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The Case of the Missing Money

THE RELATION between the demand for money balances and its determinants is a fundamental building block in most theories of macroeconomic behavior. Since it is also a critical component in the formulation of monetary policy, it is not surprising that the money-demand function has been subjected to extensive empirical scrutiny. The evidence that emerged, at least prior to 1974, suggested that only a few factors (essentially income and interest rates, with due allowance for lags) were needed to explain adequately the quarterly movements in money demand. There were episodes that, during their course, gave the impression that the money-demand function was shifting. On the whole, however, in the time allowed for final data revisions by a "wait and see" attitude, the apparent puzzles tended to clear up.[1]

As has been widely documented,[2] the U.S. economy is once again experiencing an apparent shift in the money-demand function. In particular, when money-demand functions that have been successfully fitted to pre-1974 data are extrapolated into the post-sample period, they consistently and significantly overpredict actual money demand. Furthermore, as the economy has moved into the upturn phase of the business cycle, the forecasting errors have mushroomed. While one might hope that subsequent data revisions could "solve" the present puzzle, this sanguine attitude seems unwarranted for a variety of reasons.

First, the sheer magnitudes of the forecasting errors suggest that im-

1. Such econometric "benign neglect" begs the real problems facing the monetary authorities, who are striving to make reasonable policy choices during these episodes.
2. See, for example, Jared Enzler, Lewis Johnson, and John Paulus, "Some Problems of Money Demand," *BPEA, 1:1976*, pp. 261–80.

plausibly large data revisions would be required to explain current developments with equations of the sort I reported earlier. Second, the large forecasting errors for 1974–76 coincide with unusual conditions. Among other things, that period saw the most severe recession of the postwar era; an extended bout of double-digit inflation; the highest interest rates in many years; and many institutional changes in the financial structure. While the failure of an empirical macro relationship under such extreme conditions is perhaps not surprising, it should at least prompt the question of whether the specification was adequate to cope with them. In short, a reassessment of the current state of knowledge on the demand for money balances seems called for.

Outline

The plan of the paper is as follows. The next section reviews the forecasting experience with "conventional" money-demand equations, documenting the source and magnitude of the recent errors. It also considers whether the deterioration in the money-demand equation observed in the current cyclical episode had any counterpart in previous periods of recession and recovery. The second section reexamines the specification of the conventional equation, points out some of its potential shortcomings, and estimates a number of alternative specifications of an aggregate equation for demand deposits and currency, M_1. Sectoral money-demand functions are taken up in the third section, while the fourth briefly discusses recent institutional developments and presents estimates of demand equations for time deposits and M_2 (M_1 plus time deposits). The final section attempts to draw morals for both specification and policy from the empirical results.

Some "Conventional" Equations

In a previous paper, I examined a number of specifications of the demand function for money balances.[3] The simplest, stemming from a transactions approach, led to an equation in which the real stock of money

3. Stephen M. Goldfeld, "The Demand for Money Revisited," *BPEA, 3:1973*, pp. 577–638.

balances was a function of real gross national product, the interest rates on savings and time deposits at commercial banks and on commercial paper, and a lagged dependent variable. In logarithmic form, this specification was used to explain average quarterly holdings of the money stock narrowly defined, M_1, over the period 1952:2 to 1972:4. A general finding was that this simple specification both produced sensible parameter estimates and exhibited sufficient stability to be useful for extrapolation purposes. As alluded to earlier, the most recent data have raised substantial doubts about the stability of the equation. As the broad details of this doubt have already been spelled out,[4] the magnitude of the problem needs only brief comment.

The first row of table 1 contains a reestimate of my earlier "basic" equation with the sample period extended four quarters to the end of 1973. The present results are generally consistent with the old ones, although the income elasticity has declined somewhat. Aside from the additional four observations, the differences also reflect the recent substantial revisions in both the GNP accounts and the data on the money stock.[5]

While the estimates look reasonable, the equation performs extremely poorly when extrapolated beyond the period of fit. The summary results are reported in the last three columns of table 1 while the quarterly forecasts and errors are given in table 2. In a "static" simulation, the equation consistently overpredicts the demand for real money balances although the errors are hardly dramatic. However, this is not a very stringent test, since a static simulation feeds in the *actual* value of the lagged money stock in each period's prediction, a procedure that tends to put the equation back on track each quarter. A more relevant test is to extrapolate the equation dynamically by using the *predicted* value of the lagged money stock in the prediction for each period.

Quite evidently, this causes the equation to exhibit dramatically large errors. For the ten-quarter period as a whole the equation overpredicts by an average of $13 billion in 1972 prices. The root-mean-square error (RMSE) is 6.3 percent and the error for 1976:2 is a whopping 9.8 percent, or nearly $30 billion in current prices. Such errors are hardly typical for post-sample extrapolations. The same specification estimated through 1971:2 and dynamically extrapolated for the subsequent ten quarters

4. See, for example, Enzler and others, "Problems of Money Demand."

5. The time deposit rate also differs slightly in that the passbook rate is used, but this is of little consequence. See ibid, p. 268.

Table 1. Conventional Money-Demand Equation for Alternative Measures of Money Balances, 1952:2–1973:4

	Coefficient[a]				Summary statistic			Out-of-sample error		
		Interest rate						Root-mean-square error[b]		Dynamic error for 1976:2[c]
Dependent variable	*Income*	*Time deposits*	*Commercial paper*	*Money lagged*	R^2	*Standard error*	ρ	*Static*	*Dynamic*	
Currency plus demand deposits, M_1	0.179	−0.042	−0.018	0.676	0.995	0.0042	0.35	4.29	14.66	−22.3
	(5.4)	(4.0)	(6.5)	(10.0)				(1.8)	(6.3)	(9.8)
Demand deposits	0.158	−0.034	−0.020	0.661	0.991	0.0048	0.36	4.62	15.83	−24.3
	(5.4)	(3.6)	(6.3)	(8.9)				(2.6)	(9.0)	(14.3)
Currency	0.117	−0.026	−0.007	0.863	0.998	0.0043	0.62	0.39	0.61	1.5
	(3.5)	(2.3)	(1.9)	(21.6)				(0.7)	(1.1)	(2.6)

Source: Basic data are from Board of Governors of the Federal Reserve System.

a. All equations contain an intercept, which is not reported, and all variables enter logarithmically. The numbers in parentheses are *t*-ratios.

b. Root-mean-square error for extrapolation over period 1974:1–1976:2. Error is in billions of 1972 dollars (deflated by the implicit GNP deflator), and the percentage errors (in parentheses) are relative to the mean of the extrapolation period.

c. Error in billions of 1972 dollars (deflated by the implicit GNP deflator); the numbers in parentheses are percentage errors.

Table 2. Actual and Forecast Values and Simulation Errors for Conventional Money-Demand Equation, Quarterly, 1974:1–1976:2
Billions of 1972 dollars

Year and quarter	Currency plus demand deposits, M_1		Error	
	Actual	*Forecast*	*Dynamic*	*Static*
1974:1	244.4	245.6	−1.2	−1.2
2	241.2	244.1	−3.0	−1.8
3	236.7	242.5	−5.8	−3.1
4	232.3	241.8	−9.5	−4.2
1975:1	226.9	241.6	−14.7	−6.3
2	228.6	242.6	−14.0	−1.0
3	228.7	243.8	−15.1	−4.1
4	226.1	245.4	−19.4	−7.0
1976:1	225.9	248.2	−22.3	−5.7
2	227.9	250.3	−22.3	−3.7

Source: Based on equation in first row of table 1. Figures are rounded.

yields an RMSE of 1.0 percent and a tenth-quarter error of 2.6 percent. Something is clearly amiss in the more recent period.[6]

Disaggregating M_1 into its components, currency and demand deposits, sheds light on the puzzle. The results are again contained in table 1, which clearly shows that the demand-deposit equation is the source of the difficulty. The currency equation tends to underpredict somewhat but on the whole performs reasonably well. For demand deposits, both the RMSE and the error for 1976:2 are slightly larger in absolute terms than the M_1 results so that the percentage errors are about 1½ times larger for demand deposits. For 1976:2 the simulation error for demand deposits is an unprecedented 14.3 percent.

Although the focus here is on simulation errors, more conventional evidence yields the same conclusions. For example, coefficient estimates from separate demand-deposit equations for the two halves of the sample period look quite different from one another. Furthermore, a formal test for structural stability readily allows one to reject that hypothesis.

In summary, the relatively parsimonious basic specification used earlier continues to perform satisfactorily for currency but is quite unacceptable

6. The more detailed simulation evidence in my earlier paper, "Demand for Money Revisited," also leads to the same conclusion. It should be noted that the earlier results were expressed in 1958 prices so that one should multiply the old RMSEs by about 1.5 to make the two sets comparable.

for demand deposits and consequently for M_1. The search for reasons for the poor performance of the demand-deposit equation begins by considering the cyclical characteristics of the equation.

CYCLICAL BEHAVIOR IN POSTWAR RECESSIONS

The period since early 1974 has included a cyclical downturn and a period of recovery. Has the poor performance of the money-demand equation during the present cycle any counterpart during previous postwar cycles?

The dates of the peaks and troughs of the five cyclical episodes since 1952, the beginning of the sample period, are given in the first two columns of table 3. For each of these periods I calculated two types of within-sample dynamic simulations. In each case, I started with the demand-deposit specification in table 1 estimated over the period 1952:2–1973:4.[7] In the first instance this equation was used to compute one long dynamic simulation over the entire sample period. Since doing so abstracts from initial conditions around turning points, I also ran eight separate dynamic simulations, starting at each peak and trough. The mean errors and root-mean-square errors for these two types of simulation are shown in table 3 under the headings method 1 and method 2, respectively.

For the last three cyclical episodes in the sample it is possible to do out-of-sample extrapolations by estimating the equation through 1960:1, 1969:3, and 1973:4 and simulating from peak to trough. The simulations were restarted at the trough and then run for five additional quarters. The results for this case are given in table 3 under method 3.

These results show, first, that the mean error from peak to trough is consistently negative. This suggests that the basic equation systematically tends to overstate the demand for money in the downturn of the business cycle. Thus, qualitatively, the experience from 1973:4 to 1975:1 is not new; but, in terms of magnitudes, it stands out like a sore thumb. The RMSEs indicate that, for the first four recessions, the performance of the equation is roughly on a par with its behavior during the sample period as a whole.[8] Once again the most recent experience is conspicuous. For

7. The results use the specification with the Treasury bill rate instead of the commercial paper rate.

8. The RMSE for a dynamic simulation over the entire sample period 1952:2–1973:4 is $1.5 billion in 1972 prices.

Table 3. Errors of the Basic Demand-Deposit Equation around Cyclical Turning Points, 1953:2–1975:1

Billions of 1972 dollars

Cycle		*Mean error, peak to trough*			*Root-mean-square error, peak to trough*			*Mean error five quarters after trough*			*Root-mean-square error five quarters after trough*		
Peak	*Trough*	*Method 1*	*Method 2*	*Method 3*	*Method 1*	*Method 2*	*Method 3*	*Method 1*	*Method 2*	*Method 3*	*Method 1*	*Method 2*	*Method 3*
1953:2	1954:2	−0.99	−1.09	n.a.	1.38	1.45	n.a.	1.21	2.16	n.a.	1.33	2.18	n.a.
1957:3	1958:3	−2.05	−0.98	n.a.	2.10	1.14	n.a.	0.13	1.53	n.a.	1.58	1.82	n.a.
1960:1	1960:4	−1.91	−0.58	−1.01	1.92	0.58	1.02	−0.28	0.56	−0.01	0.49	0.58	0.35
1969:3	1970:4	−0.97	−0.66	−1.14	1.03	0.73	1.17	−1.21	−0.79	−0.79	1.51	1.22	2.01
1973:4	1975:1	n.a.	n.a.	−8.13	n.a.	n.a.	9.75	n.a.	n.a.	−10.67	n.a.	n.a.	12.75

Sources: The equation specification is as in table 1 but with the Treasury bill rate replacing the commercial paper rate. See the text for a discussion of the three methods used to obtain the errors.

n.a. Not available.

the quarters following a trough the situation is mixed. One might expect the equation to understate money demand in the upswing and while it does this in two cases, it overstates the demand in two others and the fifth is a standoff. The mean error after 1975:1 again stands out as does the RMSE for this period, because the RMSEs for the four earlier recovery periods are not particularly large.

On balance, while there is some evidence of systematic errors in earlier cycles one cannot escape the conclusion that the present period is unusual.

Some Alternative Specifications

Of necessity, empirical macroeconomic relationships tend to be practical compromises between theory and data. Consequently, estimated relationships are typically caricatures that obviously abstract from many features of potential importance. The failure of new data to fit well to historically estimated relationships is thus hardly surprising. This section first briefly reviews the underpinnings of the simple money-demand specification estimated above. It then examines the possible shortcomings of the basic specification and reports estimates for alternative specifications.

