Money Demand—Some Long-Run Properties

Many observers have cited the acceleration in the ratio of GNP to M1 ("velocity") in the mid-1970s and its subsequent sharp decline in the 1980s as evidence of unprecedented instability in the demand for money. This interpretation has generally been supported by comparing the M1 statistics with the results obtained from econometric money demand equations estimated from the 1950s to the mid-1970s—a period when money demand was viewed as a stable function.[1] An alternative way of looking at the recent shifts in money demand is also possible, however. If it can be shown that the period from the 1950s to the mid-1970s was a unique episode, then these subsequent shifts in the demand for M1 may simply represent further instances of the money demand instability that occurred before the 1950s.

Identifying the more correct view has important implications for the use of M1 as a guide to policy in the future. The apparent stability of money demand from the 1950s to the early 1970s led many to view stability in this function as the norm. Consequently, apparent shifts in money demand in the mid-1970s and again in the 1980s were taken as exceptions to the norm, quite possibly linked to developments such as deregulation and innovation that were unique to these periods. Thus, a return to "more normal" stability would be a reasonable expectation for the future. On the other hand, however, if a longer-range analysis of money demand suggests that other such money demand shifts have occurred, the view that money demand is normally "stable" and will return to this state after the current period of change has run its course would be open to some question. This article examines the latter possibility through a statistical analysis of money demand over a much longer period of time.

In his recent book, *The American Business Cycle*, Robert J. Gordon published statistics for the basic determinants of money demand (interest rates, GNP, and the price level) that span a considerably longer time period than is contained in most data bases.[2] Hence, these statistics enable us to put the unusually weak M1 growth in the mid-1970s, as well as what appears to have been unusually strong growth during much of the 1980s, into the perspective of a longer time period. By and large, our results suggest that the stability in the demand for M1 observed with data from the 1950s to the mid-1970s was a rather unique experience. Using statistics from 1915 through 1987, we were able to identify additional periods during which it appears that money balances deviated from econometric estimates by more than 10 percent. Unlike the demand for M1, the demand for M2 has not shown dramatic instability since the mid-1970s. But we were able to identify some periods in the years preceding the mid-1970s when the actual values of M2 diverged from econometric results by 10 percent or more.

In the first section of this article, we report some

[1]For more detail, see David Laider, *The Demand for Money: Theories, Evidence and Problems* (New York: Harper and Row, 1985); and John Judd and John Scadding, "The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature," *Journal of Economic Literature*, September 1982, pp. 993-1023.

[2]Robert J. Gordon, ed., *The American Business Cycle* (Chicago, Illinois: University of Chicago Press, 1986), pp. 781-849. Gordon's statistics cover the period from 1915 to 1983. The author of this article used conventional splicing techniques to add data for the 1984-87 period.

money demand estimates for the 1915-87 period as well as some estimates over selected subperiods. The results suggest that even though the parameters for money demand equations estimated over long time spans are consistent with economic theory, the size of these parameters has differed considerably within subperiods. This is particularly true for the demand for M1 in the 1950-73 period when both the income and interest rate elasticities were quite small. In the second section, we examine more closely the errors from the money demand equations. Here we find that the 1950-73 period was an unusually stable period for money demand. In addition, we find that in more recent years the errors from the M1 and M2 demand equations have not been as highly correlated as they were in earlier periods. Hence, M2 appears to have become a more useful guide for policy purposes during this period of instability in the demand for M1. In the final section, we use sequential, 10-year money demand estimates to identify some of the changes in the elasticities of the demand for money that have occurred over time. The analysis in this final section suggests that the recent changes in the responsiveness of the demand for M1 to income and interest rates, while quite dramatic, have not been totally unprecedented by long-run standards. It has not been uncommon for money demand coefficients to vary considerably over time.

Money demand estimates: 1915-87

This section presents some money demand estimates for M1 and M2 over the 1915-87 period and during some selected subperiods. The primary objective is to analyze the demand for M1 over the 1950-73 period both in the context of an extended time period and relative to the demand for M2.

Earlier studies of the demand for money over long time spans have used statistical time series that ended in the mid to late 1970s.[3] Hence, much of the instability in the demand for narrow money during the 1980s has not been closely examined in this context. Moreover, these earlier studies have not assessed the stability of the demand for M1 in relation to that for M2 over the past 10 to 15 years—an important consideration given the apparently greater stability in the M2 function than in the M1 function during the 1980s. The Federal Reserve has not set targets for M1 in recent years but continues to establish targets for the broader aggregates.

Much of the initial impetus for setting targets for M1 was based on the stable trend in its velocity in the 1950-70 period (Chart 1). One of the first problems encountered with monetary targeting was the unexpected acceleration in velocity beginning in the mid-1970s.[4] Over time, the Federal Reserve took this more rapid velocity growth into account in setting the monetary targets because the acceleration appeared to stem from greater emphasis on cash management encouraged by rising nominal interest rates and increasing inflation. But as interest rates fell in the 1980s because of a decrease in actual and expected inflation, M1's velocity began an outright decline, not just a slowdown in growth rate terms. As a result, the authorities found it difficult for a second time in 10 years to set targets for M1 because of a pronounced unexpected shift in the trend of velocity.

While this decline in velocity during the 1980s was quite surprising to most analysts, it was not unprecedented in the context of a longer time span (as Chart 1 reveals). From 1915 to 1945, M1's velocity declined gradually and showed considerably more volatility relative to trend than was the case from 1950 to 1973. M2's velocity was also quite volatile in this earlier period.[5] Indeed, the velocities of M1 and M2 followed a very similar pattern until the late 1950s. At that time, M2's velocity began to level off, remaining fairly constant in subsequent years, while M1's velocity started on a pronounced upward trend that lasted until the early 1980s.

The changes in the trend of M1's velocity in recent years have also been associated with periods of instability in the demand for M1. Money demand equations estimated over the 1950-73 period have not been able to track the growth of M1 accurately since that time. The demand for M1 was generally overestimated in the 1974-80 time span and underestimated in the 1981-87 period, suggesting that the demand for M1 has become more sensitive to interest rates since the mid-1970s. Hence, it appears that three periods could be studied

[3]For more detail, see G. S. Laumas and J. S. Fackler, "Economic Instability and the Demand for Money, 1908-1980," *Eastern Economic Journal*, vol. 13 (July-September 1987), pp. 249-57; K. Garbade, "Two Methods for Examining the Stability of Regression Coefficients," *Journal of the American Statistical Association*, March 1977, pp. 54-63; Mohsin S. Kahn, "The Stability of the Demand-for-Money Function in the United States 1901-1965," *Journal of Political Economy*, November-December 1974, pp. 1205-19; and G. S. Laumas and Y. P. Mehra, "The Stability of the Demand for Money Function, 1900-1974," *Journal of Finance*, June 1977, pp. 911-16.

[4]For a further elaboration, see Stephen M. Goldfeld, "The Case of the Missing Money," *Brookings Papers on Economic Activity*, vol. 3 (1976), pp. 683-740.

[5]In terms of quarterly growth rates, the standard deviation of M1's velocity was 16.7 percentage points in the 1915-49 period. It fell to 4.8 percentage points in the 1950-73 period and increased to 6.3 percentage points in the most recent period. The standard deviation of M2's velocity fell from 16.8 percentage points to 5.6 and then to 5.1 percentage points. Both the GNP and money supply series showed considerably less volatility in the post-1949 period. This reduction in the volatility of the GNP statistics, however, is open to some question. For more background, see Christina D. Romer, "Is the Stabilization of the Postwar Economy a Figment of the Data?" *American Economic Review*, vol. 76, no. 3 (June 1986), pp. 315-34.

for money demand stability in a longer-run context: the period running from 1915 to about 1949, the period from 1950 to the mid-1970s, and finally the period since the mid-1970s, which has shown some evidence of increased sensitivity of money demand to increases and declines in interest rates. The demand for M2 during the same subperiods will be examined in order to make certain comparisons with the demand for M1. Table 1 contains money demand estimates for the total period and for these three subperiods, for both M1 and M2.

The first two equations contain the results for M1 and M2 over the entire period.[6] Both equations appear to give reasonable results, especially considering both the overall length of the period and the difficulty of tracking M1 growth with conventional money demand equations in recent years. The coefficients on all of the independent variables are of the correct sign and are statistically significant. The short-run and long-run interest rate elasticities in the M2 equation are considerably smaller than those in the M1 equation.[7] The M2 equation

