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Economic Instability and the Demand for Money, 1908–1980

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INTRODUCTION

The primary purpose of this paper is to investigate whether the 1973 shift in the demand for money was a unique event or whether similar shifts in the demand for money have occurred in the past. This issue is examined using the quarterly data for the period 1908 to 1980 compiled by Professor Robert J. Gordon (1982). This is an interesting issue which, despite the large volume of research on the demand for money, has largely been ignored. The availability of a lengthy time series of data makes it easier to study this issue.

We are aware of only two money demand studies which use long period data and employ formal techniques available which test the stability of an equation over time.[1] These are: the Cooley-Prescott varying parameter technique, (VPR) and Brown-Durbin-Evans (BDE) cusum-of-squares techniques. One is by Khan (1974) using the BDE technique and the other is by Laumas and Mehra (1977) which uses the VPR technique. A third study by Garbade (1977) tests the relative robustness of the VPR and BDE techniques and using Khan's data concludes that VPR is a more robust technique.

Based on annual data for the United States from 1900–1974, Laumas and Mehra find that the conventional money demand equation is unstable for the period.[2] Khan and Garbade, using data for the period 1901–1965, find it to be stable. In fact, Garbade finds it stable using the VPR technique. Why this radical difference in the results among the studies by Laumas-Mehra and Khan and Garbade.[2] The difference in the results arises from the fact that Khan and Garbade use first-differences of the logs of the data and thus constrain the serial correlation coefficient (rho) to unity whereas Laumas-Mehra use levels of log data and thus do not constrain rho. The evidence presented below indicates that the estimated value of rho over the entire sample period as well as each of the sub-periods is always more than two standard errors below unity.[3] Further support for the decision not to constrain rho to unity comes from investigations of the log-likelihood surface for various values of rho for various time periods. This technique, suggested by McMillan and Fackler (1983), does find "flat" regions on this surface, but never shows a flat log-likelihood function in the neighborhood where rho is set to unity. Thus there is no justification for Khan (and Garbade who used Khan's data) to have specified a first difference formulation of the M2 demand for money. The misspecification of the equation by Khan and Garbade leaves us with only the Laumas-Mehra study, which implies instability of the equation. Before proceeding further it should be pointed out that this study did estimate the first difference specification of the money demand equation for the whole period 1908 to 1980 using quarterly data and employing both the VPR and BDE stability tests, and found it to be stable.

We agree with Milton Friedman (1956, p. 16) that "there is indeed little if any difference between asserting that the demand for money is highly unstable and asserting that it is a perfectly stable function of an infinitely large number of variables." At the same time we should

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not be surprised to find that economic agents adjust their behavior with regard to the demand for money balances when major economic "events" (whether in real aggregates as output and employment, or in the financial structure) occur. In fact, the demand for money remains stable until some outside event occurs; economic agents change their behavior and the new, stable behavior pattern persists until the next event shocks a change in behavior. More specifically, the evidence presented below shows that the demand for money is unstable for the whole period 1908 to 1980; however, it is stable for various subperiods. The start and end of each of these periods roughly coincides with some outside event. Economic agents adjust very quickly to a new behavior in the demand for money balances; they behave *within the general framework of rational expectations*. Thus our results are consistent with the view that the behavior of economic agents will change in response to important structural changes in the economy or to obvious changes in economic policy but that the behavior of these agents is stable within economic or policy regimes.

Section II of this paper presents the stability tests, section III is devoted to estimates of the demand for money and a discussion of these results and a summary and conclusions are given in the final section.

MONEY DEMAND AND STABILITY

Our estimated equations employ the M2 definition of money. Investigation of the stability of an M2 money demand function is interesting on a number of grounds. First, Friedman and Schwartz (1963, p. 652n) argue that, for a substantial part of our sample period, there exists "a generally more stable relation between the total we call money [M2] and other economic magnitudes than between the sum of currency and demand deposits adjusted and the same economic magnitudes." Second, in Friedman (1959), which used annual M2 data to examine the money demand function during the 1870–1954 period, the behavior of money demand was investigated over the business cycle in an effort to reconcile short-run ("cyclical") and long-run ("secular") results. Lacking the currently-available battery of stability tests, Friedman's analysis may be viewed as an important pre-cursor to the issue of stability of M2 money demand. Third, as a result of recent financial innovations, in the fall of 1982 the Federal Reserve publicly announced that it would place less emphasis on narrowly defined money (M1) and relatively more weight on broader aggregates, including M2. Even though this recent attention to M2 falls outside our sample period, it nonetheless raises the issue about the historical performance of the broader aggregates in the past and whether they might reasonably be assumed stable.[4]

Thus our estimated equation takes the form:

$$m_t = b_0 + b_1 Y_t + b_2 R_t + b_3 m_{t-1} + e_t, \quad (1)$$

in which m represents the natural log of the real M2 definition of money, Y is either real GNP or real permanent GNP, R is the prime commercial paper rate and e is the disturbance term.