A CONVENTIONAL MODEL

The conventional transactions view of money balances results in a demand function that relates the quantity of money balances (M) to a measure of the volume of transactions (T), an interest rate on a riskless asset (r), and a "brokerage charge" (b), or transactions cost of converting from the riskless asset to money. The simplest expression of this relationship is the so-called square-root law:

$$M = \sqrt{\frac{bT}{2r}}. \tag{1}$$

Equation 1 is typically put in real terms by rewriting it as

$$\frac{M}{P} = \sqrt{\frac{\left(\frac{b}{P}\right)\left(\frac{T}{P}\right)}{2r}}, \tag{2}$$

where P is the price level.

Empirical implementation of equation 2 obviously requires the choice of some observed variables as counterparts to its theoretical constructs. In the previous section this was accomplished by use of real GNP as a measure of T/P and of the rates on time deposits and commercial paper as measures of r, and by assuming that real transactions costs, b/P, are constant. In each instance, however, other choices are possible and, in view of the poor performance of the equation in recent periods, should be explored. But first two general issues of specification and the question of the strategy to be pursued require attention.

PARTIAL ADJUSTMENT

In most empirical work, especially with quarterly data, equation 2 is not estimated directly. Rather, it is used as a basis for defining "desired" money balances toward which actual money balances are posited to adjust. More particularly, assuming that real transactions costs are constant and denoting transactions by y, following equation 2 one can write the desired stock of real money balances (m^*) as

$$\ln m_t^* = a_1 + a_2 \ln y_t + a_3 \ln r_t. \tag{3}$$

Given equation 3, there are a number of ways one can specify an adjustment equation. Two possibilities are

$$\ln m_t - \ln m_{t-1} = \gamma (\ln m_t^* - \ln m_{t-1}) \tag{4}$$

$$\ln M_t - \ln M_{t-1} = \gamma (\ln M_t^* - \ln M_{t-1}), \tag{5}$$

with $M_t^* = m_t^* P_t$.

Combining equations 3 and 5 yields

$$\ln \left(\frac{M_t}{P_t}\right) = c_1 + c_2 \ln y_t + c_3 \ln r_t + c_4 \ln\left(\frac{M_{t-1}}{P_t}\right), \tag{6}$$

while combining 3 and 4 yields the same equation except that the lagged dependent variable enters as $m_{t-1} = M_{t-1}/P_{t-1}$.

The logical difference between the two cases is that equation 5 implies that a reduction of the lagged value of the nominal money stock due to rising prices is subject to partial or lagged adjustment while equation 4 implies that such a reduction is subject to immediate adjustment. Although in the previous section and in most of my earlier work I relied on the real-adjustment model of equation 4, I now think it more plausible to use the nominal-adjustment model of equation 5.[9] When this modification is made to the M_1 equation of table 1, nothing dramatic happens, but the post-sample RMSE and the error for 1976:2 of the resulting equation are 25 percent smaller. Since, in any event, this specification makes more sense a priori, it will be adopted in what follows.[10]

POPULATION DEFLATION

The second general issue of specification concerns deflation by population. A priori, this seems desirable, at least for household money demand, although the number of households might be a better deflator. For total money holdings the issue is less clear-cut but even here a per capita basis seems to make sense. Despite this presumption, after some crude tests made in earlier work, I rejected deflation. Since at least one of these tests was flawed I reexamined this issue by estimating a per capita equation, adding the logarithm of population as a separate variable. If the per capita specification is appropriate, the population variable should be insignificantly different from zero and, with one marginal exception, the null hypothesis was accepted for a variety of specifications of the other variables. Consequently, all of the results in this section will use the per capita nominal-adjustment specification.[11]

STRATEGY

The rest of this section explores alternative specifications of the money-demand relationship. The goal, of course, is to see whether a plausible respecification of the conventional equation can better explain the recent

9. In fact, as noted in my earlier paper, "Demand for Money Revisited" (p. 611), it is possible to interpret my original results as confirming the desirability of specification 5 relative to 4.

10. One effect worth noting is that the speed of adjustment declines somewhat with the nominal-adjustment model. Thus the adjustment to price changes, rather than being instantaneous, may in fact be slower than that to nominal income changes, perhaps because of slowness in adjusting the "perceived" price level to the actual one. A model of this sort is considered briefly below.

11. The equation used in the MPS (MIT-Penn-Social Science Research Council) model and the specification reported in Enzler and others, "Problems of Money Demand," use as a dependent variable the ratio of demand deposits to nominal income and include as independent variables real per capita income and the ratio of lagged deposits to current income. A little algebra reveals that this is equivalent to the per capita version of equation 6 above.

behavior of money demand. Since care is needed in making the judgment, the strategy to be followed is worth some attention.

In the first instance, all estimation was carried out over a sample period 1952:2–1973:4. Because this period predates the difficulties with the money-demand equation, one can judge whether specification changes that improve the predictions for recent quarters could have been anticipated given the information available at the time.[12] I then dynamically simulated those equations with promising in-sample characteristics over the ten out-of-sample quarters ending in 1976:2. The equations were also estimated over the entire period through the middle of 1976 and some subperiods, and a test for stability was performed because the conventional specification was not stable over the entire period.

However, these procedures were not quite enough. Even the acceptance of some particular modified specification (in a conventional statistical sense) based on data up to 1973 does not mean that it should be used for extrapolation purposes. The question remained: How did the proposed specification perform in a series of post-sample dynamic simulations prior to 1974? As a consequence, several of the relatively most successful results to be presented below were subjected to this backward-looking scrutiny.

As a final word of introduction, all the results in this section pertain to aggregate concepts such as M_1 or total demand deposits.[13] Results for sectoral money holdings will be described in the next section.

MEASURES OF TRANSACTIONS

As indicated above, researchers have often used real GNP as a measure of transactions. But the apparent success of this variable rests on a number of tenuous assumptions. For one, GNP ignores transfers, and transactions in financial assets and in existing goods, all of which may result in transactions demand for money. For another, GNP involves imputations that may require no transactions balances. Probably more important,

12. This, of course, begs the question of data revisions.

13. As the coefficient estimates and *t*-statistics were quite similar for the two aggregates, I present the results for M_1 only. However, as is already evident in table 1, despite similar parameter estimates for a given specification, the demand-deposit equation resulted in absolutely larger simulation errors in virtually all cases. As a consequence, the summary statistics for the demand-deposit simulations will also be reported.

GNP nets out intermediate transactions so that using it implicitly assumes that total transactions are proportional to GNP. Keynes, in fact, looked with considerable skepticism on the notion of the income velocity of money, suggesting that "it is as [if one] were to divide the passenger-miles travelled in an hour by passengers in trams by the aggregate number of passengers in trams *and trains* and to call the result a 'velocity.' "[14]

The relationship between intermediate and final transactions may change for a number of reasons. First, changes in the degree of integration of firms may alter the relationship. In addition, both secular and cyclical changes in the composition of output may affect the volume of intermediate transactions at any given level of GNP.[15]

Confronted with the potential shortcomings of GNP as a transactions variable, investigators have recently turned to other measures. Most prominent among these have been bank debits, which measure the value of checks written on privately held demand deposits at commercial banks. Since they reflect payments for intermediate goods, financial transactions, and existing assets, on the face of it, debits may be a more appropriate transactions variable.[16] The secular rise in the ratio of debits to GNP shown in table 4 suggests that if debits form the appropriate transactions variable, the use of GNP would involve a misspecification. Furthermore, as has been reported by Enzler and his coauthors, debits appear uncharacteristically low relative to GNP in the most recent recovery period, just when money demand weakened; this finding suggests that debits may have something to contribute to an empirical explanation of money demand.

But, are debits necessarily a fully appropriate transactions variable? Their virtue is their comprehensiveness, but in that also lies some of their defects. In particular, as is often argued, increasingly sophisticated cash-management practices have tended to reduce the volume of money balances necessary to support any given level of economic activity. However—and this is the crux of the difficulty—such economizing has been brought about in part by *increasing* the volume of debits. This increase reflects, among other things, transfers of balances among a firm's multiple

14. John Maynard Keynes, *A Treatise on Money*, vol. 2 (Harcourt, Brace, 1930), p. 25. Italics added.

15. It is, of course, possible that, even aside from intermediate transactions, the composition of output may have a direct influence on money-demand behavior.

16. Charles Lieberman has argued this proposition in a series of papers. See, for example, "The Transactions Demand for Money and Technological Change," *Review of Economics and Statistics* (forthcoming).

Table 4. Selected Measures of Bank Debits, Selected Years
Dollar amounts in billions

Measure	*1950*	*1960*	*1970*	*1975*
Debits				
Total	1,552.1	3,180.6	10,221.3	22,998.4
Excluding New York City banks	985.6	1,958.1	5,717.3	12,184.3
Nominal GNP	286.2	506.0	982.4	1,516.3
Ratio, debits to GNP				
Total	5.42	6.29	10.40	15.17
Excluding New York City banks	3.44	3.87	5.82	8.04

Sources: *Federal Reserve Board; Survey of Current Business*, relevant issues.

accounts. Moreover, both firms and individuals may increase debits by expanding their purchases and sales of financial assets simultaneously with attempts to reduce money holdings. Debits data can also be distorted by the huge and highly volatile volume of transactions generated by securities dealers, brokers, and the like.[17] Since many of these financial transactions take place in the New York City banks, some see debits excluding New York City—also shown in table 4—as a better measure. Even with this modification, the potential logical shortcoming of a debits-based transactions variable remains. Clearly, it should be used with caution.[18]

Two other types of transactions variables reflect some of the same factors as a debits variable: a weighted-GNP variable and a wealth variable. As for the first, Enzler and his coauthors have proposed a variable in which "residential construction received a weight of 1.5, exports received a weight of 0.5, and government purchases of labor services a weight of zero, while all other GNP expenditure categories received a weight of 1.0."[19] The basic idea is to reflect intermediate transactions

17. The most complete discussion of debits is contained in George Garvy and Martin R. Blyn, *The Velocity of Money* (rev. ed., Federal Reserve Bank of New York, 1970). As an extreme example, a 1959 survey they report revealed that government securities dealers had a turnover of more than 11,000 per year, or about 50 per working day.

18. There is also a practical problem in that forecasting or policy analysis is concerned with GNP or its components. Thus a money-demand function based on debits requires an explanation of debits in terms of GNP. An analysis of debits should be viewed as a possible step in analyzing the behavior of money demand rather than the end product of ultimate interest.

19. Enzler and others, "Problems of Money Demand," p. 278. The construction of this variable was indirectly motivated by appeal to the debits data.

Table 5. Transactions, Debits, and Net Worth in Money-Demand Equations[a]

	Coefficient[b]							Out-of-sample error (billions of 1972 dollars)[c]			
	Interest rate									Demand-deposit form of equation	
Equation	Time deposits	Treasury bills	Transactions variable[d]	Money lagged	Marginal debits[e]	Net worth	ρ	Root-mean-square error	Error for 1976:2	Root-mean-square error	Error for 1976:2
5.1	−0.035	−0.010	0.112	0.822	...	...	0.54	11.3	−19.8	13.3	−22.6
	(2.9)	(4.2)	(5.4)	(14.1)				(4.8)	(8.7)	(7.6)	(13.3)
5.2	−0.027	−0.008	0.034	0.838	...	...	0.68	17.2	−27.0	17.1	−27.1
	(2.1)	(3.0)	(3.9)	(13.2)				(7.4)	(11.8)	(9.7)	(16.0)
5.3	−0.039	−0.038	0.091	0.836	−0.063	...	0.57	10.1	−16.8	11.8	−19.4
	(4.2)	(3.2)	(3.9)	(14.5)	(2.2)			(4.3)	(7.4)	(6.7)	(11.4)
5.4	−0.030	−0.010	0.099	0.841	0.087	...	0.49	8.4	−14.6	10.9	−18.1
	(2.7)	(4.5)	(5.1)	(15.6)	(3.3)			(3.6)	(6.4)	(6.2)	(10.7)
5.5	−0.036	−0.010	0.113	0.816	...	...	0.54	10.2	−18.4	12.8	−22.0
	(3.0)	(4.2)	(5.5)	(14.0)				(4.4)	(8.1)	(7.3)	(13.0)
5.6	−0.039	−0.010	0.076	0.842	...	0.057	0.54	9.2	−17.3	11.6	−20.9
	(3.3)	(4.3)	(3.0)	(14.6)		(2.3)		(4.0)	(7.6)	(6.6)	(12.4)

Sources: *Federal Reserve Board; Survey of Current Business*, relevant issues; and for net worth, MPS data bank.

a. All variables enter logarithmically per capita and all equations are estimated by a Cochrane-Orcutt least-squares procedure over 1952:2–1973:4. All summary statistics for extrapolations are based on dynamic simulations beginning in 1974:1.

b. The numbers in parentheses are t-ratios.

c. The numbers in parentheses are percentage errors.

d. The transactions variable is real GNP except in equation 5.2, where it is debits, and 5.5, where it is a weighted-GNP variable (see text).

e. Equation 5.3 uses the deviation of debits from a regression on GNP and time; 5.4 uses the change in debits.

more satisfactorily, although it is difficult to know what the proper weights should be.

