rates are all taken to be exogenous, and agents are assumed to adjust nominal balances in response to changes in these exogenous variables. To convert a specification derived at the individual level into one appropriate for estimation with aggregate data, it must be assumed in parallel fashion that the aggregate nominal money supply is completely passive in the face of changes in each argument in the demand for money function. But when the money supply or monetary base is set by the central bank in a way that makes money respond less than completely to the arguments of the money demand function, the estimated parameters cannot reveal the parameters of the demand for money function. This "impossibility theorem" has been discussed by Cooley and LeRoy (1981), who claim that the interest elasticity of money demand cannot be identified. Here we examine identification and simultaneity issues in the context of two specific feedback rules for the central bank.

In this discussion we use a stripped-down demand function for real balances:

$$(23) \qquad M_t^d - P_t = \alpha_1 Q_t + \alpha_2 R_t + \varepsilon_t^d,$$

in an economy that also has a money supply function relating nominal money balances to the monetary base (B), the same interest rate (R), and an error term:

$$(24) \qquad M_t^s = \beta_1 B_t + \beta_2 R_t + \varepsilon_t^s.$$

The first of two alternative monetary control rules, the central bank sets the interest rate at some desired value plus an error:

$$(25) \qquad R_t = R_t^* + \varepsilon_t^R.$$

Implementation of this rule makes the monetary base endogenous with respect to the arguments of the money demand function and the errors in the money supply and interest rate equations:

$$(26) \qquad B_t = \frac{1}{\beta_1}[P_t + \alpha_1 Q_t + (\alpha_2 - \beta_2)(R_t^* + \varepsilon_t^R) + \varepsilon_t^d - \varepsilon_t^s].$$

Possible difficulties in estimating the money demand function (23) include inconsistency in the case of (a) correlation between ε_t^d and ε_t^R, or (b) an effect of the current money supply on R_t^*, which will make ε_t^d correlated with R_t, or (c) autocorrelation of ε_t^d together with an effect of the lagged money supply on R_t^*.

The problem becomes much worse if the Federal Reserve follows a feedback control rule for the monetary base, allowing the desired base B_t^* to respond to output and the inflation rate:

$$(27) \qquad B_t^* = B_0 + \psi_1 Q_t + \psi_2 (P_t - P_{t-1}).$$

In (27) the coefficients ψ_1 and ψ_2 are negative if the Fed pursues a countercyclical policy. With partial adjustment of the actual base to its desired value, we have:

$$(28) \qquad B_t = \phi B_t^* + (1-\phi)B_{t-1} + \varepsilon_t^B$$

$$= \phi[B_0 + \psi_1 Q_t + \psi_2(P_t - P_{t-1})] + (1-\phi)B_{t-1} + \varepsilon_t^B.$$

When (24) is used to substitute for B_{t-1} in (28), and then (28) is substituted back into (24) for B_t, we can write the money supply as:

$$(29) \qquad M_t^S = \beta_1\phi[B_0 + \psi_1 Q_t + \psi_2(P_t - P_{t-1})] + \beta_2 R_t$$

$$+ (1-\phi)[M_{t-1}^S - \beta_2 R_{t-1} - \varepsilon_{t-1}^S] + \varepsilon_t^S + \beta_1\varepsilon_t^B.$$

With some rearrangement we can rewrite (29) as an equation that determines real balances:

$$(30) \qquad M_t^S - P_t = \phi[\beta_1 B_0 - P_{t-1} + \beta_1\psi_1 Q_t] + (1-\phi)(M_{t-1}^S - P_{t-1})$$

$$+ \beta_2[R_t - (1-\phi)R_{t-1}] - (1-\psi_2)(P_t - P_{t-1})$$

$$+ \varepsilon_t^S - (1-\phi)\varepsilon_{t-1}^S + \beta_1\varepsilon_t^B.$$

Here we have real balances determined by all the familiar variables in the standard Goldfeld specification (9) -- Q, R, and lagged M-P. There are a few additional variables, but we have already seen that these were arbitrarily excluded from (9), including the lagged interest rate R_{t-1} (which appeared above in (15)), and inflation (which appeared as an innovation in (20) as well as directly in (10')). We note also that the error term is serially correlated, a usual feature of estimated versions of (9).

A New Interpretation of Parameter Instability

It is clear that estimation of an equation containing most or all of the variables in (30) may tell us nothing about the parameters in the underlying money demand function, if the central bank has followed a control rule like (28). More important, the interpretation of any such estimated equation will be strongly influenced when the central bank shifts from an interest rate rule like (25) to a base rule like (28). For instance, in the Goldfeld equation the coefficient on output should be positive when (25) is in effect, but it may shift to negative when (28) is in effect, since in (30) the output coefficient appears in the form $\phi\beta_1\psi_1$, with ϕ and β_1 positive and ψ_1 negative. Similarly, under the interest-rate rule, the coefficient on the interest rate should be negative (although it may be biased by correlation between the two error terms ε_t^R and ε_t^d). But in (30) the coefficient on the current interest rate is positive and equal to β_2, the interest elasticity in the money supply function, while the coefficient on the lagged interest rate is zero. The closer ϕ is to zero, the closer the interest rate effect approaches a first difference with a positive sum of coefficients. Only if base adjustment in (28) is instantaneous does the lagged interest rate effect disappear.