It should be pointed out that equation (1) was estimated with real GNP as well as with real permanent GNP.[5] The results were largely invariant to the use of either of the income variables. We have presented the results with real GNP only.[6] We include the lagged dependent variable both because we employ quarterly data and because in certain of our subperiods the adjustment process is likely to be slow. The inclusion of a lagged dependent variable when estimating money demand functions with quarterly data is now common practice and is commonly interpreted as reflecting the assumption that the adjustment of actual money holdings to their desired level

requires, in the aggregate, more than one quarter. Further, in some of our subperiods, such as prior to the establishment of the Federal Reserve and during the period of widespread bank failures, we expect the adjustment process to be especially slow in view of the lack of, or instability of, appropriate financial institutions.

We subjected equation (1) to stability tests using the VPR technique, the adaptive regression model, which is a special case of the more general varying parameter regression model, and the BDE cusum-of-squares tests associated with "recursive" regressions.[7] For equation (1), the results of this test are presented in the third column of Table 1.[8] Stability is then tested by comparing the cusum-of-squares statistic with the appropriate critical value.

The subperiods over which the money demand function is stable were determined through extensive experimentation with the data. From the beginning of the data set data were added a year at a time, testing each successive equation for stability using both the adaptive and more general varying parameter regression techniques. When adding a year's worth of data produced an instability, data were then deleted quarter by quarter, from the end of the data, to determine the particular quarter in which the shift in money demand occurred. Finally, given the set of subperiods over which the function was stable, each subperiod was also checked for stability with the cusum-of-squares test. The results of this process, reported in Table 1, suggest that although the demand for money function has not been stable over the entire period, it *is* stable

TABLE 1
Stability Results

Period	Stability Test Results		
	Adaptive	VPR	Cusum-of-Squares
1908:1–1980:4	.50*	N.A.	.342*
	(0.079)		(<.128)
1908:1–1916:1	0.0	0.0	.193
	(0.004)	(0.0001)	(.293)
1916:2–1920:4	0.0	0.0	.242
	(0.009)	(0.0003)	(.367)
1921:1–1928:1	0.0	0.0	.117
	(0.004)	(0.0001)	(.309)
1928:2–1932:4	0.0	0.0	.246
	(0.009)	(0.00003)	(.367)
1933:1–1942:1	0.0	0.0	.148
	(0.002)	(0.00008)	(.279)
1942:2–1952:1	0.0	0.0	.272
	(0.009)	(0.00005)	(.273)
1952:2–1955:1	0.0	0.0	.220
	(0.024)	(0.0005)	(.446)
1955:2–1958:2	0.0	0.0	.191
	(0.024)	(0.0004)	(.446)
1958:3–1973:3	0.0	0.0	.206
	(0.001)	(0.00002)	(.224)
1973:4–1980:4	0.0	0.0	.113
	(0.004)	(0.00007)	(.309)

[a]Reported are estimated values (standard errors) for the stability parameter, γ. An asterisk indicates a significant shift at the 5 level.

[b]Reported are the computed cusum-of-squares (critical value of the cusum-of-squares at the 5 level). An asterisk indicates a significant shift at the 5 level.

over a relatively small set of subperiods. However, in every case considered, extending any of the sample periods into either the previous or the following period leads to rapid deterioration of that specific regression; such extended subperiods fail the stability tests.[9] Thus while the estimated functions are stable over the subperiods reported in Table 1, it does not appear possible to identify longer periods of stability.

MONEY DEMAND: ESTIMATES AND DISCUSSION

In this section we present and discuss estimates of the money demand function for the entire period and for the subperiods listed in Table 1. Our primary purpose is to argue that each subperiod is distinguished from those preceding and following it by obvious changes in the economic structure.

Each equation reported in Table 2 is estimated using a maximum likelihood estimator with a first-order serial correlation correction. The maximum likelihood estimator is chosen over the Cochrane-Oruntt technique since the former does not discard the information contained in the first observation of the estimation period. For ease of comparison, all equations are presented with their serial correlation coefficients; we note that for cases where rho is zero, the estimator reduces to the usual least squares estimator.