Wealth, or net worth, has had a long history in money-demand functions. Some writers, in fact, prefer it to income as the basic scale variable in the demand for money. Alternatively, this variable can be used—in level or first-difference form—in conjunction with another transactions variable such as income in the hope that it will capture the effects of financial transactions on money demand.

EMPIRICAL RESULTS

The basic equation—5.1—using real GNP as a transactions variable, is reported in the first row of table 5. It has a post-sample RMSE of 4.8 percent (expressed as a percent of the mean of the dependent variable over the extrapolation period) and a 1976:2 error of 8.7 percent. This, then, is the starting point for the analysis. Equation 5.2 reports the results obtained by using debits outside of New York City as a transactions variable. Taken by itself, this is clearly a step in the wrong direction.[20] However, equations 5.3 and 5.4 suggest that the debits data can help explain the puzzle. Equation 5.3 includes the deviation of actual debits from debits predicted by a regression on GNP and time.[21] When actual debits fall short of predictions, money demand should be lower and that is precisely what the negative coefficient for this equation shows. The variable also improves the simulation performance of the equation, although not dramatically. A different use of the debits data in equation 5.4 produces a slightly bigger improvement. That equation adds the change in debits to the basic equation and it gets a significant and appropriately positive coefficient. Relative to equation 5.1, both the RMSE and the 1976:2 error improve by about 25 percent.

Equation 5.5 reports the results obtained with the weighted-GNP variable which, when substituted for real GNP, leads to only a slight improvement in simulation performance.[22] The final equation in the table, 5.6,

20. Choosing the proper price deflator for a debits variable presents a problem. Having little imagination, I stuck with the implicit GNP deflator used in the other equations.

21. The equation related "real" debits to real GNP and was estimated over the same sample period as the other equations—from 1952:2 to 1973:4.

22. Following the general spirit of the weighted-GNP variable, I also estimated some equations using measures of the composition of GNP, along with GNP itself. These were entered as "share" variables—that is, the ratio of an expenditure cate-

uses the level of net worth in conjunction with real GNP. In my earlier paper net worth was not significant in this context, but recasting the equation in per capita terms apparently permits both GNP and net worth to attain statistical significance. As is evident from the table, the net-worth variable reduces the simulation error slightly in the post-1973 period.[23]

The upshot of these various attempts is that real GNP works about as well as any basic transactions variable I could find, but that the debits and net-worth data do appear to contribute something.[24] However, the size of the remaining error suggests the need to continue reexamination of the specification of the money-demand function.

TRANSACTIONS COSTS AND RATCHET EFFECTS

As noted above, the brokerage fee or transactions cost plays a prominent role in the theoretical derivation of optimal money holdings. The notion covers a multitude of sins since it is meant to account for any sort of cost of converting from "the" earning asset to money—the cost of "trips to the bank," penalties for premature withdrawal of funds, or explicit brokerage charges. By assuming that the net brokerage cost is

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gory to GNP. In many cases I was able to reject the hypothesis that these variables did not matter as a group but the individual coefficients were often not significant or had questionable signs.

23. When the change in net worth was used in conjunction with GNP, both were statistically significant but the simulation error was essentially unchanged from that for equation 5.1. A considerably more dramatic improvement in the post-1973 simulation performance is achieved if the income variable is simply replaced by the net-worth variable. This serves to reduce the RMSE to 1.8 percent and the error in 1976:2 to 3.9 percent. Lest one leap to conclusions, however, this specification does quite poorly in the kinds of tests summarized in tables 7 and 8 below, and is not a serious candidate for explaining money demand in the years before the recent shortfalls.

24. While these variables perform in qualitatively the same way for demand deposits as for M_1, as indicated in the last two columns of table 5, they improve the simulation performance less. Also the demand-deposit errors in table 5 are not consistent with those reported in Enzler and others, "Problems of Money Demand," table 7. This inconsistency does not stem primarily from the different sample periods used, but from an arithmetic error that apparently crept into the calculation of simulation errors in that paper. Thus, while the authors report a simulation error in their basic equation 7.1 of 8.5 percent in 1976:1, for their sample period the correct estimate is 11.5 percent. They also report a corresponding improvement to 7.3 percent with their proposed transactions variable, while the corrected number is 11.4 percent, or a miniscule improvement.

fixed in real terms—an exercise in handwaving—such costs are typically ignored in empirical work. Quite recently, numerous institutional developments that appear to have reduced transactions costs have called this assumption into serious question. Unfortunately, translating institutional developments into a measurable brokerage fee is not an easy task.[25]

The impact of transactions costs on money demand may also change if expected shifts in interest rates and other factor prices influence the choice of cash-management techniques. This point has been argued by Duesenberry and more recently by Quick and Paulus.[26] The basic idea is that once people recognize that active cash management involves some fixed cost and also become familiar with new techniques through "learning-by-doing," the transactions technology (for example, as symbolized by b in equation 2) plausibly may be considered a decision variable of the money holder. Furthermore, once a new technology is adopted, firms and individuals will not necessarily abandon it should current or expected interest rates fall. Thus, there may be a ratchet effect in the demand for money.

One simple way to allow for this effect is to introduce "previous peak" variables for interest rates or income or both.[27] The first two equations of table 6 report the results obtained when these variables were separately added to the basic specification of equation 5.1. In equation 6.1 the income-ratchet variable is entered as the ratio of GNP to previous peak GNP and it obtains an appropriately positive coefficient with a t-statistic of 1.9. Thus, given GNP, the higher the previous peak GNP the lower money demand will be. Comparison of table 6 with table 5 indicates that the RMSE for M_1 is reduced from 4.8 percent to 3.1 percent. The previ-

25. See the fourth section for a brief discussion of the relevant institutional developments and a partial assessment of their quantitative impact on the demand for money.

26. James S. Duesenberry, "The Portfolio Approach to the Demand for Money and Other Assets," *Review of Economics and Statistics,* vol. 45 (February 1963, Supplement), pp. 9–31, and Perry D. Quick and John D. Paulus, "Financial Innovation and the Transactions Demand for Money" (Board of Governors of the Federal Reserve System, Banking Section, n.d.; processed).

27. Income is potentially relevant since, in the simple Baumol-Tobin model, whether an individual will be an active money manager, or at a corner solution in which all transactions balances are held in cash, depends in part on both his income and the interest rate he faces. Previous-peak variables are certainly not the only way to capture these effects and, in fact, one should probably allow for some dampening in these peak variables. However, attempts to allow for dampening made little difference. See Quick and Paulus, "Financial Innovation."

ous peak rate on commercial paper is used in equation 6.2 and it both obtains a significantly negative coefficient and improves the simulations.

Equations 6.3 through 6.5 combine these ratchet variables with some of the debits variables from table 5. Equation 6.5, which simulates the best of the three, has driven the RMSE down to 2.0 percent and the error in 1976:2 down to 4.1 percent, a reduction of nearly 60 percent from equation 5.1. A substantial further reduction is achieved in equation 6.6 with the substitution of a linear functional form for the peak interest rate. Quick and Paulus argue in favor of this specification, suggesting that money managers are more sensitive to absolute than to proportional differences,[28] and this specification works quite well in the post-sample period. Indeed, the 1976:2 error of $5 billion (or 2.2 percent) is only one-quarter that of the original equation 5.1 and is fairly respectable in absolute terms as well.[29]

On the face of it, then, this approach has made a substantial dent in explaining the recent puzzle in money demand. However, the strategy outlined earlier suggests a more careful retrospective look at the leading contenders—after consideration of whether further improvements would flow from modifying the remaining potential shortcomings of the basic equation.

INTEREST RATES

As with other variables, the appropriate interest rate poses a question. Among the possibilities are the commercial paper rate, the Treasury bill rate, various savings and time deposit rates, some longer-term security rates, and perhaps even an implicit rate on demand deposits. However, given the size of the puzzle to be explained, it is hard to foresee much payoff from trying various interest rates, and indeed I got none. Simulation performances of equations using alternatively the commercial paper rate and the Treasury bill rate were virtually identical. The same is true for comparisons of several different variables for time and savings deposit rates. As for longer-term rates, the corporate bond rate proved to be, if

28. For a brief discussion of the functional form see ibid., appendix.

29. As in table 5, the improvement in the error in the corresponding demand-deposit equation (not shown) is not nearly as marked. For example, the demand-deposit version of equation 6.6 still has an RMSE of 3.2 percent and a 1976:2 error of 6.7 percent, compared with 7.6 percent and 13.3 percent, respectively, for equation 5.1.

Table 6. Money-Demand Equations with Various Ratchet Effects[a]

Equation	Coefficient[b]: Interest rate: Time deposits	Coefficient[b]: Interest rate: Treasury bills	Coefficient[b]: Real GNP	Coefficient[b]: Money lagged	Coefficient[b]: Ratio of GNP to previous peak GNP	Coefficient[b]: Previous peak commercial paper rate	Coefficient[b]: Marginal debits	Out-of-sample error (billions of 1972 dollars)[c]: Root-mean-square error	Out-of-sample error (billions of 1972 dollars)[c]: Error for 1976:2
6.1	−0.031	−0.012	0.108	0.839	0.146	...	...	7.3	−15.2
	(2.6)	(4.7)	(5.3)	(14.8)	(1.9)			(3.1)	(6.7)
6.2	−0.037	−0.009	0.154	0.767	...	−0.020	...	8.4	−15.5
	(3.3)	(4.2)	(6.6)	(13.4)		(3.3)		(3.6)	(6.8)
6.3[d]	−0.041	−0.009	0.131	0.782	...	−0.022	−0.071	6.6	−11.7
	(3.7)	(4.3)	(5.4)	(14.0)		(3.6)	(2.7)	(2.8)	(5.1)
6.4[e]	−0.034	−0.009	0.136	0.789	...	−0.016	0.076	6.8	−12.2
	(3.1)	(4.5)	(6.0)	(14.5)		(2.9)	(3.0)	(2.9)	(5.4)
6.5[d]	−0.039	−0.010	0.121	0.799	0.098	−0.019	−0.077	4.7	−9.4
	(3.5)	(4.4)	(4.8)	(14.0)	(1.5)	(3.0)	(2.8)	(2.0)	(4.1)
6.6[d]	−0.037	−0.011	0.113	0.835	0.118	−0.003[f]	−0.075	2.9	−5.0
	(3.3)	(4.7)	(4.4)	(15.0)	(1.4)	(3.3)	(2.7)	(1.3)	(2.2)

Sources: See tables 4 and 5.

a. See notes to table 5. The estimated serial-correlation coefficients (not shown) were all about 0.5.

b. The numbers in parentheses are *t*-ratios.

c. The numbers in parentheses are percentage errors.

d. The marginal-debits variable in this equation is the deviation from the regression on GNP and time.

e. The marginal-debits variable in this equation is the change in debits.

f. The linear functional form of the peak commercial paper rate was used in this equation. See Perry D. Quick and John D. Paulus, "Financial Innovation and the Transactions Demand for Money" (Board of Governors of the Federal Reserve System, Banking Section, n.d.; processed).

anything, inferior to either of the short-term market rates. Finally, I made one crude attempt at relaxing the constant-interest-elasticity assumption implicit in a linear-logarithmic specification by adding the square of the logarithm of the interest rate to the basic equation. In principle, this specification is rich enough to allow for a higher elasticity at low interest rates (which is often alleged to be the case) but these variables were never significant.

ESTIMATION TECHNIQUES

Another possible shortcoming of the results presented above arises because they are based on single-equation estimation techniques. While I had earlier found correction for simultaneity to be of little consequence, it seemed worth checking out again. However, as before, estimation by two-stage least squares with either a money magnitude or an interest rate on the left-hand side produced no surprises. In fact, the interest-rate equation corresponding to 5.1, when solved for M_1, produced no better simulation than the basic equation. And when simulated for the interest rate it produced equivalently large errors in the out-of-sample period.

A related issue concerns the generality of the lag structure used above. The simple stock-adjustment model implies a potentially restrictive geometric lag pattern, which I relaxed both by including lagged values of income and interest rates (and a two-period lag for money) and by estimating some polynomial distributed-lag versions. However, neither method improved on the simulation performance of the basic equation or of any of a number of the variants reported above.

PRICE EFFECTS

Alternative ways of getting prices into the equation constituted the final variation tested. The implications of a nominal- versus a real-adjustment model were discussed earlier; but given the exceptional inflation of recent years, further alternatives, employing proxies for expected inflation in the money-demand function, were also pursued. In one attempt, I used a distributed lag of current and past rates of inflation both in a stock-adjustment version and in an equation that used polynomial distributed lags on income and interest rates as well. When these versions were estimated over 1952:2–1973:4, the inflation variable always obtained a significantly negative coefficient, but the post-1973 simulation performance was essentially unchanged.

In a further attempt, money holders were assumed to adjust to a "perceived" price level, P_t^*, which need not in the short run equal the actual price level. The model can be derived as follows.