Some investigators have estimated money demand equations over varying sample periods, with the stated intention of studying changes in the income and interest rate elasticities of the demand for money. Yet such coefficient shifts may tell us more about changes in policy rules than about the characteristics of the underlying money demand function. This task is made particularly difficult in the United States by the eclectic behavior of the Fed, which in some periods has "leaned against the wind"

of changing interest rates without stabilizing them completely, while in other periods has attempted without much success to stabilize the growth rates of one or more monetary aggregates. Thus the typical policy regime has been a mixture of interest rate and money stabilization, and as a result the coefficients in a Goldfeld-type specification are likely to represent a blend of money demand parameters with the supply parameters of (30), and shifts in the estimated coefficients are as likely to tell us about shifts in the policy mix as about responses of money demand behavior.

V. DYNAMIC SPECIFICATION AND ERROR CORRECTION

The previous analysis suggested that the standard approach to the specification of money demand equations is subject to serious problems of misspecification and identification. Simple examples indicated that the usual Goldfeld specification imposes several arbitrary exclusion restrictions, including (a) the omission of lagged output variables in addition to current output, (b) the imposition of the same lag distribution on output and one or more interest rate variables, and (c) the omission of variables to represent supply shocks or other sources of systematic shifts in the price level. The identification problem arises because (d) an econometric equation linking real balances to output and interest rates, with assorted lagged money and price terms, may be derived from either a model of money supply or money demand. The coefficients in the standard equation can be interpreted as parameters of money demand only if the central bank has followed a regime of interest rate stabilization, and instability in coefficients of standard equations may tell us more about shifts in central bank regimes than about

shifts in money demand behavior.

The empirical section of this paper estimates equations in which real balances appear on the left-hand side, and standard explanatory variables (output and interest rates) appear on the right-hand side. The novelty consists of examining results for several alternative arrangements of these variables to determine the effect on previous results of dynamic misspecification (points a and b above); the introduction of proxies for supply shocks from my previous work on inflation to determine the importance of point (c) above, and an interpretation of remaining shifts in coefficients in terms of the money supply vs. money demand identification issue, point (d) above.

Dynamic Specification in the General Single-Equation Case

The standard partial adjustment model is only one of several alternative arrangements of variables, within the general class of autoregressive distributed-lag equations:

$$(31) \qquad d_0(L)Y_t = \sum_{i=1}^{N} d_i(L)X_{it} + \varepsilon_t,$$

where $d_i(L)$ is a polynomial in the lag operator (L). Hendry, Pagan, and Sargan (1982), hereafter HPS, present a useful "typology" of alternative types of dynamic models based on the first-order version of (31):[13]

$$(32) \qquad Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_{t-1} + \beta_3 Y_{t-1} + \varepsilon_t.$$

This is assumed to be a structural relationship, with X_t weakly exogenous and the error term assumed to be white noise. The notable

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[13]An earlier exposition of the typology is provided by Hendry (1980a).

features of (32) are that both current and lagged explanatory variables appear, in addition to the lagged dependent variable, and that both Y_t and X_t are entered as levels rather than differences. The standard partial adjustment model that has dominated the money-demand literature is a special case of (32):

$$(33) \qquad Y_t = \beta_0 + \beta_1 X_t + \beta_3 Y_{t-1} + e_t,$$

where β_2 in (32) is assumed to be zero.

HPS develop a taxonomy of nine different versions of (32), differing in the assumed parameter restrictions, of which partial adjustment (33) is only one. In this section we contrast (33) with two of the eight other possibilities that seem most promising for the study of the short-run dynamics of money demand, that is, the first-difference and error-correction models. Interested readers are referred to HPS for the full typology of nine models, which they point out

> "describe very different lag shapes and long-run responses of Y to X, have different advantages and drawbacks as descriptions of economic time series, are differentially affected by various misspecifications and prompt generalisations which induce different research avenues and strategies." (HPS, 1982, p. 27)

The most important weakness of partial adjustment is the possibility of invalid exclusion of X_{t-1} (or in the more general case all relevant lags of X_t). In turn this may result in reaching the erroneous conclusion that speeds of adjustment are slow when in fact they are not. Further, many derivations of partial adjustment equations like (33) entail that e_t is autocorrelated, leading to the usual statistical problems. These two problems interact, since the

coefficient β_3 is biased upward in the presence of positive serial correlation, leading to an overstatement of the mean adjustment lag $\beta_3/(1-\beta_3)$.[14] Goldfeld and his followers uniformly adopt the Cochrane-Orcutt "rho-correction" method of correction for serial correlation and obtain significant positive values of rho, with little comment regarding the implication that the original untransformed equation like (33) may be misspecified (either by imposing $\beta_2 = 0$ or by omitting one or more relevant explanatory variables).