The first equation reported in Table 2 is for the entire period under investigation, 1908:1–1980:4.[10] In many respects, this equation appears much like other equations reported elsewhere for much shorter periods. Specifically, both real income and the interest rate are significant and the speed of adjustment, per quarter, of actual money holdings to their desired level is about 12 percent. The implied long-run elasticities of M2 with respect to income and interest rates are 1.07 and −.138, respectively. Finally, the estimated value of the serial correlation coefficient is approximately 0.4.

Despite the "reasonable" appearance of this equation, the stability tests conducted in the previous section demonstrate that the coefficients estimated for the stable subperiods will be quite different from those of the equation estimated over the entire period. Of particular interest is the fact that for most of the subperiods, the coefficient on income is not significant at standard levels. In contrast, the interest rate does generally achieve significance and lagged money holdings are always statistically significant. However, the estimated coefficients on each of these variables are often substantially different from period to period, as are the point estimates of the long-run elasticities. We note, in addition, that the estimated serial correlation coefficient for most periods is not significantly different from zero.[11]

Equation (2.2) in Table 2 represents a "pre-Federal Reserve" period in which interest rates and lagged money holdings are significant but in which income is not. We note that the speed of adjustment of actual to desired money holdings is at a rate of only 5 percent per quarter. One possible rationale is that the banking panic of 1907 pointed to the instability in, and need for reform of, the financial system. Until such reform was implemented, most notably by the establishment of the Federal Reserve, the ability to adjust money holdings was limited. The period covered by equation (2.2) corresponds quite closely to the Friedman-Schwartz "postpanic" period of 1908–1914; the endpoint of equation (2.2), 1916:1, includes the year 1915 in which pre-Federal Reserves monetary arrangements were employed while the institutional changes stimulated by the Federal Reserve Act were still being put in place. Alternately, the endpoint of equation (2.2) approximately corresponds to substantial U.S. involvement in World War I and to the beginning of a period of rapid wholesale price inflation.

TABLE 2
Estimation Results for M2 Money Demand, Various Periods

	Period	Coefficient Estimates				Implied Speed of Adjustment	Long-run Elasticities		Summary Statistics		
		Const	Y	R	$M2_{t-1}$		Y	R	R^2	S.E.	rho
(2.1)	1908:1–1980:4	−.637	.129	−.017	.879	.121	1.07	−.138	.99	.016	.398
		(7.69)	(7.86)	(6.83)	(57.10)						(7.35)
(2.2)	1908:1–1916:1	−.239	.058	−.032	.951	.049	1.18	−.66	.98	.014	.048
		(0.70)	(0.87)	(2.21)	(19.02)						(0.25)
(2.3)	1916:2–1920:4	.526	−.088	.001	.589	.410	−.21	.004	.41	.032	−.164
		(0.60)	(0.54)	(0.04)	(2.33)						(0.58)
(2.4)	1921:1–1928:1	−.090	.038	−.035	.886	.114	.33	−.309	.99	.012	.151
		(0.22)	(0.47)	(1.75)	(11.45)						(0.68)
(2.5)	1928:2–1932:4	−.800	.242	−.066	.272	.728	.33	−.091	.94	.007	.016
		(6.98)	(8.93)	(8.54)	(3.18)						(0.06)
(2.6)	1933:1–1942:1	.310	−.044	−.093	.902	.099	−.44	−.939	.99	.014	.076
		(1.32)	(0.95)	(7.28)	(21.53)						(0.44)
(2.7)	1942:2–1952:1	−1.06	.199	−.031	.876	.124	1.60	.250	.97	.018	.089
		(4.44)	(5.16)	(3.83)	(36.22)						(0.54)
(2.8)	1952:2–1955:1	−.076	.055	−.014	.813	.187	.29	−.075	.99	.005	−.23
		(0.15)	(0.54)	(1.42)	(5.21)						(0.71)
(2.9)	1955:2–1958:2	−.173	.149	−.033	.461	.539	.28	−.061	.99	.003	.064
		(0.23)	(1.52)	(7.80)	(3.88)						(0.18)
(2.10)	1958:3–1973:3	−.467	.084	−.032	.959	.041	2.13	−.780	.99	.004	.436
		(1.65)	(1.62)	(7.90)	(19.70)						(3.52)
(2.11)	1973:4–1980:4	−2.14	.421	−.044	.624	.376	1.12	−.117	.99	.006	.18
		(4.24)	(4.26)	(7.37)	(6.36)						(0.92)

[a]The dependent variable in all regressions is the natural log of M2. Y and R represent, respectively, the natural logs of real GNP and the commercial paper rate. All equations are estimated using a maximum likelihood, first-order autoregressive estimator. Numbers in parentheses represent t-statistics.