Take the nominal-adjustment model,

$$\ln M_t - \ln M_{t-1} = \gamma (\ln M_t^* - \ln M_{t-1}), \tag{5}$$

but instead of assuming that the desired nominal stock is equal to the desired real stock times the actual price level—that $M_t^* = m_t^* P_t$—posit that $M_t^* = m_t^* P_t^*$. The desired real stock is also assumed to depend on P_t^*, as in

$$\ln m_t^* = a + b \ln \left(\frac{Y_t}{P_t^*}\right) + c \ln r_t, \tag{7}$$

where Y_t is nominal income and r_t is "the" interest rate. These equations can be combined to yield

$$\ln M_t = \gamma a + (1-\gamma) \ln M_{t-1} + \gamma b \ln Y_t + \gamma c \ln r_t + \gamma(1-b) \ln P_t^*. \tag{8}$$

Equation 8 is in nominal terms but, with $P_t^* = P_t$ in the long run, it reduces to an appropriately homogeneous equation.

Completing the story calls for a proxy for P_t. Perhaps the simplest is

$$\ln P_t^* = \sum_{i=0}^{n} w_i \ln P_{t-i}, \tag{9}$$

where w is the relative weight on the lagged price level. Substituting equation 9 into 8 gives an equation one can estimate and I tried a few versions. A typical equation over the sample period 1952:2–1973:4 (with $n = 2$) is

$$\begin{aligned} \ln M_t = {} & \underset{(0.6)}{0.152} + \underset{(4.6)}{0.158} \ln Y_t - \underset{(4.4)}{0.011} \ln RTB_t - \underset{(3.2)}{0.034} \ln RTD_t \\ & + \underset{(11.3)}{0.785} \ln M_{t-1} + \underset{(1.1)}{0.111} \ln P_t - \underset{(1.4)}{0.189} \ln P_{t-1} + \underset{(1.1)}{0.117} \ln P_{t-2}, \end{aligned}$$

where *RTB* is the Treasury bill rate and *RTD* is the rate on time deposits, and the numbers in parentheses are *t*-statistics. Although I did not impose any constraints on the price coefficients, w_i, their sum is not far from the "right" long-run value. The equation produces an RMSE in the post-sample period of 3.3 percent and a 1976:2 error of 6.1 percent, better than either the previous nominal- or the real-adjustment model. Unfortunately, however, the pattern of coefficients on the price variables is a bit difficult to rationalize.[30] Constraining the price coefficients to fit an Almon lag posed the same problem. Thus, while this more flexible approach to modeling the impact of prices shows promise, it hardly solves the puzzle.

One other "cure" for the money-demand mystery has recently been advanced. Sinai has suggested that the basic specification suffers most because the assumption of a unitary price elasticity is no longer appropriate.[31] In my earlier paper I could not reject the hypothesis of a unitary elasticity, but when Sinai adds the logarithm of the price level to my old basic equation extended to the end of 1975, it appears that the hypothesis is rejected and that the elasticity is significantly less than unity.[32] One possible explanation for this result is that real transactions costs have declined over this period. Since the basic specification implicitly assumes that these costs are constant, their decline obviously would produce a price elasticity of less than unity. The solution is a proper measure of transactions costs rather than a distortion of the price coefficient. While finding one is not an easy matter, one crude test of the acceptability of the lower estimated price coefficient is whether the same results obtain with one of the improved specifications given in table 6. The answer is a resounding no. For example, when the logarithm of the price level is added to equation 6.5, it gets a coefficient of 0.003 and a *t*-statistic of 0.15. This evidence simply confirms the rather strong a priori case against a nonunitary elasticity in the *long run*. In short, this is not a solution to the puzzle.

After all these attempts, then, the results in table 6 stand as the best I can offer. It is now time to see how good they really are.

A CLOSER LOOK AT THE RESULTS

The several plausible specifications of the money-demand function, which extrapolate reasonably well in the most recent period, need ex-

30. The coefficients on the price variables curiously imply that prices approximately enter as a constant times $[\ln(P_t/P_{t-1}) - \ln(P_{t-1}/P_{t-2})]$, which is the change in the rate of inflation.

31. Allen Sinai, "The Money Supply Puzzle: An Econometric Analysis" (processed).

32. This result is certainly correct, as I found by adding log P to equation 5.1 estimated through 1976:2, although it should be noted that the *t*-statistic is considerably larger for my original real-adjustment equation.

Table 7. Root-Mean-Square Errors for Four-Quarter Extrapolations for Alternative Specifications of Money Demand, 1966:2–1975:2 Endpoints[a]

Billions of 1972 dollars

Estimation endpoint (year and quarter)	*Equation form 5.1*	*Equation form 5.6*	*Equation form 6.2*	*Equation form 6.5*	*Equation form 6.6*
1966:2	6.2	6.0	2.7	2.8	2.0
1967:2	2.1	2.0	3.5	3.8	4.1
1968:2	1.2	0.6	4.0	3.6	4.3
1969:2	2.5	1.5	1.6	1.9	3.6
1970:2	0.7	1.0	1.8	1.9	2.0
1971:2	3.9	3.7	2.2	2.6	3.0
1972:2	0.8	0.5	1.4	1.6	1.5
1973:2	0.8	0.4	1.0	1.2	2.0
1974:2	6.2	4.5	4.5	1.8	0.8
1975:2	6.9	6.9	7.3	8.2	7.7

Sources: Based on tables 5 and 6.

a. Each sample period begins with 1952:2 and has a terminal point that moves systematically from 1966:2 in steps of four quarters.

amination. One way to address this issue is to ask how the various specifications would have performed had they been used in earlier periods for short-term forecasting or in somewhat longer-term extrapolations. To examine the short-term forecasting properties, a number of specifications were estimated from 1952:2 to an endpoint that was first set at 1966:2 and subsequently extended four quarters at a time. The detailed results will not be reported; but all of the "new" variables examined in table 6 above—the marginal-debits variables, previous peak interest rates, and income—were virtually always statistically significant in the various regressions. That this is not a sufficient basis for preferring these modifications is indicated in table 7, which reports the RMSEs for four-quarter post-sample forecasts. While scorekeeping with these numbers is not an unambiguous matter, for either five or six of the eight stopping points before the recent puzzle set in, the basic specification of equation 5.1, or the version with net worth, equation 5.6, outperformed the various specifications from table 6. The net-worth version is, in fact, better than equation 5.1 in seven out of the eight years.[33]

Another result apparent in table 7 is that the linear form of the peak

33. The perhaps conspicuous absence of a net-worth variable in table 6 reflects the fact that net worth turns insignificant if used along with the ratchet variables.

interest rate, which performed so well in the extrapolations of equation 6.6, estimated through 1973:4, is inferior to the logarithmic version prior to 1974.[34] This conclusion is even more strongly reinforced by the data in table 8, which reports summary statistics for simulations that begin in various years and run forward to the end of 1973. The equation based on the linear peak rate (6.6) clearly extrapolates distinctly worse than the one based on the logarithmic form (6.5). However, the latter is still not as good as the basic specification of equation 5.1.

What this suggests to me is that the equations in table 6 provide only a mirage of an explanation of the recent puzzle. More particularly, with data prior to 1974, either the conventional equation, 5.1, or the equation with net worth added, 5.6, is clearly preferable to the best of the alternatives in table 6.

Furthermore, decomposing the post-1973 errors, as table 7 does, makes clear that the modified equations are somewhat less impressive relative to the basic equation even in the most recent period. Notably, while the modified equations do better for the year 1974:3–1975:2, they do worse for the last four quarters shown, ending in 1976:2.[35]

Not surprisingly, a Chow test on the last four observations allows one to reject the hypothesis of stability for equations 6.5 and 6.6.[36]

How should these various findings be interpreted? Perhaps the puzzle remains because I simply have not been clever enough, and I have some sympathy with this view. In particular, the uniform statistical significance of the peak-interest-rate variable and the various debits variables suggests that something systematic is going on above and beyond the conventional specification. While I have exploited these regularities to some extent, there may yet be a better way to handle them. Perhaps the money-demand function has truly shifted. If this is the case, a number of important questions must be answered. The first order of business, however, is to examine

34. The individual regressions that lie behind table 7 reveal a systematic decline over time in the coefficient of the peak interest rate when entered in linear fashion, thus suggesting a functional misspecification.

35. Of course, as noted above, this is not true for simulations starting in 1974:1. What this points up, in part, is the sensitivity of simulation exercises to initial conditions, especially for short forecasting horizons. This, in itself, should make one wary of basing any firm conclusions on simulations in a particular sample period.

36. This shift does not show up if one splits the entire period in half and does a conventional stability test on the equations in table 6. However, a crude examination of the subperiod equations suggests that something different is going on in the two halves of the sample.

Table 8. Errors for Longer-Term Simulations for Alternative Specifications, 1966:2–1970:2 Endpoints[a]

Billions of dollars

	Root-mean-square error				Out-of-sample error for 1973:4			
Estimation endpoint (year and quarter)	*Equation form 5.1*	*Equation form 5.6*	*Equation form 6.5*	*Equation form 6.6*	*Equation form 5.1*	*Equation form 5.6*	*Equation form 6.5*	*Equation form 6.6*
1966:2	8.7	8.3	9.3	18.6	−13.4	−13.0	13.5	29.1
1967:2	2.1	2.5	13.4	21.3	−1.3	−0.2	18.4	31.0
1968:2	3.2	2.1	8.9	15.9	−4.6	−3.9	11.4	21.7
1969:2	3.4	1.9	5.0	9.0	−4.7	−2.8	5.7	11.3
1970:2	2.7	2.1	2.1	2.2	−3.7	−3.6	2.5	3.1

Sources: Tables 5 and 6.

a. The equations were estimated from 1952:2 to the endpoint.

a third possibility—that aggregation over behaviorally diverse sectors may induce the kind of instability observed.

Sectoral Disaggregation of Money Demand

Like all economic aggregates, total money demand reflects the actions of diverse groups, each of whom, in principle, may have a different behavioral function. In view of the nature of the results obtained in the previous section, disaggregation into more homogeneous behavioral groups seems worthwhile.

Unfortunately, as I discovered in earlier work, this is easier said than done. One problem is data. Two basic sources yield sectoral splits of money holdings, the complete set of sectoral accounts contained in the Federal Reserve Board's flow-of-funds accounts (FOF), and its Demand Deposit Ownership Survey (DDOS).[37] The FOF data are available quarterly since 1952 and permit a breakdown of money holdings into five major sectors: household, nonfinancial business, financial business, state and local government, and the rest of the world. The DDOS data are available monthly, but unfortunately only since 1970 so that they are not directly very useful for the type of analysis pursued here.[38] Indirectly, however, they may be valuable since they appear to have permitted a substantial improvement in the breakdown between the business and household sectors in the FOF accounts.

Some selected data from the most recent revision are given in table 9. Comparing these with "old" data for 1972 indicates that money holdings of business for that year have been revised upward by nearly $20 billion while those of households have been marked down by $15 billion.[39]

37. One important difference between the two sources is that the FOF data comprise currency plus demand deposits while the DDOS data cover demand deposits only. For a more detailed description of the DDOS data and a reconciliation with the FOF data, see "Survey of Demand Deposit Ownership," *Federal Reserve Bulletin*, vol. 57 (June 1971), pp. 456–67.

38. The monthly data have recently been used in an interesting paper by Helen T. Farr, Richard D. Porter, and Eleanor M. Pruitt, "The Demand Deposit Ownership Survey" (Board of Governors of the Federal Reserve System, n.d.; processed). Besides making a strong case for the virtues of a sectoral disaggregation of money demand, the paper provides a good introduction to the DDOS data.

39. The business data are defined here (and in my earlier paper) to include mail float. This is a slight overstatement but unfortunately there are no data for a reliable sectoral breakdown of mail float.

Table 9. Money Holdings by Sector, End of Year, 1952, 1972, and 1975
Billions of dollars

Sector	*1952*	*1972*	*1975*	*1972 before revisions*
Business[a]	52.9	91.5	98.9	72.3
Household	62.4	141.4	170.1	156.5
State and local government	7.2	15.1	14.3	14.6
Financial	6.7	14.9	16.9	17.0
Rest of the world	2.0	8.1	14.0	7.8
All sectors	131.2	271.0	314.2	268.3

Sources: Board of Governors of the Federal Reserve System, "Flow of Funds Accounts, 1945–1972" (FRB, 1973; processed); "Flow of Funds Accounts, 2nd Quarter 1976; Revised Data, 1966–1975" (FRB, 1976; processed). Figures are rounded.
a. Includes mail float.

In principle, money holdings for each sector should be analyzed in the context of a full treatment of its assets and liabilities. To keep things manageable, however, I shall take a somewhat more empirical approach, relying on the same general form of specification used above.[40]

BUSINESS SECTOR

For the nonfinancial business sector, which currently holds roughly 30 percent of the narrowly defined money stock, at least four measures of transactions are readily available: GNP, gross business product, manufacturing and trade sales, and debits. Equations using each of these measures in conjunction with the commercial paper rate, the previous peak commercial paper rate, and a lagged dependent variable are shown in table 10.[41] All these equations seem reasonably successful, and they are compared further in the first four columns of table 11. That table reports the RMSEs for longer-term simulations (ending in 1973:4) based on

40. I used both available forms of the basic data—the seasonally adjusted flows and the unadjusted end-of-quarter levels. The flows were used by cumulating them into stocks, with the initial stock calculated by assuming that the average adjusted and unadjusted stocks were equal for the year 1952. The unadjusted stocks were used directly along with seasonal dummy variables. The two methods, in fact, gave closely similar parameter estimates so, with the exception of some summary simulations, only the seasonally adjusted results will be reported.