"Differenced data" models are another special case of (32) that impose two restrictions, $\beta_3 = 1$ and $\beta_2 = -\beta_1$:

$$(34) \qquad y_t = \beta_0 + \beta_1 x_t + e_t.$$

Here we retain our earlier notational device of using lower case letters to represent differences in logs in contrast to upper-case letters that continue to represent log levels. Differencing is often recommended as a simple way to achieve stationarity and to avoid the spurious regression problem, e.g., by Granger and Newbold (1974) and Plosser and Schwert (1978). In an earlier paper on money demand (1984a) I showed that a differenced data specification for the Goldfeld variables yields much smaller post-1972 errors in dynamic simulations than the log-level partial adjustment specification, especially when the dependent variable is differenced nominal rather than real money. However, this result is subject to the same criticism as any application of the general

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[14] Further, Hendry (1980), p. 97, shows that the skewness imposed on the lag distribution by (33) yields a mean lag that is 50 percent higher than the median lag when β_3 is estimated to be 0.95, as sometimes occurs in money demand studies.

differenced form, that the equilibrium solution to (34) is left indeterminant. In fact, if $\beta_0 = 0$ and e_t in (34) is white noise, then there is no long-run relationship between the levels of Y and X.

This disadvantage of the differenced format is avoided by shifting to the "error-correction mechanism" (ECM) that has been studied and advocated by David Hendry (1980a), James Davidson (1984a), and their various co-authors, with applications to the study of U. K. money demand equations in Hendry (1980b), and Davidson (1984b). The ECM takes the original general dynamic equation (32) and imposes the restriction that $\beta_1 + \beta_2 + \beta_3 = 1$:

$$(35) \qquad y_t = \beta_0 + \beta_1 x_t + (1-\beta_3)(X-Y)_{t-1} + e_t.$$

Notice that the differenced equation (34) is a special case of (35) that imposes the additional restriction that $\beta_3 = 1$, implying that since $\Sigma\beta_i = 1$, $\beta_1 = -\beta_2$. The phrase "error correction" comes from the fact that with $y = x = e = 0$, from (35) we have $Y = X$, so that the term $(X-Y)_{t-1}$ measures the "error" in the previous period, and agents "correct" their decision about Y_t in light of this disequilibrium. The differenced format of (34) by contrast allows the level of Y_t to wander about without any tendency toward correction.

Some of the examples in the literature have assumed that in equilibrium Y has a unitary long-run elasticity to changes in X. If we we let g represent the steady state growth rate of both X and Y, then we can substitute into (35) and obtain:

$$(36) \qquad g = \beta_0 + \beta_1 g + (1-\beta_3)(X-Y),$$

implying

$$(37) \qquad Y = X + \frac{\beta_0 - (1-\beta_1)g}{1-\beta_3} .$$

The proportionality assumption might be appropriate for relations that seem to exhibit a unitary elasticity over a long period, e.g., the demand for M2 in the U. S. where the velocity of M2 is observed to be roughly constant since 1960. For the study of some other relationships, e.g., the demand for M1, the proportionality assumption may not be appropriate, and the ECM model can be written:

$$(38) \qquad y_t = \beta_1 x_t + (1-\beta_3)(X-Y)_{t-1} + (\beta_1+\beta_2+\beta_3-1)X_{t-1} + e_t$$

$$= \delta_0 x_t + \delta_1 (X-Y)_{t-1} + \delta_2 X_{t-1},$$

and the restriction $\delta_2 = 0$ in (35) can be tested directly. If the restriction is rejected, then the long-run form becomes

$$(39) \qquad Y = \frac{(\beta_1+\beta_2)X + \beta_0 - (1-\beta_1)g}{1-\beta_3} .$$

Almost all of the empirical applications of the ECM have been to U. K. data, and it remains to be seen whether this approach can shed light on the short-run behavior of the demand for money in the U. S. At least in principle, the main advantage of the ECM approach over simple differencing is that it provides a sensible long-run interpretation, as in (37) and (39).

Application to the Short-Run Demand for Money

The empirical section of the paper studies the sensitivity of coefficient estimates, post-sample dynamic simulation errors, and Chow test measures of structural shift to alternative forms of dynamic specification, while maintaining a uniform sample period and set of

explanatory variables. In each equation the dependent variable is the level or first difference of the log of real M1, using the GNP deflator as the price index to deflate M1. The explanatory variables are real GNP, the GNP deflator, the Treasury bill rate, the savings deposit rate, and the lagged dependent variable.

The only difference in the data used in this paper, compared to most earlier research, concerns the interest rate variables. As stated above in connection with (8), the interest rate that enters into the money demand equation should be the opportunity cost of holding money. Previous research on the demand for M1, by including a short-term market rate like the Treasury bill or commercial paper rate, as well as the savings deposit rate, has implicitly assumed that own-return on M1 is zero. Here we enter both the Treasury bill rate and savings deposit rate as the excess over the own-return on M1, using a series for the latter provided by Michael Hamburger. The Hamburger own-rate series measures only the pecuniary return on M1, not the implicit services received by holders of demand deposits, and ranges from zero before 1963 to a modest 1.3 percent in late 1983. This figure represents the weighted average of the zero pecuniary return on currency and conventional demand deposits, with the positive rates received on NOW, super NOW, and other interest-bearing accounts in M1. The savings deposit rate is the average of one series provided by Goldfeld and one by Hamburger. While these are similar before 1974, after that date they differ, and so we used an unweighted average of the two.

Our choice of alternative dynamic specifications is motivated in part by the analysis of the short-run demand for money in the earlier sections of the paper. Our suggestion that the demand for real balances

should respond with different lags to changes in output, prices, and the interest rate is pursued by introducing a set of additional unconstrained distributed lags into the standard partial adjustment formulation. Our analysis of supply shocks is followed up by introducing a proxy for the effects of supply shocks into the equation for real balances. Finally, the identification problem introduced by the possible existence of a money supply or reaction function helps to guide our interpretation of shifts in coefficients after 1973.