[b]The reported R^2's are for the rho-transformed data. Numbers in parentheses represent t-statistics.

Equations (2.3) and (2.4) represent successive periods in which neither income nor interest rates achieve significance at conventional levels. The first of these equations covers the 1916:2–1920:4 period, a time period encompassing the First World War and turbulence in prices and output. For example, Friedman and Schwartz point out that wholesale prices in May, 1920 were about two and one half times their September, 1915 level. The second of these equations covers the period from 1921:1 through 1928:1, a period of relatively rapid growth without a major downturn in economic activity. We note that this latter period corresponds roughly to what Friedman and Schwartz refer to as the "high tide of the Federal Reserve System, 1921–29."

Equation (2.5) corresponds to a period of declines in the money stock, from early 1928 when the Fed began to pursue a restrictive policy due to its anxiety with regard to the boom in stock prices through the end of 1932 when the dramatic year-to-year declines in the money stock finally moderated. Of course, this period also coincides with the dramatic drop in output and prices that characterized the Great Depression.

The period from 1933:1 through 1942:1 includes not only the establishment of the Federal Deposit Insurance Corporation in the Banking Act of 1933, which reduced the risk of holding bank deposits, but also the emergence of a strengthened Federal Reserve in which open market operations were centralized in the Federal Open Market Committee. This period also corresponds to the gradual rise in production from the depths of the Depression. It ends with the onset of interest rate "pegging" by the Fed.

Equation (2.7) in Table 2, which corresponds to the 1942:2–1952:1 period, roughly represents the period over which the Federal Reserve pegged interest rates on Treasury securities. Equations (2.8) and (2.9) represent the period of the mid-1950's and are the shortest periods in our analysis. The first corresponds to the period of the Korean War and its immediate aftermath and perhaps to the adjustment of monetary policy to the post-Accord period. The second period runs through the 1958 recession.

The penultimate period, described by equation (2.10) covers a period, 1958:3–1973:3, of substantially stable prices and generally expanding output. The end of the period corresponds not only to a point where many believe there was a "shift" in money demand but also to a point at which the economy began to experience substantial economic turbulence; the end of 1973 corresponds to the end of the Nixon wage-price controls program, the first oil shock and just precedes the sharp recession which began in 1974.

The final period, 1973:4–1980:4, is characterized by parameter coefficients that appear to be "acceptable" in that both income and interest rates are significant and with long-run elasticities that are remarkably close to those for the period as a whole. Nonetheless, it should be clear that despite the resemblance of equations (2.1) and (2.11), the money demand function for the recent period has quite different characteristics than for previous periods.

SUMMARY AND CONCLUSIONS

Our objective in this paper has been to investigate the stability of the M2 money demand function over the 1908:1–1980:4 period. Unlike previous investigators, we do not find the function has been "econometrically stable" over the entire period. Nonetheless, we do argue that the function might be characterized as "economically stable." The distinction between these concepts of stability is important and deserves re-iteration.

In the analysis undertaken in this paper, we demonstrate that although the money demand function has not been stable over the entire time period, this time period can be partitioned into a set of subperiods in each of which the estimated function is highly stable.

It is perhaps interesting to note that although it is quite common to estimate money demand functions for the post-Accord period, our analysis suggests that the results of such regressions are quite misleading. For example, estimating our M2 function over 1952:1–1980:4 results in a highly significant coefficient on income, a result at odds with those in equations (2.8) to (2.10). Further, the equation estimated over this period has an implied speed of adjustment of about 16 percent and income and interest rate elasticities of about 1.25 and −.18, respectively; these elasticities are not far from those estimated either for the 1973:4–1980:4 period or for the entire 1908:1–1980:4 period. However, just because elasticities appear "plausible" is not a sufficient reason for uncritical acceptance of the results.

We have extended each of the subperiods which correspond quite closely to those analyzed by Friedman and Schwartz in each direction and always find that such extended equations deteriorate quickly, both in terms of the formal stability tests and in terms of the estimated coefficients. We are thus confident that our partition of the entire time period is the appropriate one.