41. All use the nominal-adjustment specification. The GNP deflator is used in equation 10.1 while the business-product deflator is used in the remaining three equations.

Table 10. Money-Demand Equations for the Business Sector with Alternative Transactions Variables[a]

		Coefficient				Summary statistic	
		Commercial paper rate					
Equation	*Transactions variable*	*Current*	*Previous peak*	*Trans-actions*	*Money lagged*	R^2	ρ
10.1	Sales	−0.032 (3.7)	−0.004 (0.3)	0.127 (3.0)	0.785 (10.7)	0.929	0.16
10.2	Debits	−0.022 (2.8)	−0.011 (0.5)	0.043 (2.1)	0.858 (12.7)	0.925	0.13
10.3	Business product	−0.028 (3.5)	−0.028 (1.8)	0.138 (3.3)	0.760 (10.1)	0.931	0.14
10.4	Gross national product	−0.026 (3.3)	−0.033 (1.9)	0.123 (3.3)	0.767 (10.2)	0.894	0.13

Sources: See tables 5 and 9. The numbers in parentheses are *t*-ratios.

a. All variables enter logarithmically per capita and all equations are estimated by a Cochrane-Orcutt least-squares procedure over 1952:2–1973:4.

Table 11. Errors for Simulations for the Business Sector, 1966:2–1973:4 Endpoints[a]

Billions of dollars

					Variations on equation 10.4			
Estimation endpoint (year and quarter)	*Equation form 10.1 (1)*	*Equation form 10.2 (2)*	*Equation form 10.3 (3)*	*Equation form 10.4 (4)*	*Peak rate linear (5)*	*Peak rate omitted (6)*	*Seasonally unadjusted data (7)*	*Business loans instead of GNP (8)*
			Root-mean-square error to 1973:4 from estimation endpoint					
1966:2	9.6	4.2	3.1	3.4	3.6	4.7	2.4	3.3
1967:2	5.5	2.8	2.4	2.2	6.4	2.8	2.4	2.3
1968:2	6.8	2.9	2.4	1.9	6.7	2.8	2.4	2.9
1969:2	7.5	3.4	2.3	2.4	2.4	3.7	2.2	1.9
1970:2	6.4	3.6	2.7	2.7	2.7	3.4	2.5	2.4
			Root-mean-square error to 1976:2 from 1973:4					
1973:4	8.3	8.8	5.8	5.6	3.9	5.7	6.6	5.2
				Error in 1976:2				
1973:4	−13.3	−14.3	−10.3	−9.8	−7.4	−10.2	−10.1	−8.2

Source: Derived from equations in table 10.

a. The equations were estimated from 1952:3 to the endpoint and extrapolated to 1973:4, except for the 1973:4 endpoint, for which the extrapolation is to 1976:2.

table 10 specifications estimated through various parts of the sample along with simulations from some variants of equation 10.4. In comparisons of the first four columns, the equations using GNP or business product (10.3 and 10.4) dominate the sales or debits specifications (10.1 and 10.2). The choice between GNP and business product is a toss-up.[42]

All the equations characterized in the first four columns make use of the peak commercial paper rate in logarithmic form, a variable whose status was left in question in the aggregate results above. However, as columns 5 and 6 of table 11 show, the logarithmic peak rate dominates a specification that excludes this variable or a specification in which it is entered linearly.[43]

While equations 10.3 and 10.4 seem reasonable over the pre-1974 period, a number of other variables were tried to see whether they could be improved upon. Among these were previous peak GNP, the marginal-debits variables used earlier, and various output-composition variables including inventories. None of these improved on the record of the simpler equations.

Business Loans. One explanation often advanced for business money holdings is the need to hold compensating balances against loans, lines of credit, or other services.[44] Thus a shift in business financing away from loan demand, or even an expectation of such a shift on the part of businesses, could cause a decline in business holdings of deposits. One crude way to allow for this factor is to include the volume of commercial loans in equation 10.4.[45] The resulting coefficients on both GNP and loans are positive but insignificant. Commercial loans and any of the transactions variables are so highly correlated that it is impossible to disentangle their separate effects.[46] Adopting the bizarre tack of using a commercial-loan

42. To keep the results with different deflators comparable, all RMSEs have been expressed in terms of the overall implicit deflator.

43. It might also be noted that, in logarithmic form, the coefficient of the peak rate appears quite stable for different sample periods.

44. Indeed, at least one writer has argued that this is essentially the only reason that firms hold demand deposits. See Case M. Sprenkle, *Effects of Large Firm and Bank Behavior on the Demand for Money of Large Firms* (American Bankers Association, 1971).

45. This method is crude for a variety of reasons: compensating-balance requirements may vary cyclically; balances may compensate banks for other services; and firms would hold some of these balances in any event.

46. The correlation between GNP and the stock of commercial loans over the period 1952–73 is 0.995. Attempts at getting around this by constraining the income elasticity and estimating a loan coefficient revealed a total inability to discriminate among the various point estimates on the basis of the sum of squared residuals.

variable *instead of* a measure of transactions yields an equally acceptable equation, as shown by the simulation results in column 8 of table 11.

My inability to identify a separate effect for the commercial-loan variable is unfortunate in view of the recent behavior of commercial loans. Indeed, as has been noted elsewhere, one of the unique features of the present period is the failure of business loans to grow, as they typically do during recoveries.[47] Such loans have, rather, declined, with the drop particularly noticeable at large banks. In part, this reflects the strong growth of funds internally generated by firms, the extended period over which inventories have been reduced or increased only moderately, and a shift to longer-term financing by firms.[48] The inability to get a separate explanatory role for loans in the equations means an inability to capture the possible importance of these effects in the recent period.[49]

Post-1973 Results. The performance of the business equations in the most recent quarters is summarized in the last two rows of table 11. There, the error characteristics in the post-1973 quarters show that the performance of the business equation prior to 1974 breaks down dramatically for all the specifications in the most recent ten quarters. The results in column 4, for example, imply an RMSE of about 7 percent and a 1976:2 error of about 13 percent. As in the aggregate equations, the bulk of the error in the last ten quarters stems from the performance of the equations over the last four quarters.[50] While it is certainly possible that business-loan and business-financing variables partially solve the puzzle, this judgment is at best speculative.[51]

HOUSEHOLD SECTOR

Several equations for the household sector using alternative transactions variables are given in table 12. All the equations seem to "work," al-

47. For a discussion, see Alton Gilbert, "Bank Financing of the Recovery," Federal Reserve Bank of St. Louis, *Review*, vol. 58 (July 1976), pp. 2–9.

48. For details, see ibid. I also tried variables relating to internal funds, gross investment, and funds raised in credit markets, but these never attained statistical significance over the pre-1973 period.

49. However, it should be noted that Farr and others, "Demand Deposit Ownership Survey," who were able to get a loan variable in their monthly equation, still had considerable difficulty with the most recent period.

50. This can be seen in table 15 below, which reports the RMSEs for four-quarter intervals.

51. In this regard, it is somewhat curious that the specification that uses commercial loans as a transactions variable (column 8) does better than most of those with a conventional transactions variable.

Table 12. Money-Demand Equations for the Household Sector with Alternative Transactions Variables[a]

Equation	Transactions variable	Coefficient				Summary statistic	
		Time deposit rate	Trans-actions	Money lagged	Change in wealth	R^2	ρ
12.1	Gross national product	−0.045	0.170	0.886	...	0.955	−0.26
		(3.2)	(4.5)	(21.0)			
12.2	Consumption	−0.066	0.234	0.830	...	0.960	−0.27
		(4.0)	(4.9)	(17.7)			
12.3	Personal income	−0.070	0.222	0.804	...	0.961	−0.26
		(4.3)	(5.3)	(16.5)			
12.4	Personal income	−0.069	0.218	0.812	0.205	0.962	−0.32
		(4.4)	(5.4)	(17.5)	(2.0)		

Sources: See tables 5 and 9.

a. The equations are in logarithmic per capita terms and are estimated from 1952:3 to 1973:4. The gross national product deflator is used in 12.1 and the consumption deflator in the remaining equations. The numbers in parentheses are *t*-ratios.

Table 13. Errors for Simulations for the Household Sector, 1966:2–1973:4 Endpoints[a]

Billions of 1972 dollars

Estimation endpoint (year and quarter)	*Equation form 12.1*	*Equation form 12.2*	*Equation form 12.3*	*Equation form 12.4*	*Equation form 12.4 with seasonally unadjusted data*
	Root-mean-square error to 1973:4 from estimation endpoint				
1966:2	13.7	11.4	10.2	8.0	9.9
1967:2	11.3	8.2	7.6	4.8	7.4
1968:2	6.6	2.8	3.2	2.3	4.8
1969:2	4.1	2.3	2.4	2.6	3.5
1970:2	4.1	2.3	3.0	2.4	3.2
	Root-mean-square error to 1976:2 from 1973:4				
1973:4	4.0	5.7	4.8	4.4	3.7
	Error in 1976:2				
1973:4	−6.2	−10.1	−8.0	−8.8	−4.8

Sources: Derived from equations in table 12.

a. The equations were estimated from 1952:3 to the endpoint and extrapolated to 1973:4, except for the 1973:4 endpoint, for which the extrapolation is to 1976:2.

though it should be noted that the Treasury bill rate is omitted from these equations because it was never significant. Among other variables that proved equally inconsequential are the two ratchet variables, various output-composition measures, and the level of net worth. A change in the wealth variable, however, was marginally significant and one result with this variable is reported in equation 12.4.

Table 13 reports the summary results for the longer-term simulations with the household-sector equations, paralleling table 11 for the business sector. Some of the RMSEs are a bit large in the earlier periods, but they settle down after a while. Of the three transactions variables, in the pre-1974 period GNP is clearly the worst, while consumption and personal income are equally good. It is also clear that the change-in-wealth variable substantially improves the simulation performance prior to 1974.

In the most recent period, the overestimate in money demand that appears in the aggregate and business-sector projections is readily apparent in the household sector as well, although the percentage errors are smaller than those in the business sector. For example, equation 12.4 yields an

RMSE of 3.4 percent and an error in 1976:2 of 6.8 percent. Other specifications, such as equation 12.1, do somewhat better but, as in the business sector, these are not the equations one would have bet on using the prepuzzle results. Interestingly, the equation with seasonally unadjusted data does the best in the recent-period projections.

REMAINING SECTORS

One estimated equation for each of the remaining three sectors is given in table 14. Money holdings of the financial sector, which is something of a hybrid, are taken to depend on savings deposits (as a scale variable) and the Treasury bill rate.[52] In the state and local government sector money holdings were taken to depend on state and local government spending as a transactions variable and on the current and previous peak values of the commercial paper rate. Money holdings of the rest of the world were taken simply as a function of GNP.

Quite evidently, all these equations are extremely ad hoc, although they do fit the data reasonably well. Furthermore, as the last two columns in table 14 indicate, they extrapolate in satisfactory fashion in the post-1973 period. Evidence on the performance of these equations in earlier periods is contained in table 15. However, since the main reason for estimating these equations is merely to "close the system" so as to be able to predict M_1 by aggregating the various components, these specifications will not be scrutinized further.

ADDING UP

There are two primary reasons for carrying out the present exercise in disaggregation. The first, based on the premise that sectors behave differently, is to move away from the implicit specification error committed in an aggregate equation. In this regard, sectoral differences clearly emerge in the previously reported results. For example, different sets of explanatory variables were important for the household and the business sectors. Furthermore, the long-run income and interest elasticities differed in the two sectors. For households, the income and interest elasticities are

52. The financial sector is considerably more extensive than the thrift institutions so that a broader-scale variable is undoubtedly appropriate. I tried a proxy for financial debits, but it was not significant.