The alternative models of dynamic specification begin with Model A, the standard partial adjustment equation used by Goldfeld and most of his followers. This corresponds in our general notation to (33), which has the notable features that no lagged values of any independent variables are included, and only a single lag of the dependent variable. Model B introduces a proxy for supply shocks into the same partial adjustment specification. Model C loosens the dynamic restrictions imposed by the usual partial adjustment model by adding four lags of each explanatory variable, as well as the second through fourth lag of the dependent variable. This generalized dynamic model explaining the log level of real balances (Y_t) in terms of the lagged values of N explanatory variables (X) can be written as:

$$(40) \qquad Y_t = \beta_0 + \sum_{i=1}^{N} \sum_{j=0}^{L} \beta_{ij} X_{t,t-j} + \sum_{j=1}^{L} \beta_{N+1,j} Y_{t-j} + e_t.$$

Model D is like C but loosens the restriction in the Goldfeld formulation that excludes the current and lagged price level, which amounts to imposing the assumption that the demand for real balances is homogeneous of degree zero in prices instantaneously. Models C and D share with B the inclusion of the same proxy for supply shocks, in each case entered

as a current value and four lagged values.

Model E is the differenced data format for the change in the log of real balances. This is estimated in an unrestricted format that is parallel to (40) and includes the current value as well as four lagged changes for each independent variable, and four lagged changes of the dependent variable. This is the generalization of the "differenced data" model suggested by HPS (1982, p. 27):

$$(41) \qquad y_t = \beta_0 + \sum_{i=1}^{N} \sum_{j=0}^{L} \beta_{ij} x_{i,t-j} + \sum_{j=1}^{L} \beta_{N+1,j} y_{t-i} + e_t.$$

The last model (F) is the error correction model (ECM), generalized to be symmetric with (41) by allowing for multiple lags:

$$(42) \quad Y_t = \beta_0 + \sum_{i=1}^{N} \sum_{j=0}^{L} \beta_{ij} x_{i,t-j} + \beta_{N+1}(X-Y)_{t-1} + \sum_{i=1}^{N} \beta_{N+i+1} X_{t-L-1} + e_t.$$

Here the differenced independent variables are entered exactly as in (41). Then comes the error correction term. The final set of terms consists of each independent variable, entered as one additional lag beyond L, to test the possible non-proportionality of Y to X in the steady state.

VI. EMPIRICAL RESULTS

Basic Results for the Six Models

Results are shown in Table 1. The six columns correspond to the six models, estimated over the sample period 1956:Q3-1972:Q4. In addition to the coefficients (or sums of coefficients where lagged variables are involved), and the adjusted R^2 and standard error, the Cochrane-Orcutt "rho" coefficient of serial correlation is shown for the

TABLE 1

Alternative Dynamic Specifications
for Sample Period 1956:Q3-1972:Q4
and Post-1972 Dynamic Simulation Errors

Dependent Variable: Real M1

	Partial Adjustment, No lags on X	Add Supply Shocks	Add Lags	Add Deflator	Differenced Data	Error Correction
	(A)	(B)	(C)	(D)	(E)	(F)
ΣQ_{t-i}	0.18**	0.17**	0.06	0.14*		
$\Sigma \Delta Q_{t-i}$					0.73	0.68
ΣP_{t-i}				-0.07**		
$\Sigma \Delta P_{t-i}$					-0.03	0.14
ΣR^{TB}_{t-i}	-0.01*	-0.01	-0.01	-0.01		
$\Sigma \Delta R^{TB}_{t-i}$					-0.03*	-0.05
ΣR^{SD}_{t-i}	-0.03*	-0.03*	-0.01	-0.01		
$\Sigma \Delta R^{SD}_{t-i}$					-0.11*	-0.13
Σyz_{t-i}		-1.72*	-0.44	-2.26	-0.35	-0.05
$\Sigma (M-P)_{t-i}$	0.63**	0.60**	0.87**	0.71**		
$\Sigma \Delta (M-P)_{t-i}$					-0.24	-0.93
$(P+Q-M)_{t-5}$						0.14
Q_{t-5}						-0.07
R^{TB}_{t-5}						-0.01
R^{SD}_{t-5}						-0.00
$\bar{R}^2$	.992	.992	.994	.995	.523	.563
S.E.E.(%)	0.50	0.48	0.42	0.38	0.45	0.43
ρ	0.41*	0.46*				
Simulation (% Errors)						
RMSE (to 76/83)	4.7/ 11.8	4.3/10.0	4.9/ 9.8	2.0/ 2.4	3.3/ 6.3	6.1/ 11.0
Mean Error (to 76/83)	-3.9/-10.1	-2.8/-8.5	-3.9/-8.8	0.6/-0.3	-2.1/-5.3	-5.1/-10.0

Note: Asterisks indicate significance at the 5 percent (*) or 1 percent (**) levels. All equations also include constant terms.

Goldfeld specification in the first two columns; this transformation is not applied in the other columns where the inclusion of four values of the lagged dependent variable is sufficient to eliminate the serial correlation problem. The bottom of the table lists both root mean-squared errors and mean errors in dynamic simulations for the 1973-83 period (1973-76 and 1973-83 errors are shown separately). These simulations are "dynamic" in the sense that they generate the lagged dependent variable endogenously while treating as exogenous all of the other variables. The dynamic simulations of the ECM generate the lagged velocity variable endogenously as the ratio of exogenous P+Q to endogenous M.