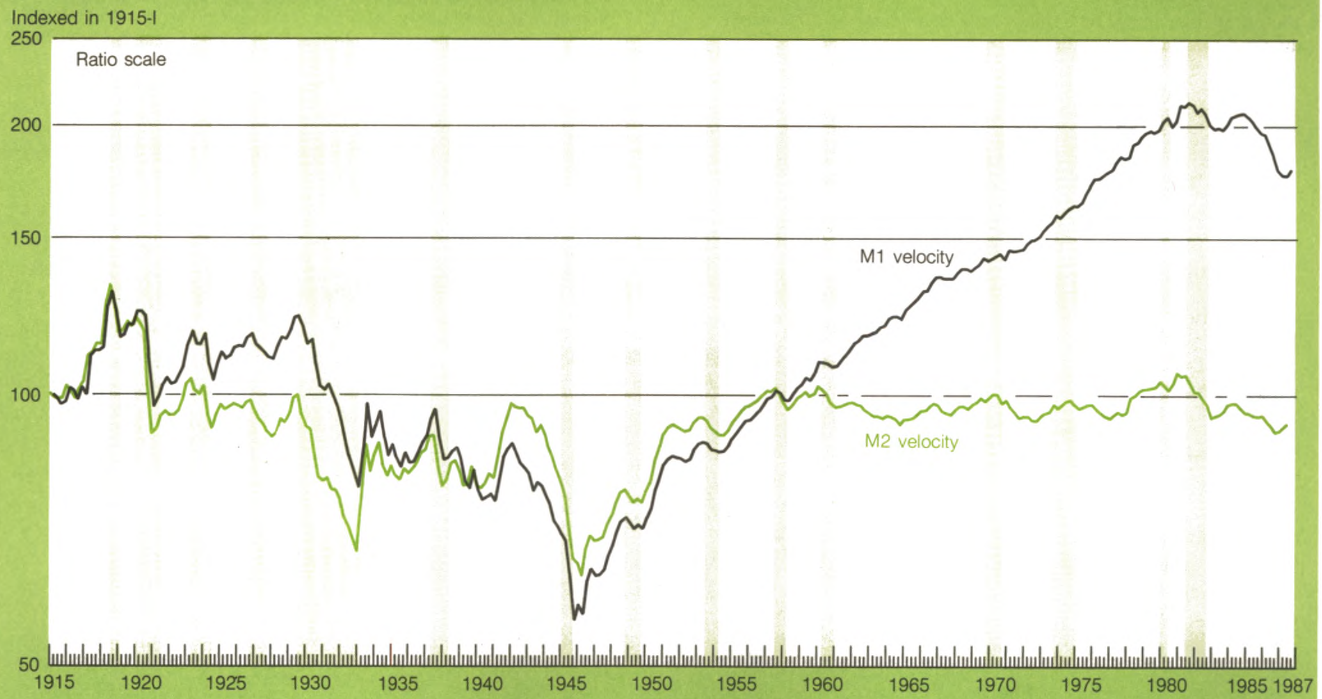
[6] In a sense, these "standard money demand equations," which do not fully take into account the changes in the own rates on the components of M1 and M2 during the process of deregulation, should more properly be viewed as semi-reduced-form equations. For more detail on research efforts to account for changes in the rates offered on the components of M1 and M2, see George Moore, Richard Porter, and Dave Small, "Modelling and Disaggregated Demands for M1 and M2 in the 1980's: The U.S. Experience," a paper prepared for the Conference on Monetary Aggregates and Financial Sector Behavior in Interdependent Economies, sponsored

Footnote 6 continued
by the Board of Governors of the Federal Reserve System, Washington, D.C., May 26-27, 1988.

[7] The long-run elasticity is calculated by dividing the short-run elasticity by one minus the coefficient on the lagged dependent variable. In theory, the value of the lagged dependent variable should be greater than zero but less than one. Within that range, the absolute value of the long-run elasticity will be larger relative to a given short-run elasticity the larger the value of the coefficient on the lagged dependent variable. The size of the coefficient on the lagged dependent variable can also be used to estimate how long it takes for the dependent variable to adjust to changes in the independent variables. For example, if quarterly statistics are used, a coefficient on the lagged dependent variable of 0.50 would mean

Chart 1

Long-Run Trends in M1 and M2 Velocity



Note: Statistics for this chart and all subsequent charts and tables were derived from Robert J. Gordon, ed., The American Business Cycle (Chicago, Illinois: University of Chicago Press, 1986), pp. 781-849.

Shaded areas represent periods of recession, as defined by the National Bureau of Economic Research.

has a short-run income elasticity almost twice as large as the one contained in the M1 equation. However, the difference in long-run income elasticities is not very large: the long-run income elasticity for M2 is equal to one, while for M1 the value, at 0.85, is close to one. The only feature of these equations that seems somewhat questionable is the large values of the coefficients on the lagged dependent variables, values that imply a rather slow speed of adjustment (see footnote 7). In any case, these statistics suggest that over the last 70 years reasonable money demand equations have existed. Thus, the more interesting question seems to be, what has happened beneath the surface over some shorter time periods?

Equations for the three subperiods are shown in the lower part of Table 1. These equations also produce reasonable results, yielding coefficients that are statistically significant and of the correct signs. For the M1 demand equations, the 1950-73 period stands out because of rather low coefficients on both the income and interest rate variables (compared with the results for either the total period or other subperiods). And for the 1974-87 period, the long-run coefficient on income of 1.47 seems very large, as does the short-run coefficient on the interest rate. In general, the demand for M1 appears to have become more sensitive since the mid-1970s to changes in interest rates and income than it was in the 1950-73 period. But the magnitude of this increased sensitivity appears to stem in part from the extremely low value of the coefficients in the 1950-73 period.[8] Indeed, M1's velocity appeared stable over this period (around its rising trend) in part because the demand for M1 was relatively insensitive to shorter-run movements in interest rates.[9]

For the M2 demand equations, the short-run income and interest rate coefficients have been increasing over time, but because of the substantial decline in the

Footnote 7 continued
a period of adjustment of 2 quarters, a coefficient of 0.75 would indicate 4 quarters, and 0.90 would mean 10 quarters.

[8]More detail on the reasons for the increased interest sensitivity of the demand for M1 can be found in John Wenninger, "Responsiveness of Interest Rate Spreads and Deposit Flows to Changes in Market Rates," this *Quarterly Review*, Autumn 1986, pp. 1-10.

[9]William Poole also notes that postwar money demand (M1) functions usually have very low interest rate elasticities. For more information, see Poole, "Monetary Policy Lessons of Recent Inflation and Disinflation," National Bureau of Economic Research, Working Paper no. 2300, July 1987. See Judd and Scadding, "The Search for a Stable Money Demand Function," for a range of elasticity estimates for money demand functions estimated with the postwar data. The interest-rate coefficients reported there are quite low and on the same order of magnitude as the one shown in equation 4 in Table 1.

Table 1
Money Demand Equations

	ln (Commercial Paper Rate)		ln (Real GNP)						
Dependent Valuable	Short-Run	Long-Run	Short-Run	Long-Run	ln (Lagged Real M1 or M2)	$\bar{R}^2$	D.W.	RHO	Sample Period
Total Period Equations									
(1) ln (Real M1)	−0.0226 (5.7)	−0.359	0.054 (5.7)	0.857	0.937 (86.1)	0.99	2.0	0.26	1915-II to 1987-III
(2) ln (Real M2)	−0.0142 (5.0)	−0.142	0.104 (5.5)	1.040	0.900 (48.6)	0.99	1.9	0.50	1915-II to 1987-III
Subperiod Equations									
(3) ln (Real M1)	−0.0234 (4.2)	−0.257	0.095 (2.8)	1.044	0.909 (35.1)	0.99	2.0	0.35	1915-II to 1949-IV
(4) ln (Real M1)	−0.0171 (4.3)	−0.182	0.045 (4.6)	0.479	0.906 (26.2)	0.95	2.0	0.32	1950-I to 1973-IV
(5) ln (Real M1)	−0.032 (5.2)	−0.311	0.147 (6.1)	1.427	0.897 (28.7)	0.98	2.0	0.18	1974-I to 1987-III
(6) ln (Real M2)	−0.0157 (2.9)	−0.160	0.097 (3.3)	1.000	0.902 (35.4)	0.99	1.9	0.47	1915-II to 1949-IV
(7) ln (Real M2)	−0.0305 (5.8)	−0.169	0.230 (5.2)	1.278	0.820 (19.8)	0.99	2.1	0.53	1950-I to 1973-IV
(8) ln (Real M2)	−0.0409 (5.4)	−0.135	0.359 (4.0)	1.181	0.696 (8.8)	0.98	2.2	0.55	1974-I to 1987-III

coefficient on the lagged dependent variable, the long-run elasticities have not increased over time (see footnote 7). Hence, in contrast to M1, the overall sensitivity of M2 to changes in interest rates and income has not increased, although the distributions of these responses over time probably have become considerably shorter. Indeed, in terms of long-run coefficients, it appears that the demand for M2 has recently become less sensitive to movements in interest rates than it was in earlier years.[10] This development makes intuitive sense. The recent elimination of interest rate ceilings on most of the components of M2 has enabled banks to retain deposits more effectively by increasing deposit rates in step with increases in market rates. Consequently, we would expect the demand for M2 to show less sensitivity to changes in market interest rates.

Money demand errors over the 1915-87 period

This section analyzes the error patterns from the equations estimated in the previous section. This exercise will provide some additional perspective on money demand stability over time and on the relative stability of the demand for M1 and M2. Chart 2 (upper panel) shows the errors (that is, actual minus predicted levels as a percent of the actual levels) from the total period M1 equation for both dynamic and static in-sample simulations. Because the equation is put on track each quarter in calculating the next quarter's value of M1, the static simulation shows considerably smaller errors than the dynamic simulation in which errors are allowed to accumulate over time.[11] The bottom panel of Chart 2 shows an alternative calculation of the errors on a year-by-year basis (see footnote 11).

As we would expect from the stable trend in velocity shown in Chart 1 for the 1950-73 period, the errors over this period appear to be the smallest in the entire sample. For the dynamic simulation, however, the errors tend to be uniformly positive during this period. In addition to showing the large negative errors in the demand for money in the mid-1970s (which in the 1980s have been more than entirely reversed), the dynamic simulation suggests that there were other periods of substantial instability in money demand, that is, errors in excess of 10 percent.[12] The dynamic simulation for the interval from the late 1920s to the early 1940s, for example, also shows large negative errors, suggesting a period of unusually weak M1 growth even more pronounced than the one that began in the mid-1970s. In terms of individual years, 1933 and 1937 show particularly large negative errors during the period from the late 1920s to 1940 (bottom panel of Chart 2).[13]

Chart 3 contains comparable simulations for M2. The dynamic simulation suggests that M2 did not have a period of unusually weak growth in the mid 1970s comparable to the slowdown in M1. But M2 apparently was quite weak relative to the equations' predicted values from the early 1950s to the early 1960s—the period when the velocities of M1 and M2 began to diverge (Chart 1). The dynamic M2 simulation, in contrast to the M1 simulation, does not suggest the possibility of large, sustained negative errors in the demand for money from the late 1920s to the early 1940s. The years 1933 and 1937, however, show large negative errors, as they did in the M1 simulation (bottom panel of Chart 3). In any case, it appears that the interpretation of events during those years depends in part on

[10]Richard G. Davis, Leon Korobow, and John Wenninger use bankers' pricing strategies to explain this declining sensitivity in "Bankers on Pricing Consumer Deposits," this *Quarterly Review*, Winter 1987, pp. 6-13.