Table 14. Money-Demand Equations for the Financial, State and Local Government, and Rest of World Sectors, by Transactions Measure[a]

		Coefficient[b]				Summary statistic		Out-of-sample error (billions of 1972 dollars)[c]	
Sector	*Transactions measure*	*Money lagged*	*Trans-actions*	*Short-term interest rate*[d]	*Peak commercial paper rate*	R^2	ρ	*Root-mean-square error*	*Error for 1976:2*
Financial	Savings deposits	0.791	0.099	−0.014	...	0.992	−0.04	0.3	−0.3
		(12.3)	(3.6)	(1.9)				(2.7)	(2.4)
State and local government	State and local government spending	0.922	0.125	−0.016	−0.017	0.863	−0.28	0.5	−0.1
		(21.6)	(2.8)	(1.1)	(2.3)			(4.8)	(0.8)
Rest of world	Gross national product	0.828	0.345	...	...	0.967	−0.16	1.2	0.3
		(13.6)	(3.1)					(11.4)	(2.8)

Sources: See tables 5 and 9.
a. For general notes see table 5. The financial equation was run in undeflated form while the remaining two equations are deflated by the implicit deflator for state and local government expenditures and the implicit GNP deflator, respectively. The root-mean-square errors and 1976:2 errors are all in terms of the implicit GNP deflator.
b. The numbers in parentheses are *t*-ratios.
c. The numbers in parentheses are percentage errors.
d. The Treasury bill rate is used in the financial sector and the commercial paper rate in the state and local government sector.

about 1.0 and 0.35, respectively, while the corresponding numbers for the business sector are about 0.5 and 0.25. These interest elasticities further suggest that the overall interest elasticities may be understated if computed from a single aggregate equation.

The second reason for disaggregation was the notion that tailoring the specifications to fit the individual sectors might yield an implied aggregate equation that was more useful for extrapolation than a directly estimated aggregate one. In the background was the hope that such disaggregation might reduce the puzzle. Failing that, of course, disaggregation would at least point to the sectors in which the problem really lies. Table 15 sheds light on some of these issues.

The table contains the RMSEs for four-quarter out-of-sample extrapolations for the various equations, for the sum of these equations, and for a single aggregate equation. The latter uses the specification of 5.1.[53] Comparing the last two columns of table 15 suggests that up to mid-1974 the disaggregated equations, on the whole, do better than the aggregate one in tracking M_1. This provides some small support for the virtues of disaggregation.

For the most recent period, the results from both the aggregate equation and the sum of the component equations are rather poor. This conclusion is reinforced by the quarterly simulation errors (listed below in billions of 1972 dollars) for the aggregate equation and the sum of the component equations, based on estimation through the end of 1973, one of the last obviously "safe" quarters.

	1974				*1975*				*1976*	
	1	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*
Aggregate	−2.8	−1.9	−6.4	−5.3	−13.4	−6.3	−9.5	−14.3	−18.1	−21.6
Sum of components	−1.5	0.3	−2.5	−0.4	− 8.9	−2.7	−6.5	−11.2	−15.2	−18.7

These results suggest that 1974 was not much of a problem, that 1975:1 perhaps marks the beginning of the trouble, and that the shortfall in money demand has really mushroomed in the last three quarters.

The residual in 1976:2 of $18.7 billion (in 1972 prices) can be attributed entirely to the business and household sectors; the other three sectors net out to a zero error. Of this $18.7 billion, businesses account

53. While other forms of the aggregate equation could have been used, as table 7 shows, equation 5.1 is probably the best choice for the pre-1974 period. The aggregate equation is based on the FOF definition of M_1 which is an end-of-quarter estimate, so the errors shown in table 15 differ slightly from those in table 7.

Table 15. Root-Mean-Square Errors for Four-Quarter Extrapolations for Sectoral and Total Money Holdings, 1966:2–1975:2 Endpoints

Billions of 1972 dollars

	Sectoral equation						
Estimation endpoint (year and quarter)	*Business*	*Household*	*Financial*	*State and local government*	*Rest of world*	*Total, all sectors*	*Aggregate equation*
1966:2	3.5	1.9	0.3	0.7	0.6	2.4	5.7
1967:2	0.9	2.2	0.4	0.4	0.3	1.6	1.8
1968:2	1.2	1.5	0.3	0.8	0.4	1.3	1.6
1969:2	1.1	2.7	0.2	1.2	0.4	2.6	4.9
1970:2	3.3	2.0	0.6	1.2	0.6	2.6	1.1
1971:2	2.4	2.4	0.5	0.5	0.4	4.7	6.0
1972:2	1.8	2.6	0.4	0.2	0.3	2.4	2.5
1973:2	1.6	2.2	0.5	0.6	1.5	2.5	1.9
1974:2	2.6	3.4	0.6	0.8	0.6	5.3	6.8
1975:2	4.4	5.3	0.3	0.6	0.5	10.3	6.4

Sources: Based on equation 10.4 in table 10, 12.4 in table 12, and those in table 14, except the last column, which is based on equation 5.1 in table 5 applied to the aggregate flow-of-funds data. Results with these data differ slightly from those presented in table 7 for equation 5.1.

for $9.8 billion while households account for $8.8 billion. The results using seasonally unadjusted data suggest that even more of the difficulty lies with the business sector.[54] By judicious choice of other specifications, one could have reduced the error in the last quarter by at least $5 billion and perhaps as much as $8 billion or $9 billion, but this is obviously silly.[55] The point of this exercise is not to exhibit the best-fitting equation over the most recent quarters, but to see how the best equations, judged by historical standards, would fit the recent period. On this criterion, recent behavior, whether looked at in an aggregate or disaggregated context, is clearly outside the range of historical experience. The bulk of the error appears to stem from the performance of the business equation in the last few quarters, although the household equation is not without its difficulties.

Overview

By this juncture it should be apparent that a large unexplained error remains in the money-demand function. Further insight into this phenomenon may come from a brief exploration of potentially important factors omitted from the specifications above, especially institutional developments that may have lowered transactions costs and thus reduced the demand for money. Among the most notable of these are negotiable orders of withdrawal (NOW) accounts, money-market mutual funds, savings deposits of businesses and state and local governments, checking accounts at mutual savings banks, automatic investment accounts, telephone transfers between savings and checking accounts, and overdraft privileges. Because it was unclear how to "model" these developments, I did not modify the specification for them. Nevertheless, it is possible to say a bit more in this context.

Data are available to reflect use of some of these innovations, and, more important, to imply that at least some part of this use has come at the expense of demand deposits. NOW accounts, for example, rose from about $200 million in mid-1974 to about $1.6 billion in 1976:3, with the

54. The corresponding error in 1976:2 is $14.8 billion, of which $10.1 billion is due to the business sector and only $4.8 billion to the household sector.

55. For example, if one used equation 10.4 with a linear peak rate and equation 12.1, the error in 1976:2 would be reduced by $5 billion.

bulk of the growth in the last year. Similarly, checking accounts at mutual savings banks have increased from $200 million in 1975:3 to $400 million in 1976:3. The most marked expansion has taken place in savings deposits of state and local governments and businesses. The former grew from about $500 million in 1975:3 to over $3 billion in 1976:3, while the latter, first authorized in November 1975, now stand at over $6½ billion. How much of the increase in all these categories has been at the expense of demand deposits is not easy to establish, but some crude evidence suggests that about $4 billion would not be a bad guess.[56]

In the spirit of identifying factors omitted from the equations, it is also appropriate to make an adjustment for compensating-balance requirements. Commercial loans at large banks fell by about $10 billion between July 1975 and July 1976, suggesting that about $1 billion to $1½ billion of the shortfall in demand deposits might be accounted for by this source. Furthermore, some survey evidence suggests that compensating-balance requirements have eased in the recent period so that the total effect from this source could be substantially higher.

Adding up all the bits and pieces gives something on the order of $5 billion to $6 billion as a plausible estimate of a money-demand shortfall that could be readily associated with the factors just described. This accounts for roughly 20 percent of the error in the basic equation 5.1 but what is left is still too large to be explained by chance.

Part of the explanation of the remaining error undoubtedly lies in the impact of institutional developments that operate in more subtle ways—telephone transfers, overdrafts, and automatic-investment accounts. Here the primary effect on transactions costs stems from the mere existence of the institution, and data on actual use (even if it were available) is, at best, indirectly relevant. For example, the availability of an overdraft privilege, which removes the problem of check bouncing, might lead individuals to cut back on demand deposits. Furthermore, this cutback could well be distributed across a broad range of assets so that it might be difficult to isolate. A similar problem is created by the automatic-investment account, under which, at the end of a working day, a bank will invest a firm's "excess" balances, often by borrowing the funds from its customer. The bank thus avoids reserve requirements and, in effect, pays

56. For more details, see J. Paulus and S. H. Axilrod, "Recent Regulatory Changes and Financial Innovations Affecting the Growth of the Monetary Aggregates" (Board of Governors of the Federal Reserve System, 1976; processed).

interest on demand deposits. However, since a firm could have invested on its own, the main consequence is the reduction of the effective brokerage charge, whose result is difficult to assess.[57]

This discussion highlights the pressing research need to come to grips with the way in which these institutional developments impinge on transactions costs and thus on money demand. Indeed, these developments are likely to become more widespread and numerous (for example, currently pending is authorization to permit transfers from saving accounts to cover demand-deposit overdrafts). Their impact on the demand for M_1 is thus likely to grow, raising the specter that future residuals in a conventional M_1 equation will dwarf the present ones.

TIME DEPOSITS AND M_2

The shortfall in M_1 demand must, of necessity, find its "mirror image" somewhere else in the balance sheet. In a limited attempt to find this image, I briefly explored the behavior of time deposits. That this is a plausible place to look is suggested both by the substantial growth in savings deposits of businesses and state and local governments just noted, and by the fact that M_2 seems to be coming in at the high end of the Fed's target-growth range while M_1 is at the low end of its range.

The first row of table 16 reports the results of estimating a per capita nominal-adjustment version (that is, an equation like 5.1) for time deposits over the period 1952:2–1973:4. The resulting parameter estimates are plausible; and, as the table indicates, when dynamically simulated, the equation understates the actual level in 1976:2 by $8 billion in 1972 prices. Taken at face value, this suggests that a significant part of the error in M_1 has shown up in time deposits. While this conclusion is in keeping with the arithmetic exercise, unfortunately it turns out to be a bit facile. As shown in table 17, which summarizes simulations based

57. A related way in which cash-management techniques may reduce the demand for money is by improving the synchronization between payments and receipts. Examples of this include arrangements for offsetting interbusiness payments without cash transactions (something banks do in a very large way through various types of clearing arrangements); use of drafts, rather than checks, which transfer funds only as needed; and use of lockbox facilities to speed up the collection process. Unfortunately, it is not clear how to quantify these developments. For a more formal approach to the problem, see, for example, Merton H. Miller and Daniel Orr, "A Model of the Demand for Money by Firms," *Quarterly Journal of Economics*, vol. 80 (August 1966), pp. 413–35.

Table 16. Equations for Time Deposits and M_2 and Errors[a]

		Coefficient[b]					Summary statistic			Out-of-sample error (billions of 1972 dollars)[c]	
			Interest rate								
Equation	*Dependent variable*	*Gross national product*	*Treasury bills*	*Time deposits*	*Thrift institutions*	*Lagged dependent variable*	R^2	*Standard error*	ρ	*Root-mean-square error*	*Error for 1976:2*
16.1	Time deposits	0.273 (3.3)	−0.037 (7.3)	0.061 (5.5)	...	0.875 (22.9)	0.999	0.007	0.59	7.1 (2.5)	8.0 (2.7)
16.2	Currency and demand and time deposits, M_2	0.206 (3.8)	−0.021 (7.5)	0.029 (2.4)	−0.071 (2.5)	0.884 (19.5)	0.999	0.004	0.52	3.1 (0.6)	−4.4 (0.8)

Sources: See table 5.

a. All variables enter logarithmically per capita and all equations are estimated by a Cochrane-Orcutt least-squares procedure over 1952:2–1973:4. All summary statistics for extrapolations are based on dynamic simulations beginning in 1974:1.

b. The numbers in parentheses are t-ratios.

c. The numbers in parentheses are percentage errors.

Table 17. Errors for Longer-Term Simulations for Time Deposits and M_2, 1966:2–1970:2 Endpoints[a]

Billions of 1972 dollars

Estimation endpoint (year and quarter)	Root-mean-square error to 1973:4 from estimated endpoint			Error for 1973:4		
	Equation 16.1	*Equation 16.2*	*Equation 16.3*	*Equation 16.1*	*Equation 16.2*	*Equation 16.3*
1966:2	19.7	16.7	15.0	33.5	20.5	22.9
1967:2	7.3	11.1	4.8	12.5	10.9	−5.6
1968:2	4.8	5.2	4.4	7.5	−6.0	−4.1
1969:2	4.1	6.2	4.4	4.3	−7.6	−4.1
1970:2	8.6	7.4	7.0	10.7	2.4	6.2

Sources: Based on table 16 and text equation 16.3.

a. The equations were estimated from 1952:3 to the endpoint and extrapolated to 1973:4.

on pre-1974 data, equation 16.1 has had a clear tendency to understate time deposits in out-of-sample extrapolations in all previous periods. Furthermore, when I compared equation 16.1 with a specification based on the real-adjustment model, it was evident that the latter had smaller simulation errors in earlier periods. This equation also produced a 1976:2 error of only \$1½ billion, hardly much of an offset to the error in M_1, and the simulation results shown in table 17 for equation 16.3 were also somewhat better than those for 16.1.[58]

The estimated equation over 1952:2–1973:4 was

$$(16.3)\qquad \ln (TD/P) = \underset{(2.3)}{-0.92} + \underset{(2.5)}{0.234} \ln y + \underset{(5.0)}{0.054} \ln RTD - \underset{(6.7)}{0.038} \ln RTB + \underset{(18.1)}{0.867} \ln (TD/P)_{-1}.$$

While I would not defend the real-adjustment specification on a priori grounds, this at least indicates that equation 16.1 does not give the definitive answer on the subject. Attempts to improve this equation by including competing rates for the thrift institutions (on both passbooks and certificates) and net worth met with little success.