The first column exhibits the results for the standard "first order" partial adjustment formulation, model A. The familiar post-sample dynamic simulation errors occur when the 1958-72 equation is extrapolated beyond its sample period; the RMSE in the dynamic simulation for 1973-83 is 11.8 percent, and the mean error is -10.1 percent (that is, actual less than predicted). This is the simulation error that is plotted in the bottom frame of Figure 1 above. The long-run elasticities implied by the coefficients for Model A are 0.49 for income and -0.11 for the two interest rates taken together; both of these are smaller than in the original Goldfeld paper, reflecting some combination of data revisions and our slightly different treatment of the opportunity cost of holding money. As always occurs with model A, there is is significant positive serial correlation, as indicated by the significant estimated "rho" coefficient of 0.41.

Model B is identical to model A but adds the current and four lagged values of a proxy for the influence of supply shocks on the rate

of inflation. This proxy is taken from my earlier work on the U. S. inflation process (Gordon-King, 1982), and consists of the actual values of four variables representing the influence of supply shocks, times their coefficients estimated in a reduced-form equation like (4) above that explains the inflation rate.[15] The top frame of Figure 1 shows the cumulative value (i.e., the integral) of this supply-shock proxy. The proxy has the expected negative sign, and the sum of coefficients of -1.72 is significant at the 5 percent level. The simulation errors of model B are uniformly smaller than those of model A, but only by a relatively small amount.

Model C contains the same variables as model B but adds four lagged values of each explanatory variable, as well as lags two through four of the dependent variable. The additional lags are jointly significant, with F(15,41) = 2.00, slightly above the 5 percent significance level of 1.92. However, there is no improvement in the dynamic simulation errors, which are almost as large as for Model A. Also notable is the substantial drop in the sum of coefficients on the supply shock proxy.

A further improvement in fit, and a dramatic improvement in post-sample simulation performance, occurs when the current and four lagged values of the GNP deflator (P) are added to model C, and these results are shown as model D. The sum of coefficients on the price variable is significant at better than the one percent level, and the addition of the price variable also causes the sum of coefficients on the supply-shock proxy to jump to -2.26, which just misses significance at the 5 percent level. The F(5,36) ratio on the addition of the five price

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[15]Details are given in footnote 12 above.

terms is 3.19, as compared to the 5 percent significance level of 2.48. Overall, the F(25,36) ratio on the addition of all the 25 extra terms in model D, as compared to model A, is 2.76, as compared to the one percent significance level of 2.30.

The dynamic simulation performance of model D is dramatically better than any of the others. The root mean squared error for the 1973-83 simulation is only 2.4 percent, as compared to 11.8 percent for model A. The mean error is only -0.3 percent, as compared to -10.1 percent. In fact in 1982:Q4, the 40th quarter of the simulation, the error is only 1.4 percent (although it grows to 5.2 percent in 1983:Q4 as part of the 1982-83 velocity puzzle discussed below).

The final two columns display results for the two models that explain the difference of the log of real balances, the differenced-data model E, and the error correction model F. The standard errors in these equations are comparable to those in models A through D, since the variables are defined as differences in logs (for convenience the stardard errors are multiplied by 100 and displayed as percentages). Models E and F have lower standard errors than models A and B, but higher errors than the unrestricted models C and D. It is interesting to note that models D and E have exactly the same number of degrees of freedom, but the sum of squared residuals for the former is 30 percent less than for the latter. The simulation performance of model E is the second best in Table 1, better than any of the others except for model D.[16]

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[16]The model that performed best in my earlier paper (1984a) was a "nominal" differenced data equation in which the difference of the log of nominal money was regressed on the log difference of nominal GNP and

The results for the error-correction model (F) are not particularly promising. None of the added variables (the lagged levels of velocity, output, and interest rates) is significant, and the F(4,32) ratio on the addition of the four level variables not present in model E is 1.83, well short of the 5 percent significance level of 2.67. Further, the dynamic simulation performance is as poor as that of model A. The best thing that can be said about model F is that the error-correction term, which is lagged velocity (equivalent to X-Y in (42) above) has the correct sign and is of a plausible magnitude. The signs on the other level varibles are also correct, and that on lagged output implies a long-run income elasticity of 0.92 (using equation (39)).

Proponents of the ECM approach might object that there are too many variables and too few degrees of freedom in model F as estimated in Table 1. To address this issue a "truncated model F" was estimated, with 13 fewer variables. Lags two through four were omitted for output and both interest rates, and lags one through four were omitted for the price level. The resulting truncated equation has a slightly lower standard error and higher adjusted R^2, and the coefficient on the error-correction term is close to the 5 percent significance level. However, there is no improvement in the post-1972 simulation performance.[17]

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the other variables in Table 1. A reestimated version of this model does not fit as well as model E, although it yields a slightly better simulation performance.

[17]The root-mean squared and mean errors for 1973-83 are about the same as for model F in Table 1, although the 1973-76 errors are smaller (about the same as those for model E). The long-run income elasticity is 0.85.