[11]For many econometric exercises that extend for more than one quarter into the future, the dynamic or cumulative errors are of more interest because the value of the lagged dependent variable estimated by the equation is used rather than the actual value. In a sense, these dynamic, in-sample errors answer the following question: If we knew in advance what the total period money demand equation would be, and we used it to simulate various subperiods (beginning whenever the actual value equals the predicted value), what would the underlying error pattern have been? Therefore, the static and dynamic errors represent the two extreme ways of looking at the errors from a money demand equation with a lagged dependent variable. An intermediate way of examining the error patterns would be to do a series of dynamic simulations over a fixed number of quarters—for example, the four quarters of a calendar year—using the actual value of the lagged dependent variable from the final quarter of each preceding year. For more detail, see John Wenninger, Lawrence J. Radecki, and Elizabeth Hammond, "Recent Instability in the Demand for Money," this *Quarterly Review*, Summer 1981, pp. 1-9. The lower panels of Charts 2 and 3 present the errors calculated in this way, that is, for successive one-year periods. As expected, this calculation produces results less volatile than those from the dynamic simulation but more pronounced than those from the static simulation. Although the discussion in the text focuses principally on conventionally calculated dynamic and static errors, the reader should keep in

Footnote 11 continued

mind that the procedure used to calculate errors when an equation includes a lagged dependent variable can shade the picture.

[12]The 10-percent criterion for calling dynamic simulation errors "substantial" was set arbitrarily, but does not seem unreasonable. When the error reached 10 percent in the mid-1970s, economists undertook extensive research on the reason for the shift. For more detail, see footnote 4.

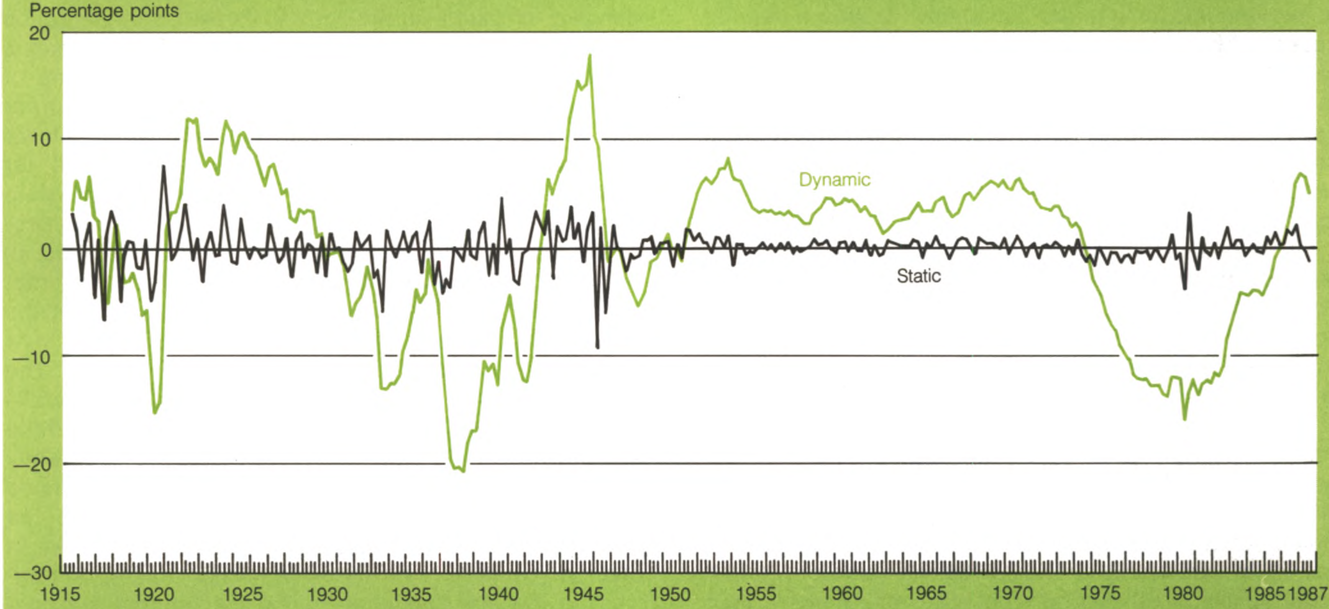
[13]For a more detailed analysis of that period and reasons why the demand for M1 might have been unstable in 1933, see Charles Lieberman, "The Long-Run and Short-Run Demand for Money Revisited," *Journal of Money, Credit and Banking*, vol. 12 (February 1980), pp. 43-57. Also see Arthur E. Gandolfi, "Stability of the Demand for Money During the Great Contraction, 1929-1933," *Journal of Political Economy*, vol. 82 (October 1974), pp. 969-83; Arthur E. Gandolfi and James R. Lothian, "The Demand for Money from the Great Depression to the Present," *American Economic Review*, vol. 66 (Papers and Proceedings of the 88th Annual Meeting of the American Economic Association, December 1975), pp. 46-51; and Arthur E. Gandolfi and James R. Lothian, review of *Did Monetary Forces Cause the Great Depression?* by Peter Temin, *Journal of Money, Credit and Banking*, vol. 9 (November 1977), pp. 679-91.

Chart 2

Alternative Measures of Money Demand Errors (M1)

Errors from In-Sample Dynamic and Static Simulations

Error as Percent of Actual



Errors from a Series of One-Year Dynamic Simulations

Error as Percent of Actual

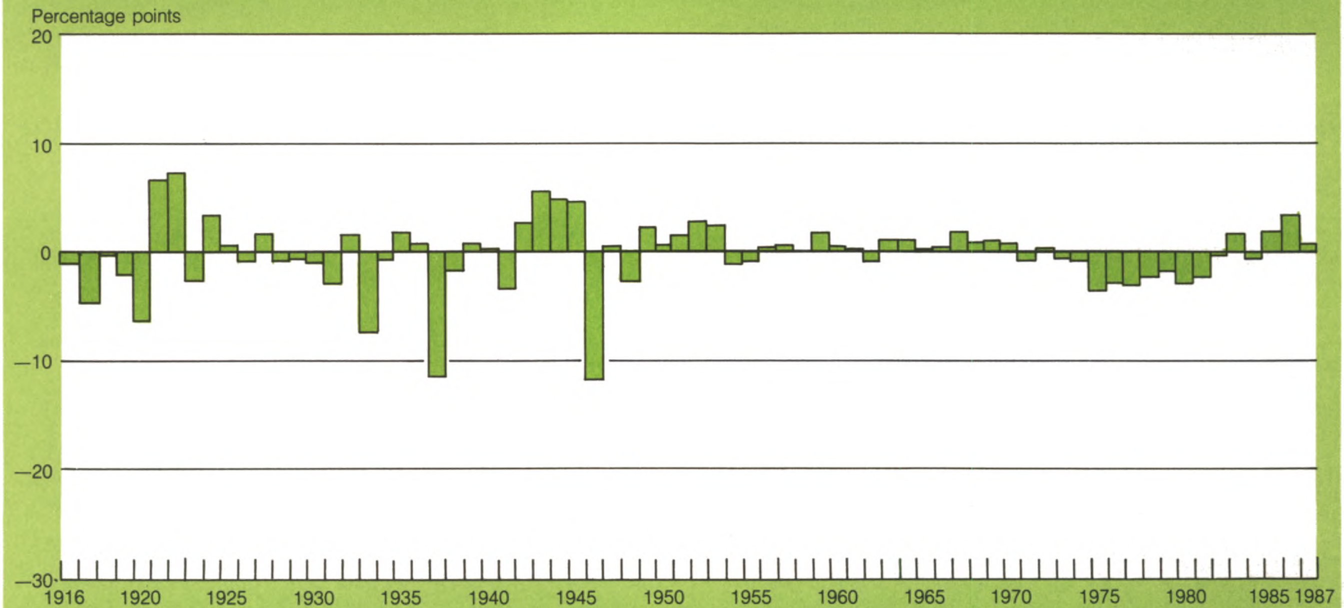
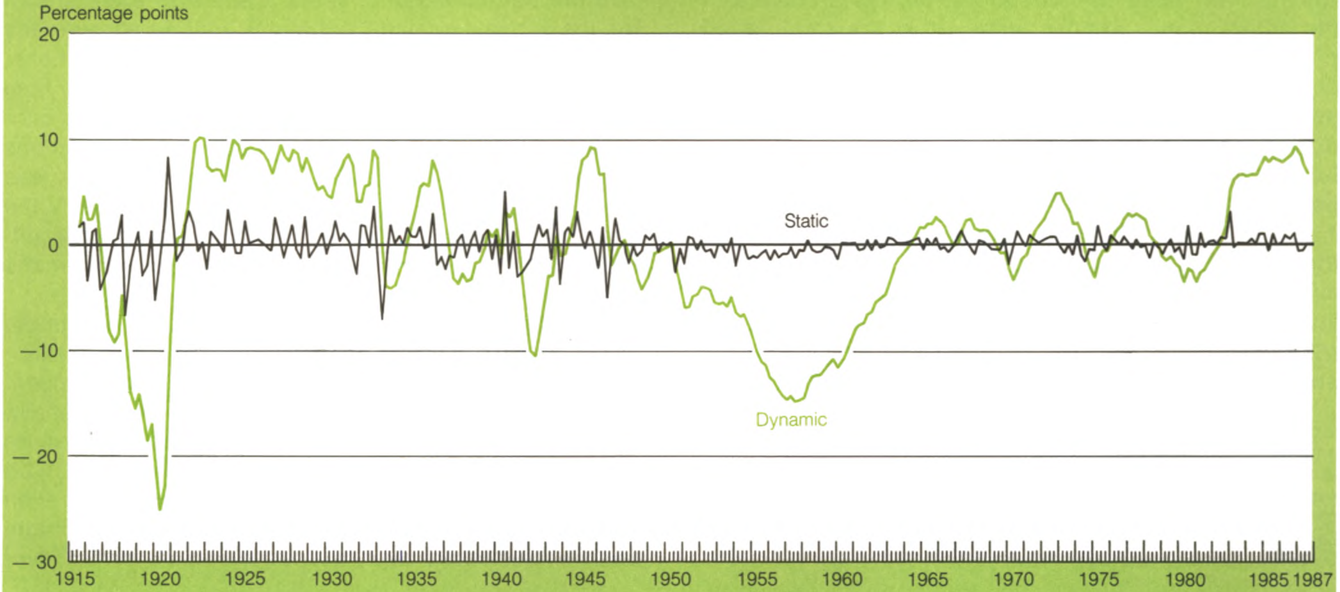