A final attempt I made in this vein was to look at M_2. The same specification as in equation 16.1 yielded an unsatisfactory equation in that the

58. Virtually all of the difference between the \$8 billion and the \$1½ billion figures stems from the use of P_t rather than P_{t-1}, and not from deflation by population.

coefficient of the time deposit rate was essentially zero.[59] However, adding the average passbook rate at savings and loan associations and mutual savings banks appears to fix the matter, as shown in equation 16.2 in table 16. All the variables in 16.2 are appropriately signed and statistically significant and the equation has an RMSE over the last ten quarters of 0.6 percent and an error in 1976:2 of only 0.8 percent. Somewhat skeptical in view of my earlier experience, I next split the full sample period from 1952:2 to 1976:2 in half and the equation passed a stability test. Finally, as the appropriate columns of table 17 indicate, at least since 1968 this equation performs reasonably well in longer-term simulations with no particular tendency to overpredict or underpredict. From this limited evidence, at least, no particular shift is apparent in the M_2 equation.

However, for several reasons, I think it would be a mistake to interpret this finding as clearing up the mystery in M_1. First, there remains the inconsistency between the equations for time deposits and for M_2, with the thrift rate important only in the latter. Second, since all of the shortfall in M_1 can hardly be expected to show up in time deposits ($M_2 - M_1$), there is a sense in which the M_2 equation "overexplains" the shortfall. Finally, the specification I have used for M_2 has not been scrutinized all that carefully in comparison with alternative specifications. Nevertheless, some may be tempted to draw some policy morals from the apparent stability of M_2, and this issue is touched on in the final section.

Implications and Conclusions

The results of this paper are difficult to characterize. Insofar as the objective was an improved specification of the demand function for M_1, capable of explaining the current shortfall in money demand, the paper is rather a failure. Specifications that seem most reasonable on the basis of earlier data are not the ones that make a substantial dent in explaining the recent data. The paper has served to pinpoint the business sector as a prime source of the current puzzle, but this hardly constitutes an explanation. Of course, negative results of the sort I have presented never "prove"

59. One of the things that has always bothered me about an M_2 equation is that the time deposit rate does double duty, serving both as an own rate for the time deposit component and as a competing rate for the M_1 component.

anything. There is always the possibility that someone with more ingenuity will be able to repackage the data so as to make one homogeneous period out of 1952 to 1976, but my fatigue at least entitles me to some skepticism. Perhaps the most promising tack is to cope with the problem of transaction costs.

For the present, while one can quibble about formal definitions of a "shift" in a behavioral function, it seems plausible to presume that, at a practical level, *some* sort of shift has occurred. This presumption, of course, is a result in itself and the question then becomes what lessons to draw from it.

The first obvious task is to ascertain both the current position of the function and whether it has in some sense settled down. One possibility is that the shift is temporary and that the previous relationship will be reestablished so that M_1 will return to its predicted level. For a variety of reasons, some relating to the kinds of ratchet effects found above and others stemming from a potential diminution of the importance of M_1 as a transactions medium, I regard this possibility as unlikely over the long run. However, should there be a tendency in this direction in the near term—for example, if loan demand induces a rebound in business money balances—it would have rather strong implications for the proper course of monetary policy.

A second possibility is that the level of money demand has gradually shifted, and the old function will still predict marginal changes well from here on. This view is suggested by a crude examination of the data on velocity, which, after a rapid rise from 1975:2 to 1976:1, has slowed in the last few quarters to a more normal pace. If this "marginal" view is correct, better forecasts for the most recent quarters might be obtained by excluding the post-1973 data from the sample period because they are likely to contaminate the parameter estimates. Indeed, a test of this procedure could be interpreted as an indirect test of the marginal view. Thus, I ran a dynamic simulation, starting in 1976:1, of equation 5.1, which was estimated through the end of 1973. It produced an error in 1976:3 of $9.8 billion (in 1972 prices). The corresponding error with the same equation estimated through 1975:4 was only $3.4 billion, but the equation displayed some strange parameter estimates. This outcome hardly provides support for the marginal view, at least as yet.

A final possibility is that explaining M_1 calls for a new function in terms of level and marginal responses and perhaps in terms of variables as well.

While I am inclined to this view, since most of the large errors in the existing equations have come in the last few quarters, there is hardly enough evidence to identify a new money-demand function with existing data.[60] Although waiting for more observations may be the inevitable research strategy, unfortunately it will not do when it comes to monetary policy. For, even admitting to confusion over the current state of money demand in itself should have implications for monetary policy. I hasten to note that a number of economists would quarrel with this view.

A "ST. LOUIS EQUATION"

Many economists of the monetarist persuasion would not see much in the present paper to disturb their conventional policy prescription. Curiously enough, many monetarists do not seem much concerned with money-demand functions. The reason may be that they think of them as interest-rate equations normalized on the wrong variable, or else as misspecified "St. Louis equations,"[61] also normalized on the wrong variable. Indeed, this group mainly fears that the apparent instability of money demand will lead to a greater emphasis on interest rates at the expense of the monetary aggregates in the conduct of policy.[62] I have heard some arguments to buttress the case against such a shift in emphasis that might be paraphrased thus: "The St. Louis equation is alive and well and therefore business can proceed as usual." Despite my basic reservations about this approach, I was curious about the factual validity of the matter and hence reestimated several versions of the St. Louis equation.

Following the distributed-lag specification of Andersen and Carlson, I related the change in nominal GNP to current and past changes of both

60. Another possible approach is one that explicitly allows for evolution over time of the estimated parameters. For an example, see Donald J. Mullineaux, "The Stability of the Demand for Money: Some Adaptive Regression Tests" (Federal Reserve Bank of Philadelphia, n.d.; processed).

61. See Leonall C. Andersen and Keith M. Carlson, "A Monetarist Model for Economic Stabilization," Federal Reserve Bank of St. Louis, *Review,* vol. 52 (April 1970), pp. 7–25.

62. At least one economist, implicitly accepting the instability of money demand, has blamed the whole thing on the introduction of flexible exchange rates and, turning things around, has used the instability as an argument for restoring fixed exchange rates. See Eugene A. Birnbaum, "Doubts About Floating Rates," *Wall Street Journal,* May 19, 1976.

the full-employment surplus and a money-stock measure. For the latter, I used both M_1 and M_2 and estimated each equation over two different sample periods, 1953:1–1972:4 and 1953:1–1973:4. These equations were then extrapolated in the out-of-sample quarters up to 1976:2.

The equation using M_1 estimated over the shorter sample period was off in the level of nominal GNP by $42 billion by 1974:3, but got back on track by 1975:2 with an error of only $17 billion. However, over the following four quarters, this equation understated the rise in GNP by a whopping $107 billion and thus ended up in 1976:2 understating the level of GNP by $124 billion. The equation estimated through 1973:4 gave only slightly better results, with the understatement of the change in the last four quarters amounting to $101 billion and an error in the level in 1976:2 of $75 billion. For the equations using M_2, the understatement of the change was somewhat smaller—either $77 billion or $71 billion, depending on which estimates were used. In broad outline, these results are quite consistent with the difficulties experienced with money-demand functions. Consequently, at least by my reading of the evidence, the St. Louis equation seems to be in no better shape than the money-demand function, and policy prescriptions based on the presumption of a stable St. Louis equation certainly need to be reexamined.

IMPLICATIONS FOR MONETARY POLICY

One of the ongoing debates in the conduct of monetary policy is whether interest rates or monetary aggregates should be used to steer the economy. A subsidiary issue in the debates, at least up to this juncture, has been the choice of a particular monetary aggregate. To make clear the principles, first consider a world with a single monetary asset. For such a world, Poole has shown that it is the relative importance of disturbances in the monetary sector vis-à-vis the real sector that determines whether interest rates or monetary aggregates merit greater emphasis in the conduct of policy.[63] Poole's results suggest that an increase in the importance of monetary disturbances should tilt policy in the direction of an interest-rate policy. In conjunction with this principle, the results

63. William Poole, "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model," *Quarterly Journal of Economics*, vol. 84 (May 1970), pp. 197–216.

in this paper clearly argue in favor of an interest-rate policy over an M_1 policy at the present time.[64]

In a realistic policy setting the situation is complicated by the existence of numerous monetary aggregates. In this context, based on the relative stability of the M_2 equation, one can argue that the monetary authority should pay more attention to M_2. It is thus hardly surprising to find that the Fed has hedged its bets by downplaying its emphasis on M_1 at the same time that it is placing more weight on both interest rates and M_2.[65]

While, given a casual application of Poole's results, this response seems plausible, there remain some unanswered questions. First, what will controlling M_2 achieve? Appeal by analogy to Poole's results does not necessarily make this policy the proper response even if M_2 is more stable than M_1. Resolving this issue requires a fleshed-out economic model which, among other things, would presumably allow one to address the virtues of controlling various monetary aggregates (such as M_3) as well as interest rates. A second issue is the controllability of the various aggregates. And a third concerns the relative weights to be attached to various aggregates and interest rates. Given my lingering suspicions of the robustness of the M_2 equation, I suspect that the Fed's relative weights between interest rates and M_2 are skewed more toward M_2 than I would like. I also suspect they are still giving M_1 more weight than it deserves.

Apart from the issue of the variables to be controlled, there remains the fundamental question of what degree of monetary stimulus is consistent with a healthy economic recovery over the near term. Even within the limited scope of the present paper, there is one exercise that might shed some light on this question. I took forecasts of real GNP, the GNP deflator, and the Treasury bill rate from the Michigan quarterly model[66]

64. The application of the Poole framework to the present circumstances is an oversimplification. That framework takes the parameters of the underlying behavioral functions as given and focuses on the additive uncertainty stemming from the disturbance terms. As indicated above, substantial doubt exists as to the values of these parameters in the M_1 equation and this form of uncertainty must be accounted for. See William Brainard, "Uncertainty and the Effectiveness of Policy," *American Economic Review,* vol. 57 (May 1967), pp. 411–25.

65. "The FOMC has taken account of this by giving somewhat greater emphasis to M_2 or money market conditions and by widening the two-months ranges especially that for M_1." Henry Wallich, "Some Technical Aspects of Monetary Policy" (paper delivered to the Institutional Investor Institute, May 1976; processed), p. 9.

66. The Michigan forecast assumes a $13 billion tax cut and leads in 1977 to a year-over-year increase in real GNP and the deflator of 4.3 percent and 5.6 percent,

and used them as inputs to extrapolate the M_2 equation of table 16.[67] The M_2 growth implied by this exercise is 12.8 percent from the third quarter of 1976 to the third quarter of 1977, with not much quarter-to-quarter variability. For what it is worth, this growth rate is well above the 10½ percent that is the upper end of the Fed's target range for M_2 for the corresponding period, suggesting that something—perhaps even the equation—has to give somewhere.

respectively. The forecast Treasury bill rate rises from just under 4.9 percent in 1976:4 to 5.9 percent in 1977:4. See Saul H. Hymans and Harold T. Shapiro, "The U.S. Economic Outlook for 1977" (University of Michigan, November 1976; processed).

67. For this purpose I assumed that the two interest rates on savings would remain at their current levels.

Comments and Discussion

David I. Fand: Goldfeld has given us a thorough analysis of the demand for money; but in spite of the care he has taken, he is unable to track the recent experience with equations that also fit the past. He reluctantly concludes that there has been a shift in the money-demand function and finds that the shift has been most prominent in the money holdings of the business sector. A reduction of perhaps 2 points in the growth rate of M_1 in the past year can be associated with recent changes affecting NOW accounts, business and state and local government savings accounts, and demand deposits at mutual savings banks. Some reduction in the recent M_1 growth rate may be due to measurement error. But, even after making these allowances, a sizable shortfall in money demand still remains unexplained and poses a particular problem for monetarists. By comparison with this large mystery in M_1 behavior, M_2 is explained reasonably well by historical relationships.

Goldfeld pays special attention to how prices should enter into the money-demand equation. In addition to comparing adjustment specifications in real and nominal terms, he estimates a model in which price-level perceptions matter to money holdings. Thus some of the answer to the M_1 puzzle may lie with a reduction in inflationary expectations in 1975, as a result of which perceived real-money balances may have exceeded recorded real-money balances. Some exploratory results in this vein are presented, but they are not wholly successful.

All in all, we are still rather far from understanding the relation between M_1 and recent economic developments. Lacking any final answers to the puzzle, it is instructive to look at the recent period against the background of different views expressed about monetary policy a year ago. First, Arthur Burns and the Federal Reserve Board held that a growth rate of

5 to 7½ percent in M_1 was appropriate. Then a more expansionary view articulated by Perry and Heller considered increases in M_1 of over 8 percent to be necessary to keep interest rates from rising. Finally, a still more expansionary view, articulated by Modigliani, held that M_1 growth rates of perhaps 10 to 15 percent might be needed in order to stabilize short-term rates.