The Carter Credit Controls and Shifts in Monetary Regimes

The technique of dynamic simulation is only one of several possible ways in which the hypothesis of structural shift can be assessed. Some writers have objected to the dynamic simulation technique, because it imposes an overly sharp dichotomy between the dependent variable and the explanatory variables, since it generates calculated values only for the dependent and lagged dependent variables while using actual historical values for the explanatory variables. Our earlier discussion of identification issues tends to support this reason for skepticism of dynamic simulation results and suggests that neither output nor interest rates may usefully be treated as exogenous during the post-1972 period if during that period the Federal Reserve attempted (even unsuccessfully) to stabilize the growth rate of the monetary base or money supply.

An alternative measure of structural change is the standard Chow test. In this section we report results for three different Chow tests, each of which is based on an F ratio that compares the residual sum of squares for a shorter period with that for a period with the same initial date but a later termination date. The first test compares equations for 1956-72 and 1956-76, thus measuring the significance of a structural break in 1973:Q1. The second compares equations for 1956-72 and 1956-83, thus providing an alternative measure of the significance of a structural break in 1973. The third test compares equations for 1956-79 and 1956-83, thus measuring the significance of a structural break in 1980:Q1.

In preliminary work on this topic, it became apparent that much of the appearance of a structural shift after 1979 could be accounted for by extremely high residuals in 1980:Q2 and 1980:Q3. These were almost

always of opposite sign and roughly equal in magnitude, supporting the conjecture that the Carter credit controls sharply reduced the money supply in 1980:Q2 and contributed to a rebound of roughly the same magnitude in 1980:Q3. The residuals in those quarters each have a value of between 2 and 3 percent at a quarterly rate, or about 10 percent at an annual rate. The residual sum of squares in the 1956-83 equation declines by as much as one-third when these two quarters are "dummied out," and this seems to be a sensible procedure for such an unusual and short-lived event (analogous to the treatment of auto or steel strikes in studies of employment or productivity behavior).

The results of the Chow tests are shown in Table 2. The first two columns exhibit the alternative tests for a break in 1973:Q1, and the third column shows the test for a break in 1980:Q1 (including the two dummy variables in the extended 1956-83 equation). The results seem to fall into two groups, models A-D and E-F. In the first four models the hypothesis of no structural shift seems to be rejected strongly, although it is interesting to note that the F ratios decline in both size and significance in making the transition from model A to model D. In contrast the hypothesis of no structural shift in 1973 seems to be accepted for models E and F, and of no structural shift in 1979 for model F. The truncated version of model F sends mixed signals.

The results summarized here can be compared with those reported recently by Rose (1984), whose basic equation is a truncated version of the error-correction model.[18] Rose finds no structural shift in the

[18]The study by Rose (1984) differs from ours in a number of details, including the use of seasonally unadjusted data, and a break point of 1974:Q1 rather than 1973:Q1. No attempt has been made here duplicate Rose's results, and so our guess as to the reason for the partial difference in his findings must be viewed as a conjecture.

TABLE 2

Chow Tests for Structural Shift

(Each cell shows an F ratio above and
degrees of freedom below;
Asterisks as in Table 1)

	1956-72 vs. 1973-76	1956-72 vs. 1973-83	1956-79 vs. 1980-83
Models			
A	5.14** (16,61)	3.59** (41,61)	3.57** (13,89)
B	2.44** (16,56)	3.15** (41,56)	4.37** (13,84)
C	1.89 (16,41)	2.90** (41,41)	2.91** (13,69)
D	2.23* (16,36)	2.36** (41,36)	2.34* (13,64)
E	1.35 (16,36)	1.29 (41,36)	1.87* (13,64)
F	1.18 (16,32)	1.43 (41,32)	1.45 (13,60)
Truncated F	1.71 (16,45)	2.18** (41,45)	1.59 (13,73)

mid-1970s "Goldfeld puzzle" period, but a sharp structural shift in the 1980s. The first column of Table 2 also finds no shift in 1973:Q1 for the full and truncated versions of model F. However, our results differ from Rose in finding no evidence of a break in 1980:Q1. This difference is probably due to the absence of any attention by Rose to the special nature of the Carter credit control period.

Further insight on the nature of the post-1972 shift is provided by Table 3, which exhibits parallel equations for the 1956-72 and 1956-83 sample periods for three of the models, A, D, and F. This presentation is intended to focus on the nature of coefficient shifts required by the various models to "explain" the behavior of real balances in the post-1972 period, in light of the identification issue raised earlier in the context of money supply and money reaction functions. There we noted that a shift by the central bank from an interest-rate stabilization regime to a monetary base stabilization regime will tend to cause systematic coefficient shifts in an equation explaining real balances (see equation (30) above). In particular, the coefficient on output may shift from positive to negative, there may be a negative effect of the inflation rate, and the coefficient on the interest rate may shift from negative to positive.