Chart 3

Alternative Measures of Money Demand Errors (M2)

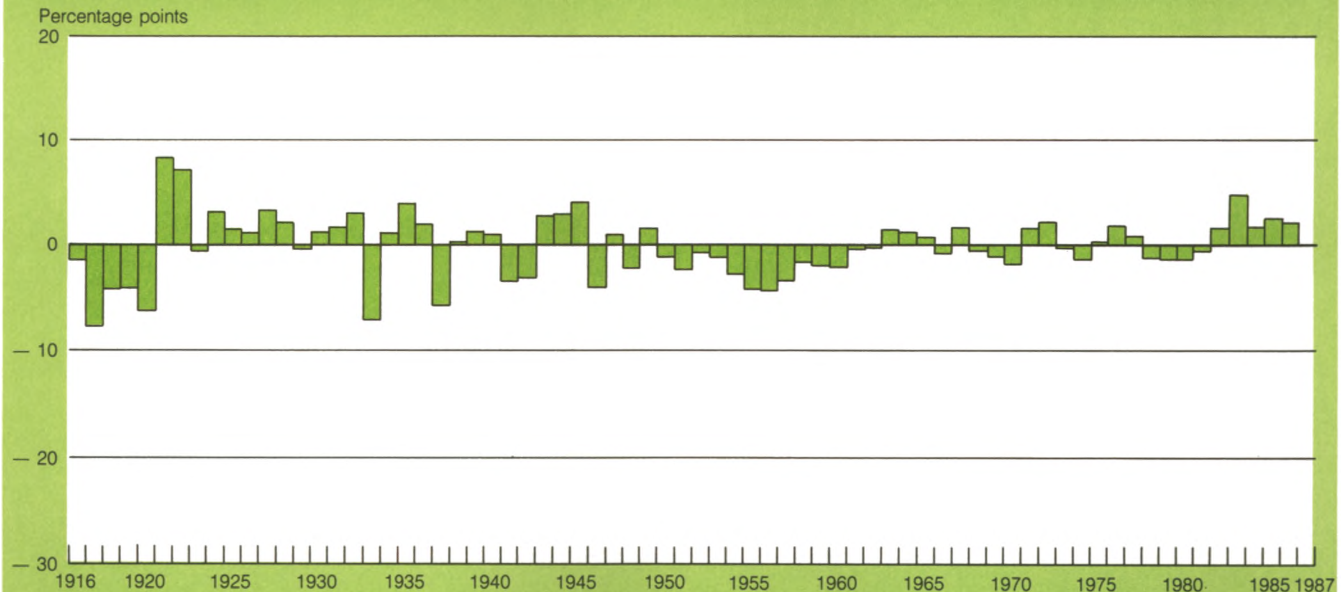
Errors from In-Sample Dynamic and Static Simulations

Error as Percent of Actual



Errors from a Series of One-Year Dynamic Simulations

Error as Percent of Actual



the monetary aggregate selected.[14] (In the final section, we will examine the stability of coefficients during that period.) By and large, the M2 equation does not seem to show as many substantial errors (errors in excess of 10 percent in the dynamic simulation) as the M1 equation displays.

The underlying error patterns can be explored more carefully across subperiods using the statistics in Table 2. This table contains the errors (as a percent of the actual money supply series) from the total-period equations in the upper part and from the subperiod equations in the lower part. Looking first at the total-period results, we find that the dynamic and static simulations for M1 show by far the smallest average absolute and root mean squared errors over the 1950-73 period—a conclusion that had been evident from Charts 1 and 2. There is, however, a large average error during this period of 3.8 percentage points for the dynamic simulation, which declines to −6.7 percentage points in the following time period. For the total-period dynamic M2 simulation, in contrast, the smallest average absolute and root mean squared errors have tended to occur in the most recent period, and these measures of the M2 errors are also considerably smaller than the comparable measures of the M1 errors for this period. In addition, the average error for M2 is considerably smaller in absolute value than the average error for M1. Again, these statistics suggest that the demand for M2 has been more stable relative to the total-period estimates than has the demand for M1 in recent years.

In the bottom panel of Table 2, the errors are shown for the money demand equations estimated over the three subperiods. For both the M1 and M2 equations, the average absolute and root mean squared errors from the dynamic simulations have tended to decline considerably for the two later time periods when equations are fitted for the individual subperiods. For M1, this was particularly true for the 1974-87 period. Apparently the changes in the elasticities that occurred over the different sample periods (Table 1) can help explain the quarter-to-quarter movements in money demand.

The discussion thus far has concerned in-sample errors, and we need to determine whether the instability in money demand over the 1974-87 period would appear much different if we used out-of-sample errors. Normally, out-of-sample errors would be expected to be more pronounced because the coefficients would not be affected by the statistics contained in the simulation period. To see how important this consideration might be, we calculated average out-of-sample errors over

[14]If one major cause of the large negative errors for the M1 demand equation during that period was the prohibition of interest on demand deposits, then it would not be surprising to see large, sustained negative errors for M1 demand, but not for M2 demand, if consumers shifted funds previously held in demand deposits into time deposits. For more detail, see Lieberman, "The Long-Run and Short-Run Demand for Money Revisited."

Table 2

In-Sample Money Demand Errors

(As a Percent of Actual)

	Total Period M1								Total Period M2							
	Dynamic				Static				Dynamic				Static			
	(1915-87)	(1915-49)	(1950-73)	(1974-87)	(1915-87)	(1915-49)	(1950-73)	(1974-87)	(1915-87)	(1915-49)	(1950-73)	(1974-87)	(1915-87)	(1915-49)	(1950-73)	(1974-87)
Average	−0.5	−1.0	3.8	−6.7	0	−0.1	0.2	−0.2	−0.4	1.0	−4.2	2.4	0	0	−0.2	0.2
Average absolute	6.2	7.2	3.8	7.9	1.2	1.8	0.5	0.9	5.3	5.9	5.4	3.7	1.1	1.6	0.6	0.6
Root mean squared	7.6	8.7	1.7	6.3	1.8	2.4	0.6	1.1	6.9	7.4	5.7	4.0	1.6	2.1	0.7	0.8
	Subperiod M1								Subperiod M2							
	Dynamic				Static				Dynamic				Static			
	(1915-87)	(1915-49)	(1950-73)	(1974-87)	(1915-87)	(1915-49)	(1950-73)	(1974-87)	(1915-87)	(1915-49)	(1950-73)	(1974-87)	(1915-87)	(1915-49)	(1950-73)	(1974-87)
Average	−0.2	−0.4	0.1	−0.2	0	0	0	0	−0.1	−0.3	0.2	0.1	0	0	0	0
Average absolute	3.7	5.7	1.7	2.3	1.2	1.8	0.5	0.7	3.9	6.1	2.0	1.7	1.0	1.6	0.5	0.5
Root mean squared	5.1	7.1	2.0	2.7	1.7	2.4	0.6	1.0	5.6	7.8	2.4	2.1	1.5	2.1	0.6	0.8

the two time periods since the mid-1970s suggested previously by the in-sample simulation—the unusually weak growth in M1 from 1974 to 1980 and the period of generally rapid growth from 1981 to 1987 (Chart 2). The results are shown in Table 3. Roughly the same patterns and magnitudes of instability that appeared in the in-sample simulations (top row) also occurred in the out-of-sample simulations (rows 2 through 5), suggesting that the sample period was sufficiently long that the results were not very sensitive to whether the simulation over the 1974-87 period was in-sample or out-of-sample. The results in Table 3 also confirm the greater stability in the demand for M2 over the 1974-87 period that was noted earlier on an in-sample basis.

Analyzing the errors from the M1 and M2 equations can help clarify one further issue: To what extent have the same factors caused instability in the demand for M1 and for M2 on a quarter-to-quarter basis? A high correlation of the errors from the M1 and M2 equations would support the presumption that certain factors have contributed to the instability in the demand for both functions. One such factor might be the development of new instruments that are attractive substitutes for both M1 and time deposits. If, on the other hand, the errors were not correlated, then it could be that much of the instability in the demand for M1 is caused by shifts of funds into and out of nontransactions M2, or that some of the factors that affect the demand for time deposits do not affect the demand for M1. From a policy perspective, of course, uncorrelated errors would be preferred; such findings would suggest that M1 and M2 are good complements, enabling analysts to check the accuracy of one as an indicator by looking at the performance of the other.

Table 4 contains the results of regressing the errors (in growth terms) from the M2 equations on the comparable errors for the M1 equations for both the dynamic and static simulations. By and large, the results suggest that the errors have become less correlated in the 1974-87 period and that M1 and M2 have been more useful complements for policy purposes. Relative to the 1950-73 period, the R^2 has dropped by at least 50 percent, regardless of whether dynamic or static simulations were used or whether the total-period equation or the equations for subperiods were simulated.