The actual experience in the past year has disappointed all three.

For a time it seemed that the conservative view was more nearly on target, as velocity growth in the first four quarters of the recovery was above even what its proponents were expecting. But if the conservative view was initially the more appropriate, the more expansionary views appear more appropriate for the economic slowdown in the last three quarters of 1976.

Interest rates were falling through most of the seven quarters of the recovery, rather than rising above their levels at the trough of the recession as the conservatives had expected and as most others would have expected, especially if they had known the course of M_1 growth. Finally, there was an unexpected divergence between M_1 and M_2 in recent quarters that needs explaining.

In short, we have all been wrong on important questions at least part of the time during recent quarters, and I am inclined to agree with Goldfeld's view that we have to take a more fundamental look at what is happening to money demand.

William C. Brainard: The "Case of the Missing Money," which Inspector Goldfeld so painstakingly investigated, gives every appearance of remaining an unsolved mystery. Inspectors Perry and Gordon of the Price Squad must take a certain pleasure in finding that their colleagues working the money side of the street are encountering difficulties just like those that plagued them in the case of the vagrant Phillips curve. I'm afraid however, that the citizenry will be alarmed by the collapse of law and order. I, for one, was surprised that so few of the suspects could be identified as being present at the scene of the crime; I had rather supposed that the embarrassment would be the number of suspects who could be incriminated. Perhaps I should also state that I am skeptical of the ability of the demand for money to receive a fair trial in any time-series court.

Goldfeld has given a careful summary of the many leads he has tracked down and the difficulty of finding explanations of the recent "error" that are compatible with earlier experience. I will confine most of my remarks to general issues that arise in the specification and estimation of the demand for money.

Like most investigators, Goldfeld motivates his specification of the demand for money and selection of variables by reference to the Baumol-Tobin transactions model. As Goldfeld recognizes, there is a substantial gap between the variables indicated by the theoretical model and those actually used in empirical studies. Much of his paper is an attempt to see whether refining or changing the variables used to represent the volume of transactions, the opportunity cost of holding money, or the "brokerage charge" for converting earning assets into money fix up the equation. I will follow him in organizing my discussion by these three categories.

Although GNP is a standard transactions variable, it is suspect for a number of reasons. As Goldfeld indicates, GNP nets out or ignores market transactions involving intermediate goods, financial assets, and existing goods, as well as transfer payments. In attempting to find out whether the historical correlation between the volume of transactions and GNP has been broken in recent years, there is probably no substitute for finding direct measures of these transactions. The volume of sales that Goldfeld used in his corporate demand function is one such variable; I would have liked him to find similar measures for other items.

A second difficulty is posed by the likely significant differences in the quantity of money demanded per dollar of different components of GNP. Some components have a higher dollar value of transactions behind a reported dollar contribution to GNP than others—for example, services as compared with final sales of petroleum products. Some components are likely to have a larger volume of transactions per agent and, given economies of scale in financial management, give rise to a smaller demand for money. Similarly, the agents represented in the various components of GNP may differ in the number of transactions (and hence average size) per dollar of transactions, or in the degree of synchronization and uncertainty of payments and receipts. These are, of course, the reasons that a given volume of transactions involving corporations are expected to generate a smaller demand for money than would be expected if the transactions were entirely among households. Market transactions have agents on two sides. Not only can their transactions technologies differ, but, in some cases, the money balances of one of the agents may not even be counted in the private domestic money stock—as, for example, in the case of the government or foreigners.

The scarcity of degrees of freedom obviously precludes entering the components of GNP separately (both product and income sides!) in a single time-series regression. In these circumstances, the idea of using a weighted "GNP" series seems sound. Goldfeld tries, with limited success, the series of Enzler and his coauthors, which infers the weights by the various components' correlation with debits. I believe more could be done along these lines, with perhaps greater weight being placed on "a priori" information about who is included in money demand and the behavior of those who are.

Goldfeld follows the common practice of running a real-money-demand equation, deflating nominal GNP and the money stock by the GNP deflator. In this specification the deflator is serving as both a "transactions" price index and a "brokerage charge" price index. In the real world, prices do not move in lockstep, and the GNP deflator seems a poor choice as a proxy for either of these. The GNP deflator is not a transactions price index. Indeed, an index such as the WPI, which "double counts" as a measure of inflation, would be preferable. Also, the deflator does not, in principle, pick up the changes in the prices of items, such as imports, that are not part of value added. These problems with the deflator may have been important in recent years.

Although it would be harder to show quantitatively, I think that most people would agree that the price index for "brokerage charges" has probably risen less in recent years than the GNP deflator or most goods prices. According to the simplest transactions model, the coefficient (in a nominal-demand equation) on each of these two types of prices should be one-half; if the above presumptions about relative-price movements are correct, it should come as no surprise that an estimated coefficient on the GNP deflator is less than one, and such an equation should not be thrown out of court on the grounds of "illusion." By running the equation in real form, and by excluding a separate price-level term, Goldfeld avoids the possibility of estimating "illusion" in the desired demand for money, which should perhaps be there. One interpretation of the short-run price illusion implied by his preferred adjustment specification is that it is compensating for this sort of misspecification in the "desired demand" function.

The fact that firms use compensating balances and hold deposits to establish lines of credit, and the dynamics of loan "take down," all provide rationalizations for including loans in the demand-for-money equations. Although the recent sluggishness of loan demand seems to help explain the money "error," the author has difficulty distinguishing the effects of loans and transaction variables. The lag structure implied by the partial-adjustment model he uses is easiest to rationalize by a "take down" story. In principle, deposits held to establish lines of credit should lead rather than lag loans and, in the absence of a good proxy for future loan demand, would depend on the prime rate, perhaps in relation to other market rates. Although the interaction between loans and the demand for money may well be important, and experimentation with these variations might be fun, I agree with Goldfeld that the time-series data are unlikely to sort them out satisfactorily.

Whatever the difficulties in distinguishing among various candidates for use as the transactions or interest-rate variables in the demand for money, they are mild compared with the difficulties in sorting out their lag structures. Goldfeld estimates the standard partial-adjustment model. This builds in the assumption that the lagged response of the demand for money is the same with respect to transactions, interest rates, and brokerage charges. This assumption seems highly implausible and, given the low estimated speed of adjustment, implies that the LM curve shifts dramatically with each error in the equation, or with changes in the money supply. I doubt that the demand equation would fit the data very well, even for the sample period, if it were simulated as part of a fuller system. The implications of the equation for the effect of a transitory change in income (say, from a temporary tax rebate) are, perhaps, the most at variance with what I take to be the sense of the transactions model. In that model, money balances serve as a buffer stock, or temporary abode of purchasing power, and one would expect the transitory income to be absorbed passively in money holdings in the short run. In contrast, Goldfeld's partial-adjustment model states that only something on the order of 15 percent of the "long-run" increase in the demand for money will be accommodated in the first quarter. The lags implied about the effect of interest rates are more plausible but still seem rather long to me.

Although estimating separate lag structures for interest rates and income is unlikely to improve the fit and will undoubtedly leave us with insignificant coefficients, it would be instructive to learn what lag structures other than Goldfeld's are compatible with the data. In any case, I don't really mind a hung jury.

General Discussion

Several discussants noted new or highly unusual features of recent experience that might be responsible for the large errors in equations such as Goldfeld's. Martin Feldstein suggested that the adoption of monetary-aggregate targets by the Federal Reserve in the early 1970s could have changed the appropriate statistical-estimation equation. John Kareken reasoned that the new exchange-rate regimes of recent years might require a new specification of money demand appropriate to an open economy with relatively unrestricted holdings of foreign assets. Walter Salant supported this view, noting that the subject of investigation was specifically the demand for dollar money, which would be influenced both by Americans getting out of it and foreigners getting into it. Goldfeld agreed that there might be something in this line and reported that William Branson had found residuals in foreign equations that were just the opposite of those for the U.S. economy.

James Tobin pointed out that the period of missing money corresponded with an unprecedented decline in business bank loans along with a widening differential between interest rates on bank loans and money-market rates. Although Goldfeld reported no success with fitting distributed lags on either past or future loans, Tobin still believed that a decline in the practice of holding compensating balances was very likely one cause of the recent mystery and that the interest-rate differential might help explain it. Kareken agreed, noting that practices with respect to compensating balances have been changing rapidly, so that they could be a source of the recent M_1 shortfall even if the loan variables did not work well in historic equations.

Robert J. Gordon suggested distinguishing the effects of changes in real wealth from changes in real income in determining the marginal flow of savings into demand and time deposits. He noted that real wealth had declined in the mid-1970s, while during the puzzle period more money than usual had gone into savings and time deposits relative to demand deposits. He reasoned that this might reflect a normal pattern of adjustments of liquid assets when individuals were saving to rebuild their wealth.

Michael Wachter thought that, instead of trying to find new variables or specifications that give stable money-demand equations over the period as a whole, it would prove more fruitful to isolate and explain the structural shifts that apparently had occurred. The best course for current analysis might be continually to reestimate the equations and settle for short-term forecasting from them. Edmund Phelps saw some merit in such a strategy, since recent empirical analysis showed that velocity resembled a random walk once the effects of interest rates were accounted for.

Hendrik Houthakker was skeptical about the quality of the data that lay behind the money puzzle. For one thing, M_1 is subject to large revisions. Furthermore, a large discrepancy has emerged between the flow-of-funds accounts and the national income accounts, with the former indicating a considerably higher personal saving rate. If the flow-of-funds accounts are correct, either GNP is overstated or national income is understated. However, as Robert Hall noted, the size of this discrepancy is small relative to the money-demand shortfall.

Phelps questioned whether, as the typical M_1 equation implied, the short-run money-demand function should be more inelastic with respect to interest rates than the long-run demand function. He said that it might well be the other way around: if the Federal Reserve sold bonds, people might at first consider the sale to be a temporary change and they would hold them without much hesitation, anticipating that the Fed would buy them back. Later, when they realized otherwise, they might sell the bonds, driving rates up further. Tobin pointed out that this analysis assumed implausibly that people changed their money holdings primarily to speculate in this way. But William Poole noted that money holdings would change unexpectedly, as a mirror of such unexpected speculative outcomes. Formally, he found this similar to a surprise change in the money stock, which would at first appear in the error term in a stochastic cash-management model.

Christopher Sims was impressed by the performance of the equation in which lagged prices were used in explaining money demand. He noted that if the equation were converted into real terms, it would imply a strong effect of the current rate of change of prices on real balances, which could reflect either the effect of inflation on the demand for real balances, or a lagged adjustment in the awareness of the price level. However, Gordon questioned this equation because it implied a substitution of commodities for demand deposits when the heart of the problem lay in the shift from demand to time deposits, a shift that ought not to have been affected by inflation because interest rates were subject to ceilings. While Sims did not want to argue strongly that a stable single-equation estimate of the demand for money had been found in this equation, it did lead him to believe that allowing for a more general lag distribution on prices in M_1 equations was a promising avenue for further investigation.

An alternative summary of the discussion was provided by Robert Lawrence:

Said Tobin, J., with sage advice,
"I'll solve the problem; I'll solve it nice.
Look at the cash that banks demand
That corporate borrowers keep on hand."

"I seek it here, I seek it there;
That demand for money, it's just nowhere."

Said Wachter, M., "It's to be expected.
Like the Phillips curve, it's been deflected.
To be rational and not deranged
It is the question that must be changed."

"I seek it here, I seek it there;
That demand for money, it's just nowhere."

And Walter Salant, that bold gallant,
Proclaimed the solution as transparent.
"Your economy's closed, just like your mind,
You'd best go abroad to get out of your bind."

"I seek it here, I seek it there;
That demand for money, it's just nowhere."

Then R. J. Gordon displayed his stealth
By suggesting it would be found in wealth.
"I know it's me that you'll be thanking
When you learn S&Ls are in branch banking."

And Edmund Phelps (who sometimes helps
With Golden Rules for saving fools)

Said, "If you will just let me talk,
I'll tell you V takes a random walk."

William Poole kept his cool,
And then to save the money rule
Said, "If you really want to catch it
Build exponential decay into your ratchet."

"I seek it here, I seek it there;
That demand for money, it's just nowhere."

Said Houthakker, Hank, "I'll just be frank,
The flow of funds is just a prank.
To find the answer, the correct decision
Is to wait until the next revision."

"I seek it here, I seek it there;
That demand for money, it's just nowhere."

His beard a-bristle, his face turned red,
Our author grimaced and then he said,
"There is nothing that you will find
That I've not tried when so inclined.

"I did it all, at least that's to my credit,
I counted every single debit.
I tried every functional form
Even one that resembled a worm.

"But the time has come to give up the chase,
To admit that it's a hopeless case.
Oh, Lord Radcliffe, tell me it's all idle chatter,
And that money really does not matter.

"I seek it here, I seek it there;
That demand for money, it's just nowhere."