There is some support in Table 3 for this analysis. In all three models there is a marked reduction in the size of the coefficient on output, and that coefficient even turns slightly negative in column (6). The coefficient on both interest rate terms declines in absolute value for models D and F, and the savings deposit rate coefficient changes sign for model A. Further, in model F the coefficients on both the inflation rate and the supply shock proxy become significantly

TABLE 3

Alternative Dynamic Specifications
for Sample Period 1956-Q3-1972:Q4
and Post-1972 Dynamic Simulation Errors

Dependent Variable: Real M1

	Model A		Model D		Model F	
	1956-72	1956-83	1956-72	1956-83	1956-72	1956-83
	(1)	(2)	(3)	(4)	(5)	(6)
ΣQ_{t-i}	0.18**	0.11*	0.14*	0.02		
$\Sigma \Delta Q_{t-i}$					0.68	-0.01
ΣP_{t-i}			-0.07*	0.00		
$\Sigma \Delta P_{t-i}$					0.14	-1.23**
ΣR^{TB}_{t-i}	-0.01*	-0.03**	-0.01	-0.01		
$\Sigma \Delta R^{TB}_{t-i}$					-0.05	-0.01
ΣR^{SD}_{t-i}	-0.03*	0.03**	-0.01	0.00		
$\Sigma \Delta R^{SD}_{t-i}$					-0.13	-0.04
Σyz_{t-i}			-2.26	-0.52	-0.05	-1.95*
$\Sigma (M-P)_{t-i}$	0.63*	0.90**	0.71**	1.00**		
$\Sigma \Delta (M-P)_{t-i}$					-0.93	-0.21
$(P+Q-M)_{t-5}$					0.14	-0.01
Q_{t-5}					-0.07	0.04
R^{TB}_{t-5}					-0.01	-0.01
R^{SD}_{t-5}					-0.00	0.00
Dummy 80:Q2		-0.02**		-0.02**		-0.02**
Dummy 80:Q3		0.01		0.02**		0.03**
$\bar{R}^2$	.992	.999	.995	.991	.563	.718
S.E.E.(%)	0.50	0.65	0.38	0.50	0.43	0.48
ρ	0.41*	0.41*				

Note: Asterisks indicate significance at the 5 percent (*) or 1 percent (**) levels. All equations also include constant terms.

negative, which would be consistent with the negative coefficient on the inflation term in the reduced-form real balance equation (30) above, reflecting the assumed monetary control regime (27) in which the desired base is negatively related to the inflation rate.

Models D and F outperform model A by three criteria--goodness of fit in every sample period, post-1972 dynamic simulation performance, and the significance of a post-1972 structural shift as measured by a Chow test. However, neither model D nor F is satisfactory as a model of the short-run demand for money. In the 1956-83 equation for model D (Table 3, column 4) no variable is significant except for the lagged dependent variable and the credit control dummies. The error-correction model F has no significant coefficients except for the inflation rate, the supply shock proxy, and the credit control dummies. It is hard to avoid reaching the conclusion that these long-period equations represent a rather futile attempt to fit a single reduced-form equation for real balances to a period when the underlying real balance equation was "changing its stripes" from something like a partial adjustment model for money demand (best described for 1956-72 by model D) to something like a money reaction function of the central bank. The fact that the coefficients on output in columns (4) and (6) are essentially zero seems consistent with the notion that the true underlying coefficient shifted from positive to negative in the wake of the conjectured change in control regimes.

The 1981-83 "Velocity Puzzle"

Throughout most of the empirical section of this paper the primary emphasis has been on an examination of the stability of alternative

models across the 1973 dividing line that marks the beginning of the "Goldfeld puzzle" period. An equally interesting period occurred more recently, between late 1981 and late 1983. During this interval there was a sharp decline in the velocity of both M1 and M2 relative to their pre-1981 trends, and a corresponding increase in the quantity of real balances relative to the predictions of most money demand equations. How do the six empirical models fare in explaining the change in real balances over this interval?

The comparison in Table 4 focusses on two quarters. The first of these, 1981:Q4, is the quarter in which most of the dynamic simulations reach their largest negative value (i.e., actual minus predicted). From then until the end of the sample period in 1983:Q3, the simulation errors uniformly shift in a positive direction. Dynamic simulation errors are shown for those two quarters in Table 4 for each of the six models. The top half of the table reports simulation errors for equations estimated through 1972, and the bottom half reports errors for equations estimated through 1979. The first three columns refer to results for the conventional measure of M1.

Although the size of the errors differs across the models, with the smallest absolute value of errors achieved for model D in the top half of Table 4 and for model B in the bottom half, the conclusions regarding the 1981:Q4 through 1983:Q3 interval are identical. Both simulations of each of the six models exhibit a marked movement of the error in a positive direction, i.e., the actual level of real M1 balances increased relative to the prediction, in most cases by between 5 and 8 percent. This shift is only slightly less than the 10 percent shortfall of velocity in this period relative to its trend from 1970 to 1980.

TABLE 4

Prediction Errors in Dynamic Simulations
in 1981:04 and 1983:03

Model	Conventional M1			Transactions M1		
	1981.IV	1983.III	(2)-(1)	1981.IV	1981.III	(5)-(4)
	(1)	(2)	(3)	(4)	(5)	(6)
Sample 1956-72						
A	-18.2	-10.6	7.6	-20.7	-16.7	4.0
B	-16.7	-11.2	5.5	-19.2	-17.4	1.8
C	-15.6	-9.6	6.0	-18.2	-16.1	2.1
D	-2.8	5.2	8.0	-7.0	-2.9	4.1
E	-11.2	-4.3	6.9	-12.0	-8.7	3.3
F	-17.5	-10.8	6.7	-17.0	-13.6	3.4
Sample 1956-79						
A	-2.6	5.6	8.2	-7.8	-3.6	4.2
B	-2.5	1.3	3.8	-7.5	-6.7	0.8
C	-0.5	5.1	5.6	-5.3	-3.2	2.1
D	3.3	11.8	8.5	-1.5	2.9	4.4
E	-0.3	5.9	6.2	-2.4	0.6	3.0
F	0.2	6.0	5.8	-1.0	2.5	3.5