Changes in money demand coefficients over time

In this final section, we explore in more detail how the individual parameters in the money demand equations have evolved over time. Breaking an extended sample period into a limited number of shorter-run periods to observe changes in coefficients or predictive accuracy is arbitrary unless it is possible to point to some specific occurrence that should have affected the stability of the demand equations. In Section I, we used a judgmental approach to identify possible breaking points approximately, but checking those results with some other technique would still be useful.

As a result, we have taken another approach in this section. We estimated money demand equations for

Table 3

Comparison of Average Errors for Dynamic Simulations: 1973-87

(Quarterly Growth Rates)*

	M1		M2	
Estimation Period	1974-80	1981-87	1974-80	1981-87
(1) 1915-87	−1.7	2.6	−0.4	1.4
(2) 1915-73	−2.7	2.2	0.3	1.5
(3) 1915-80	n.a.	1.7	n.a.	1.6
(4) 1950-73	−1.7	3.0	−0.9	0.1
(5) 1950-80	n.a.	3.3	n.a.	−0.2

*The first simulations (for M1 and M2) are the dynamic in-sample simulations shown in Charts 2 and 3 from equations (1) and (2) in Table 1. The remaining simulations are dynamic out-of-sample simulations.

Table 4

Correlation between Errors from M1 and M2 Equations

(Quarterly Growth Rates)*

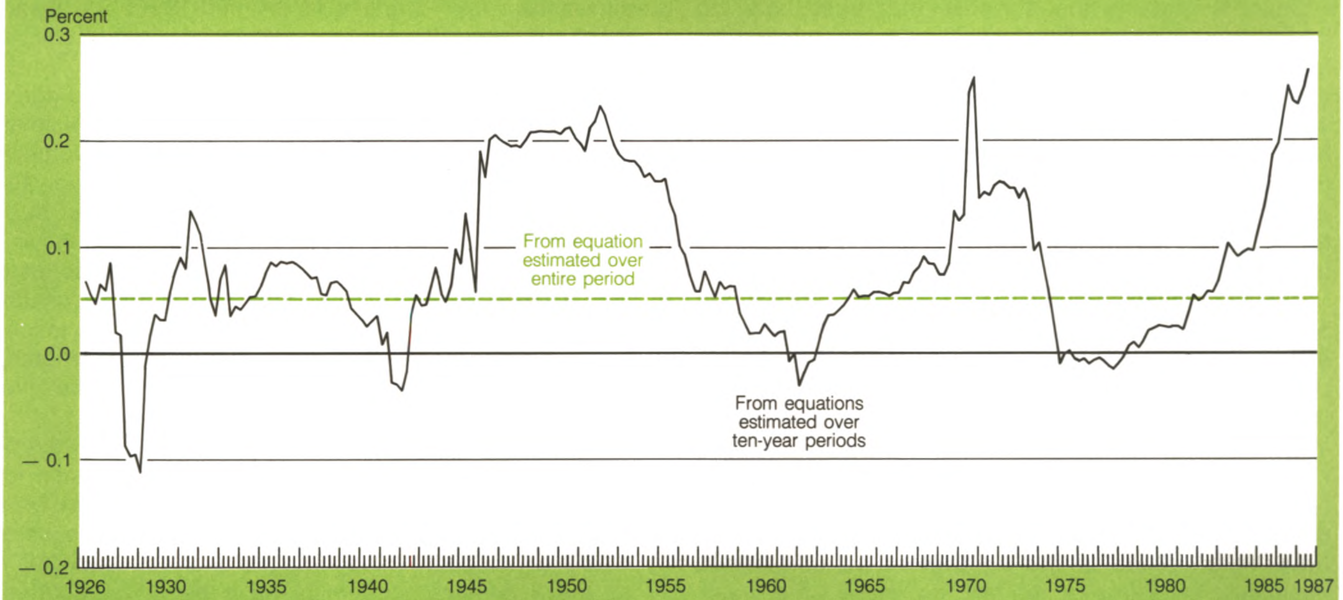
	Coefficient (t-statistic)	$\bar{R}^2$
Total period equations		
Dynamic		
1915-49	0.75 (16.1)	0.66
1950-73	0.88 (16.9)	0.75
1974-87	0.44 (5.3)	0.35
Static		
1915-49	0.69 (12.4)	0.54
1950-73	0.90 (18.3)	0.78
1974-87	0.46 (5.4)	0.36
Subperiod equations		
Dynamic		
1915-49	0.76 (16.9)	0.68
1950-73	0.86 (16.2)	0.74
1974-87	0.43 (5.1)	0.34
Static		
1915-49	0.68 (12.7)	0.54
1950-73	0.91 (17.5)	0.77
1974-87	0.46 (5.4)	0.36

*Errors were calculated as the difference between the actual and predicted quarterly growth rates. The in-sample errors from the M2 equations were regressed on the in-sample errors from the M1 equation. Adjustment was made for autocorrelation.

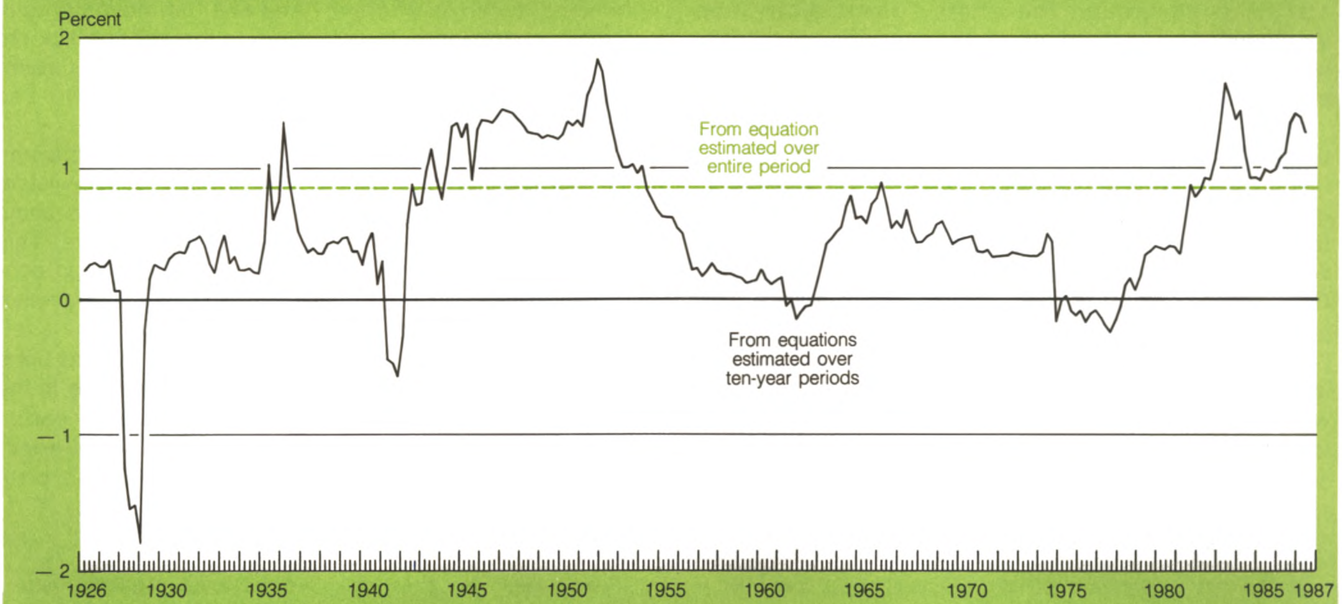
Chart 4

Comparison of Total-Period and Successive Ten-Year Coefficients

M1 Short-Run Income Elasticity



M1 Long-Run Income Elasticity



successive 10-year periods, dropping and adding one observation each time the equations were reestimated, for a total of 243 regressions for M1 as well as for M2. The coefficients were then recorded for each regression and plotted over time to obtain some rough idea of how these coefficients have evolved. These results, in turn, can be used to evaluate further some of the more recent changes noted earlier, such as the increased interest-rate coefficient in the demand for M1.[15]

Chart 4 contains the statistics that trace how the income and interest rate elasticities in the demand for M1 have evolved over time compared with the elasticities estimated over the entire sample period. In absolute value, the short-run interest rate and income elasticities have increased substantially since the mid-1970s (upper part of chart). Indeed, the short-run income elasticity appears to be at one of the highest levels ever attained for a 10-year period. These results were also apparent from Table 1.

When we look at the long-run elasticities (bottom part of chart), the differences relative to the total-period estimates do not appear quite as dramatic. Changes in the coefficient on the lagged dependent variable (Chart 6) have tended to offset some of the movement in the short-run coefficients in recent years. The estimate of M1 demand over the entire 1974-87 period (equation 5 in Table 1) tended to conceal the downward drift towards a more reasonable value that seems to have taken place in the coefficient on the lagged dependent variable over the last few years. As a result, it appears that M1's long-run interest rate elasticity has declined somewhat (in absolute value) since the mid-1970s, even though the short-run elasticity has increased. The long-run elasticity, however, is still considerably larger than it was over the 1950-73 period on average.

A rising short-run interest rate elasticity and a declining long-run elasticity in recent years seem consistent with current banking practices. Initially, when market rates increase, banks have tended not to change the rate on NOW accounts, thereby enlarging rate spreads that induce consumers to shift funds out of M1. Over time, however, if the increase in the market rate persists, banks will gradually adjust the NOW-account rate upward, matching at least part of the market-rate increase. Hence, some of the shift out of NOW accounts will be reversed. And since there is at least some flexibility in the NOW account rate compared with the earlier situation when rates were regulated, the long-run elasticity might decline.[16]

For all the M1 elasticities, very sharp downward movements occurred around 1929, suggesting instability in the demand for M1 about the time of the Great Depression. Some instability at that time was also apparent in the error pattern for the total-period equation (Chart 2), implying that the extreme fluctuations in economic activity in the late 1920s and early 1930s contributed to money demand instability. The coefficients also show large changes in the mid-1970s as observations covering the well-documented downward shift in money demand at that time are included.

In general, the results from Chart 4 do not suggest that the changes that have occurred in the coefficients in the demand for M1 function in recent years have been unprecedented by past standards. Measured over 10-year periods, these coefficients have changed substantially at other times in the past, occasionally moving outside the range of values suggested as reasonable by economic theory. In particular, the negative values obtained at times for the income elasticities are inconsistent with economic theory, since consumers generally are expected to add to their money balances as the level of income increases.

The comparable results for M2 are shown in Chart 5. The short-run interest rate coefficient in the demand for M2 has been quite stable in recent years. However, M2's long-run interest rate coefficient has declined considerably in absolute value during the 1970s and 1980s as many consumer deposits have been deregulated. Similarly, M2's short-run income elasticity has increased sharply in recent years, but the long-run coefficient remains quite close to one. And like the movements in the M1 coefficients, the changes in the M2 coefficients in recent years do not appear to be totally unprecedented by past standards. The M2 coefficients have also drifted over fairly wide ranges in the past.

In addition, M2's short-run and long-run income and interest rate coefficients also take on values inconsistent with economic theory around 1929, displaying the same extreme instability evident in the M1 coefficients. This finding also suggests that extreme fluctuations in economic activity can affect the stability of money demand. Overall, judging from the sharp movements in the coefficients in both the M1 and M2 equations at that time, it appears that money demand was quite unstable in the late 1920s and early 1930s, although as noted earlier this instability did not show up as clearly in the errors from the dynamic M2 simulation as it did in the error pattern from the M1 simulation (Charts 2 and 3).

Chart 6 contains the movements in the constant terms

[15]Other studies have noted that the coefficients in the money demand equations can differ depending on the sample period selected but have not attempted to show how the coefficients have varied over time. For more detail, see Stephen M. Goldfeld, "The Demand for Money Revisited," *Brookings Papers on Economic Activities*, no. 3 (1973), pp. 577-646.

[16]For more detail, see Wenninger, "Responsiveness of Interest Rate Spreads"; and Davis, Korobow, and Wenninger, "Bankers on Pricing Consumer Deposits."

and the coefficients on the lagged dependent variables. It is well known that the coefficient on the lagged dependent variable in M1 equations (left side of chart) increased dramatically at the time of the downward shift in the demand for M1 in the mid-1970s, actually exceeding one for a period of time.[17] Economic theory suggests this coefficient should be between zero and one (see footnote 7). More recently, however, that coefficient appears to have returned to a more reasonable value and is about 10 percent below the coefficient for the entire time period.

In contrast, the constant term in the M1 equations does not appear to be returning to a more reasonable value. It has continued to shift sharply downward, suggesting that variables other than those included in the equation have been affecting the demand for M1. And unlike many of the other movements in the coefficients over time, the downward drift in the constant term is almost beginning to appear unprecedented. Since this downward drift began in the mid-1970s, it could well reflect the increased emphasis on cash management that began at that time. However, since the constant term reflects the net of several factors that could be affecting the demand for M1, it is difficult to know whether cash management provides a complete explanation.[18]

Table 5 contains a brief summary of the results in Charts 4, 5, and 6, focusing specifically on the money demand coefficients estimated over the most recent 10-year (1977-87) period compared with the average coefficients estimated over successive 10-year periods. The large standard deviations of the coefficients relative to the estimated values again illustrate the substantial degree to which these coefficients have shifted over time, making the recent experience appear somewhat less unusual. The most notable exception, as noted earlier at an impressionistic level, is the constant term in the M1 equation. It currently stands more than two standard deviations from the mean, suggesting that M1 has been strongly influenced in recent years by factors other than the conventional interest rate and income variables. The other exception is the short-run income elasticity in the M1 equation. One possible interpretation of the large coefficient estimated for recent years is that as income grows, consumers are adding funds to M1 not only for transactions purposes but also for savings purposes now that M1 contains an interest-earning component, NOW accounts.[19]

[17]In calculating the long-run elasticities, we used the total-period coefficient on the lagged dependent variable whenever the short-run coefficient exceeded the coefficient for the total period. The total-period coefficient was already close to one, and dividing short-run coefficients by numbers close to zero (or even negative numbers) produced charts that were very difficult to interpret.

[18]The results in Chart 6 for M2 (right side of chart) are not so striking. The constant term has been drifting downward but not out of line with what has occurred before. The coefficient on the lagged dependent variable has been declining since the mid-1970s and is now generally in the same range as the coefficient from the M1 equation, suggesting roughly similar speeds of adjustment in the demand for M1 and M2 balances at this time.

[19]While some of the changes in the other coefficients in the M1 and M2 demand equations are not as dramatic as the two just

Table 5

Money Demand Coefficients

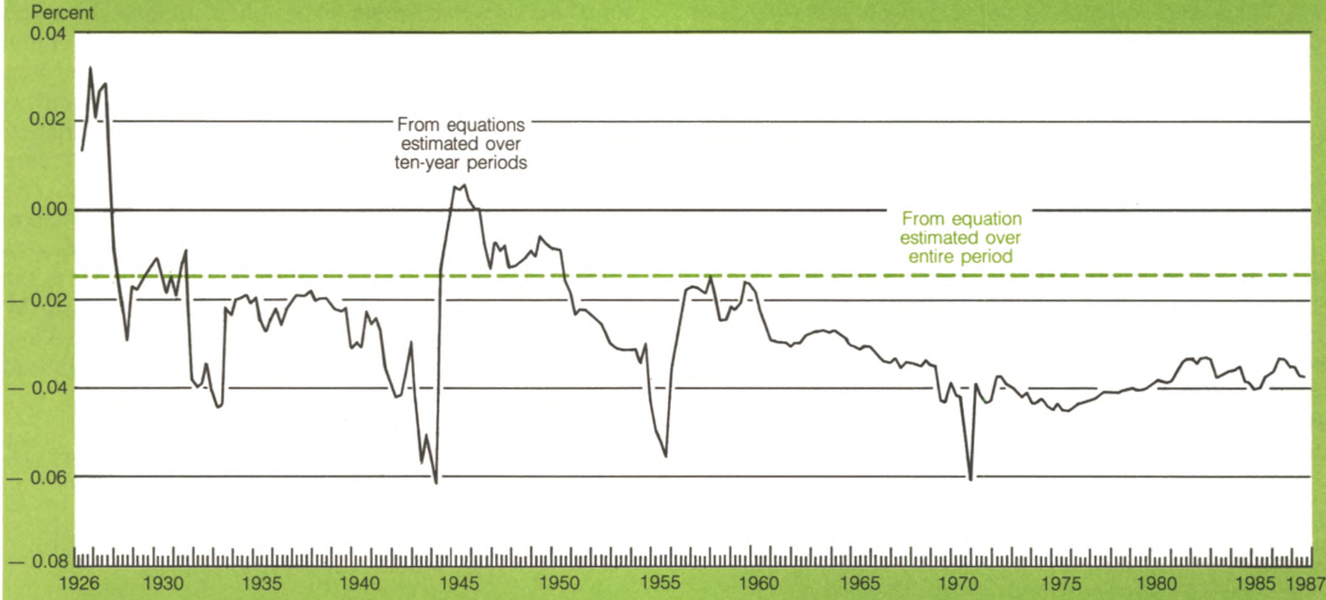
	Constant Term	Commercial Paper Rate		Income		Lagged Dependent Variable
		Short-Run	Long-Run*	Short-Run	Long-Run*	
M1						
Last 10 years (1977-III to 1987-III)	−1.709	−0.046	−0.219	0.266	1.266	0.790
Mean of 10-year periods	−0.383	−0.028	−0.240	0.096	0.656	0.836
Standard deviation (entire period)	0.467	0.015	0.151	0.067	0.436	0.108
M2						
Last 10 years (1977-III to 1987-III)	−1.512	−0.038	−0.146	0.293	1.133	0.741
Mean of 10-year periods	−0.716	−0.030	−0.188	0.175	1.050	0.824
Standard deviation (entire period)	0.597	0.012	0.095	0.063	0.378	0.072

*See footnote 17 in text for method used to calculate long-run elasticities for those quarters in which there were unusually large coefficients on the lagged dependent variable. When these calculations were made, those observations were dropped that had coefficients inconsistent with economic theory, i.e., negative income elasticities, positive interest rate elasticities, or coefficients on the lagged dependent variable equal to or greater than one. The results, however, were not very sensitive to whether or not these observations were included.