How much of this simulation error can be attributed to financial innovations which have shifted the composition within M1 of different types of deposits? While a full examination of alternative monetary measures is beyond the scope of this paper, results for one alternative measure are displayed in the right-hand half of Table 4. This is the M1 transactions measure recently introduced by Spindt (1984), constructed by a method that weights different components of M1 by their estimated frequency of turnover. Because this measure places less weight than conventional M1 on some of the newer components of M1 (e.g., NOW and ATS accounts), it increases less in 1982 and 1983 than the official measure of M1. Corresponding to this is the uniformly smaller 1981-83 shift in the simulation errors, shown in the far right-hand column of Table 4. The errors are roughly half those calculated with the conventional M1 measure, suggesting that a substantial part of the 1981-83 velocity puzzle is attributable to the consequences of financial deregulation that increased the fraction of M1 consisting of new types of deposits with a relatively low transactions turnover.[19]

VII. CONCLUSION

Relation of Empirical Results to Preceding Analysis

The analytical portion of this paper in sections II-IV suggested that the conventional approach to the study of the short-run demand for

[19] The Spindt transactions M1 concept ("MQ") is available since 1970:Q1 as an index number based in that quarter. Our results for the conventional M1 have been duplicated using the alternative concept by linking it to conventional M1 in the transition quarter. These results are not presented in the earlier tables, because they exhibit few differences that shed light on the main issues.

money is plagued by severe problems of misspecification and identification. Several problems were suggested through the analysis of models of individual and aggregate behavior. The first of these led to the implication that the usual restriction in money demand equations that includes only the current value of an explanatory variable, and no lagged values, is unjustified. A model of individual behavior based on the permanent income hypothesis of money demand yielded a specification in which numerous lags of income enter, as well as at least one lag on the interest rate. This model is supported in our empirical work by the results for models C, D, E, and F, in which several lagged values of explanatory output and interest rate variables enter significantly.

The next suggestion was that the standard money demand equation might be misspecified if there were gradual adjustment for nominal balances combined at the aggregate level with gradual adjustment of the price level. That analysis led to an equation for real money balances that adds a "supply-shock" variable (z_t) to the specification. For practical estimation my proxy for this variable is the contribution of various supply shock terms (changes in the relative price of food and energy, changes in the effective exchange rate, the deviation of productivity growth from trend, and effects of Nixon price controls) in the reduced-form equation that I previously developed for the analysis of U. S. postwar inflation. The proxy variable consists of the actual values of the supply-shock variables multiplied by their estimated coefficients in the inflation equation. This supply shock proxy is statistically significant when added to several of the models, especially when the sample period is extended to include the 1973-83 period.

The final suggestion in the analytical section was that a shift in control regimes by the central bank may shift coefficients in the reduced form relation explaining real or nominal balances without indicating any shift in the underlying parameters of the structural money demand equation. The consistent tendency in our results for the coefficient on output to decline in the 1956-83 period as compared to 1956-72 suggests that there may be something to this "regime shift" interpretation of parameter instability. The result that in several models the coefficient on inflation becomes more significantly negative in the 1956-83 period is also consistent with the view that the equation for real balances mixes together demand and supply parameters.

Verdict on the Alternative Models of Dynamic Adjustment

This paper provides a preliminary set of evidence on the consequences of varying the dynamic specification of the "money demand" relation from the standard partial adjustment approach that is almost always employed. The results indicate a tendency for the large "Goldfeld puzzle" errors that emerge after 1972 with the standard specification to decline sharply in size when the supply shock proxy is added, and when each explanatory variable is allowed to enter with four lagged as well as the current value. The verdict on the error correction approach is thus far mixed. Model D (partial adjustment with lags) fits better for 1956-72 than model F (error correction), but the reverse is true for 1956-83. Whereas model D has much smaller errors than model F in the post-1972 dynamic simulation, model F performs better in Chow tests and indicates less evidence of a post-1972 structural shift. Both models D and F when estimated for the longer

1956-83 period exhibit numerous insignificant coefficients that can be interpreted as representing a mixture of demand and supply responses.

The most important conclusion of the paper is not to contribute "one best equation" which is alleged to be stable over some subperiod of past historical data, but rather to contribute a new interpretation of why such equations are so often unstable. Coefficients in equations for real balances shift in response to changes in monetary control regimes, and the changes in coefficients in our alternative models can be interpreted plausibly as reflecting a shift by the Federal Reserve from greater emphasis on stabilizing interest rates to stabilizing monetary aggregates. This interpretation of the estimated equations as "interesting reduced forms," rather than structural money demand equations, eliminates the need to rationalize peculiar coefficients, e.g., the zero coefficient on output in models D and F for 1956-83, or the large negative coefficient on prices and the supply shock term in model F. These results are all consistent with the hypothesis that the Federal Reserve during at least part of our sample period tended to reduce M1 in response to "good news" on output and "bad news" on inflation.

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