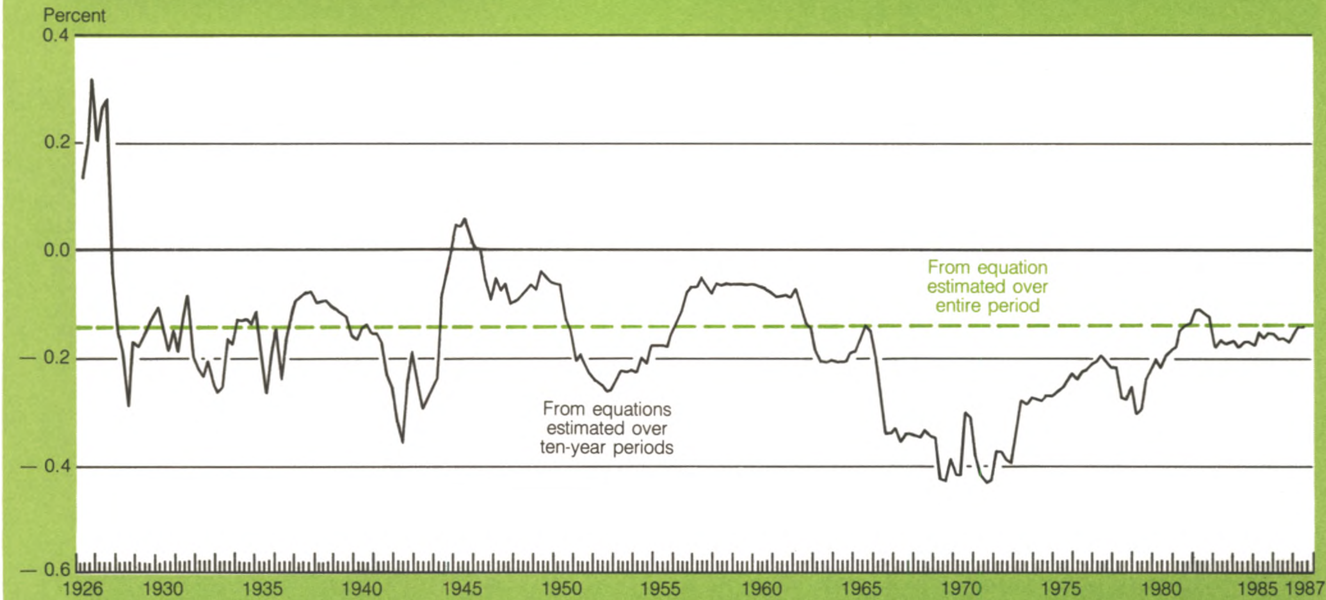
Chart 5

Comparison of Total-Period and Successive Ten-Year Coefficients

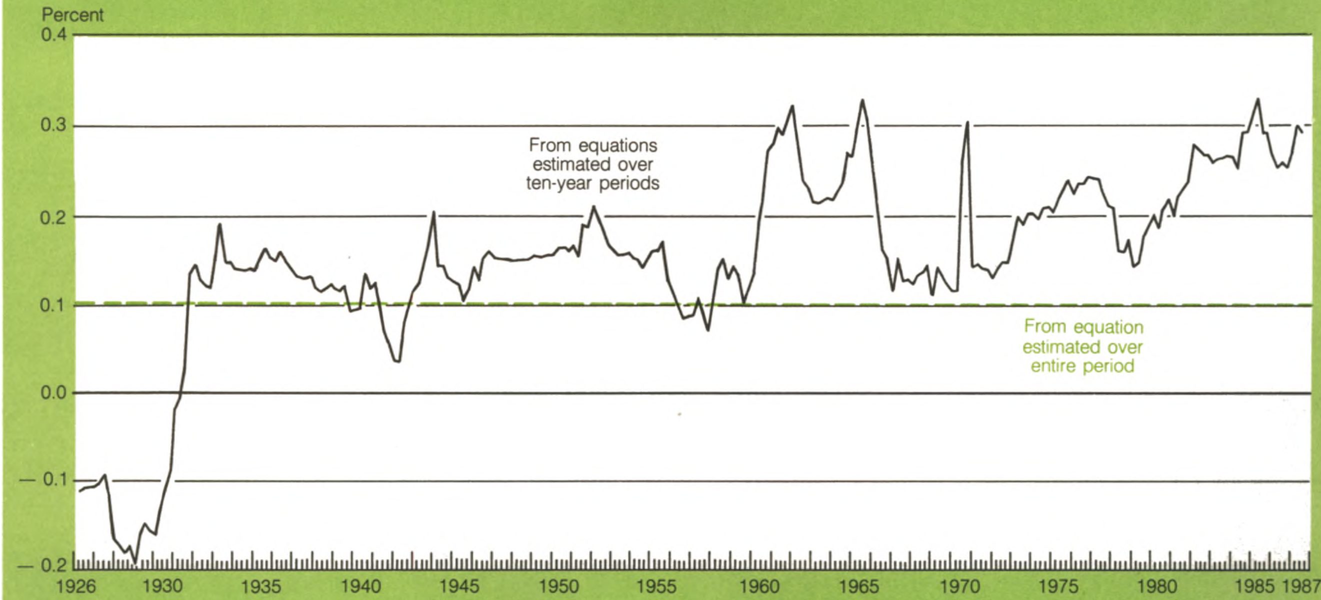
M2 Short-Run Interest Rate Elasticity



M2 Long-Run Interest Rate Elasticity



M2 Short-Run Income Elasticity



M2 Long-Run Income Elasticity

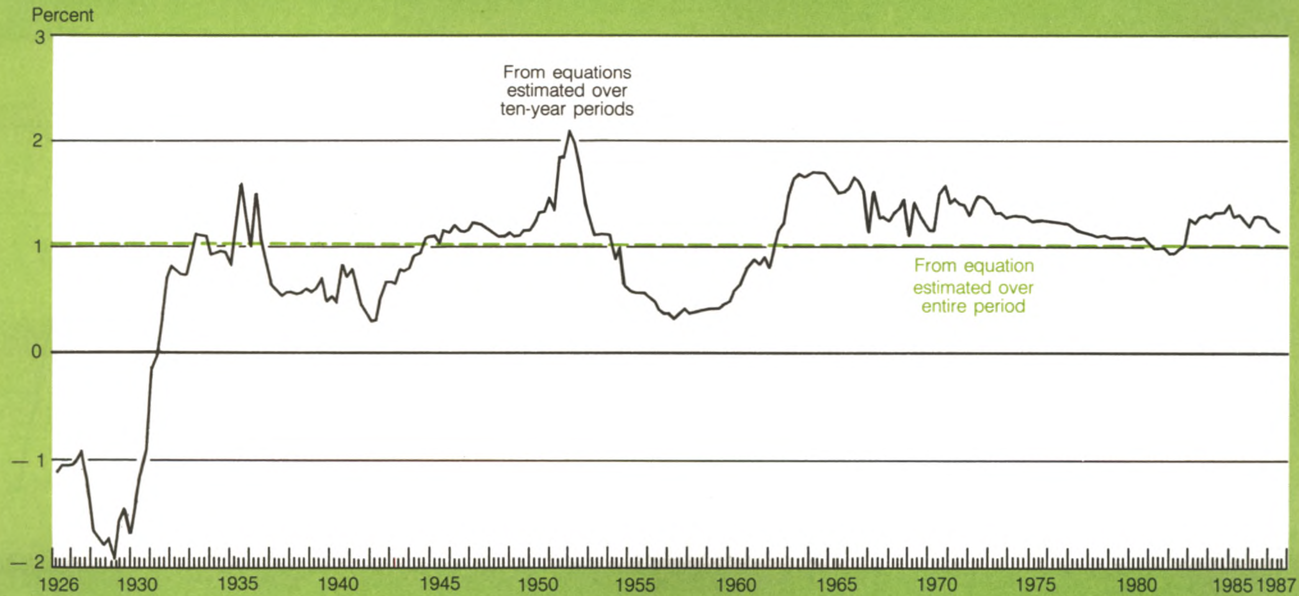
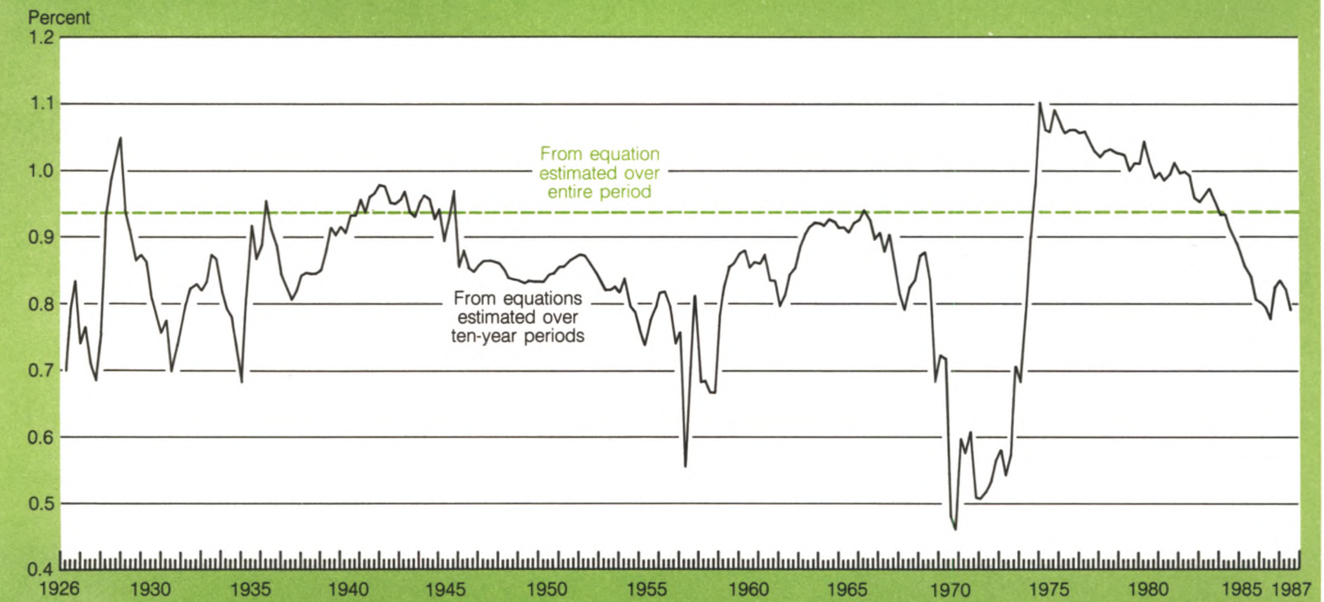


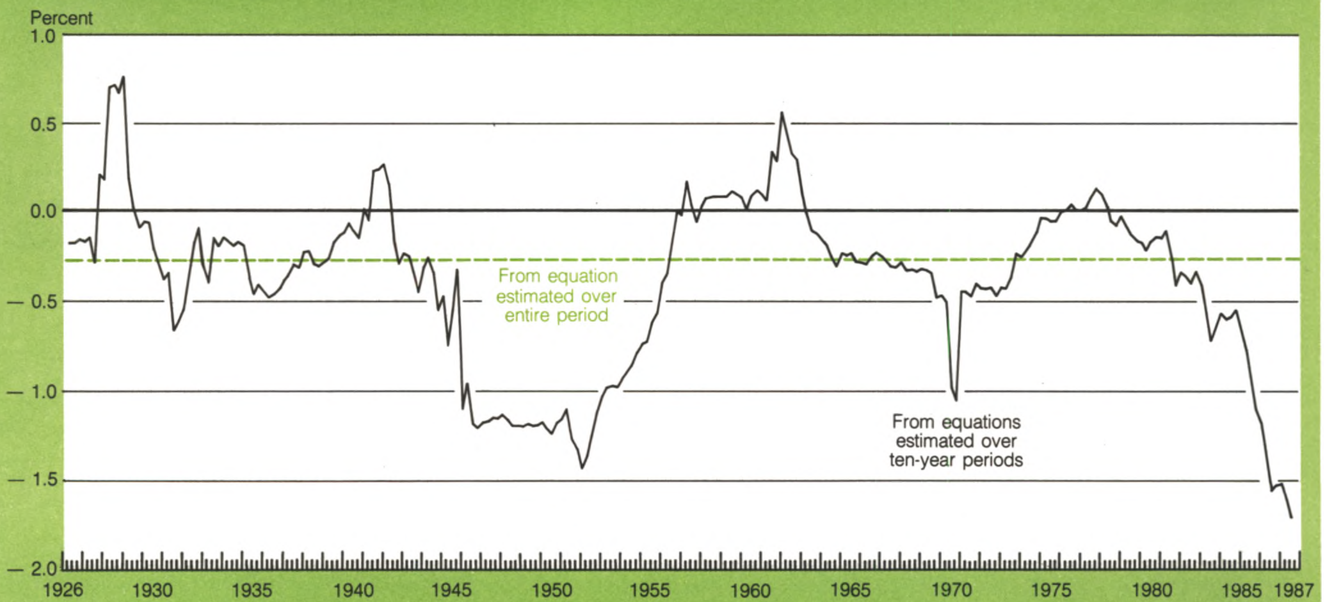
Chart 6

Comparison of Total-Period and Successive Ten-Year Coefficients

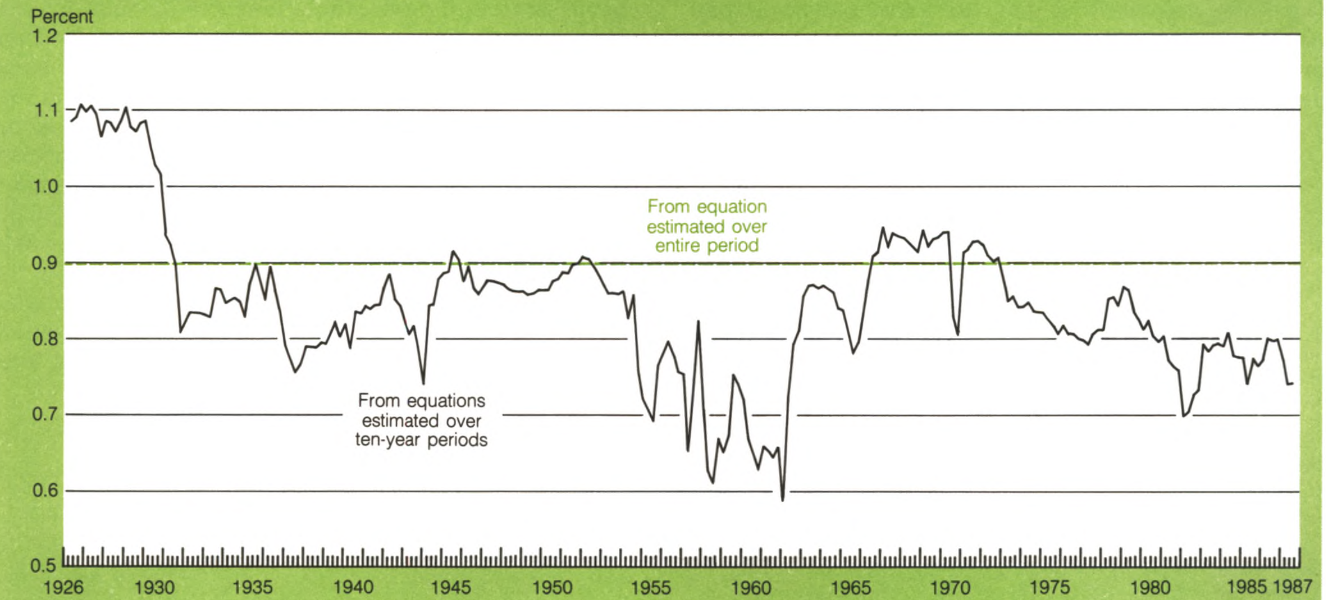
M1 Lagged Dependent Variable



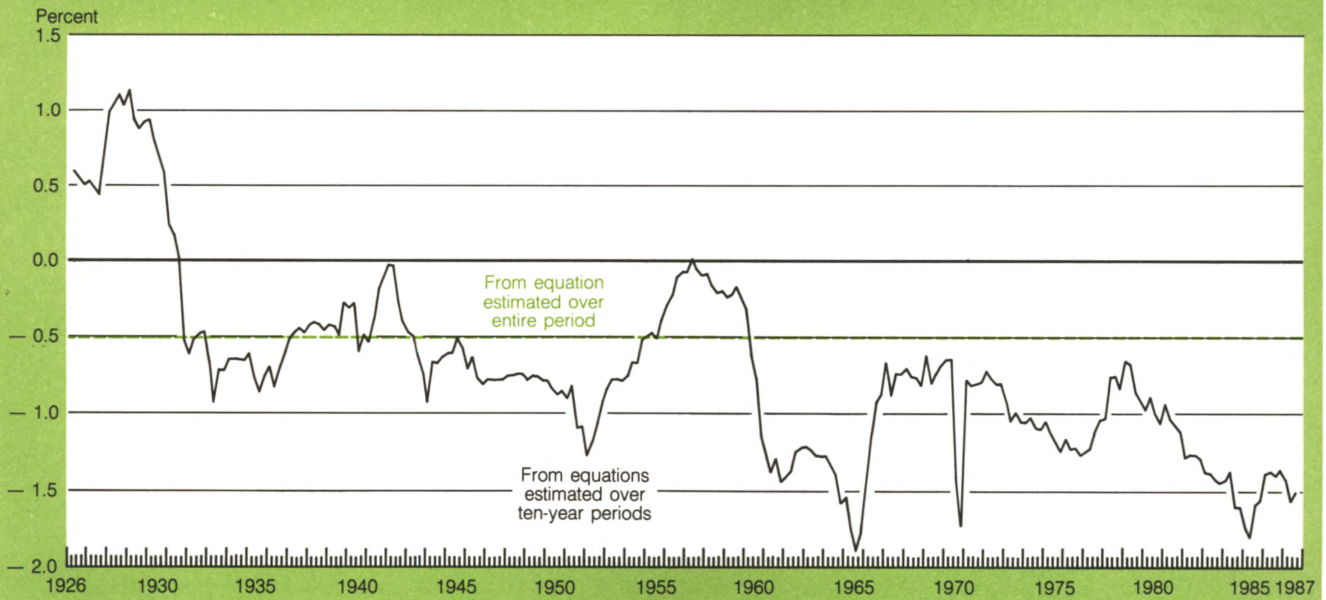
M1 Constant Term



M2 Lagged Dependent Variable



M2 Constant Term



Conclusions

In this article, we have attempted to put the recent instability in the demand for M1 into a broader context—first, by examining money demand over several decades, and second, by exploring the demand for M1 relative to the demand for M2. At the same time, we have avoided a detailed inquiry into the reasons why money demand has been unstable in recent years, since earlier studies have explored these issues at length.[20] Our chief purpose has been to show that the stable demand for M1 over the 1950-73 period was a rather unique experience. Longer term results reveal a more persistent pattern of instability in the demand for M1.

The demand for M1 over the 1950-73 period was also unique because of the rather low coefficients in absolute value estimated for the interest rate and income variables relative to the coefficients estimated for earlier and later time spans and relative to the results for the entire period. This finding suggests that the estimates of the demand for money over this period were not representative of the demand for money more generally.

In recent years, the demand for M2 appears to have been somewhat more stable than the demand for M1. In addition, the demand for M2 appears to have become less sensitive to changes in market interest rates since the mid-1970s. On a quarter-to-quarter basis, the errors from the M1 and M2 functions have tended to show considerably less correlation over the 1974-87 period, suggesting that M2 has become a more useful complement for policy purposes during this period of difficulty in interpreting the behavior of M1. Finally, when estimated over 10-year periods, the coefficients in the money demand functions for M1 and M2 have varied over fairly wide ranges, raising some questions about our ability to use estimates of these elasticities to forecast money growth out of sample.

John Wenninger

Footnote 19 continued
mentioned, some of them are, of course, still large enough to have substantial effects on the predicted growth of the monetary aggregates. In particular, the short-run interest rate coefficient for M1, the long-run income elasticity for M1, the constant term for M2, and the short-run income elasticity for M2 have shown rather large changes.

[20]See, for example, John Wenninger and Thomas Klitgaard, "Exploring the Effects of Capital Movements on M1 and the Economy," this *Quarterly Review*, Summer 1987, pp. 21-31. For a comprehensive survey of the various explanations for the decline in M1's velocity during the 1980s, see Courtenay C. Stone and Daniel L. Thornton, "Solving the 1980s' Velocity Puzzle: A Progress Report," Federal Reserve Bank of St. Louis *Review*, August-September 1987, pp. 5-23.