Having identified subperiods for which our money demand specification is econometrically stable, we next ask whether the subperiods are delineated by obvious changes in the economic

structure. We not only find that the beginning and end points of our subperiods can be explained by major economic events, but also that our subperiods correspond quite closely to those discussed in Friedman and Schwartz.

Given the high degree of stability, in terms of formal statistical tests, of our M2 function within subperiods and the instability of the same function across subperiods, it appears that economic agents rather quickly alter the way they hold money in response to major changes in the economic constraints which they face. In our interpretation, changes in behavior in response to changing constraints does not imply general instability of money demand but rather represents a rational response to changes in the economic structure.

Thus, we would characterize the overall period as one of stability in M2 money demand inasmuch as changing the way we hold money in response to abrupt changes in the economic structure is not a surprising development; "instability" in our 1908:1–1980:4 period is not the result of random parameter fluctuations or of systematic parameter drift but rather is the result of economic agents adjusting their behavior to important changes in the economic constraints which they face.

We conclude by stating that the 1973 shift in the money demand function observed by Goldfeld (1976) and others was not a unique phenomenon. Rather it was one among several shifts through whch the demand for money has gone through since 1908.

FOOTNOTES

1. Among recently used formal tests of stability are the cusum-of-squares test proposed by Brown-Durbin-Evans (1975), the varying parameter test developed by Cooley and Prescott (1973a, 1973b, 1976), and the test presented by Farley-Hinich-McGuire (1975) which allows regression parameters to be polynomials in time. Informal stability tests, notably out-of-sample predictive performance from both static and dynamic simulations, are also widely used. Recent money demand studies employing at least one of these various techniques include Boughton (1981), Goldfeld (1973, 1976), Hafer and Hein (1979, 1980), Hein (1980), Laumas and Mehra (1976, 1977), and McMillin and Fackler (1983).

   Chow (1966), Lieberman (1980), Laidler (1966), and Meltzer (1963) also investigate long-run money demand functions, but with little or no mention of *formal* stability tests. All of these studies employ annual data. Lieberman (1980) employs the data set by Chow (1966) to test for a break in 1933 in the long-run money demand function. Other potential breakpoints apparently were not analyzed, however. For additional studies, see Laidler (1977).
2. Using the same annual data Laumas and Mehra (1977) find that the M2 demand for money is marginally stable when the lagged dependent variable is included.
3. While we discuss these results in more detail below, it suffices to say at this juncture that for long periods which correspond roughly to those employed by Khan and Garbade our point estimate of the serial correlation coefficient is .4.
4. Despite the fact that we focus on M2, a preliminary investigation of M1 shows that it also seems to shift at discrete time periods, coinciding with major economic events, but is stable beteen such events.
5. The permanent income series used in our investigation was computed as explained in Laumas and Mehra (1976), and closely follows the original procedure used by Friedman (1957). Specifically permanent income, in real terms, is defined by

$$Y_p(T) = \beta^T e^{(\beta-\alpha)(t-T)} GNP(t)dt$$

   where α is the rate of growth of real GNP and β is the adjustment coefficient.
6. The quarterly data on GNP prior to 1947 was constructed by Gordon (1982) from existing GNP data (which, for the most part was annual) using a related series interpolation technique. Gordon reports in his appendix that applying the same interpolation technique to annual GNP since 1947 produces a

quaterly series with time and frequency domain characteristics which are very similar to actual quarterly GNP over the same period.

7. Specifically, the adaptive regression model investigates whether the constant term in a regression shifts over time; the VPR technique extends this methodology to the other regression coefficients.
8. To implement the cusum-of-squares test, it is necessary to assume that the serial correlation coefficient is constant over the sample period since the test must be performed in the absence of serially correlated errors. To this end, we conduct all our cusum-of-squares tests for a value of rho of 0.4, a value consistent with the overall sample period. We note that for the various subperiods tested, the estimated rho is never more than two standard errors from 0.4. It should also be pointed out that the properties of the cusum-of-squares test have not been developed for an equation with a lagged dependent variable. Thus, the results of the cusum-of-squares test are only suggestive. For details of the adaptive and VPR methods, the reader is referred to the work of Cooley and Prescott (1973, 1976) or Laumas and Mehra (1976). Details of the BDE technique are given in Brown-Durbin-Evans (1975) and Khan (1974).
9. As a dramatic, though not altogether atypical example, we note that extending the 1933:1–1942:1 period by two quarters leads to an increase in gamma (the measure of stability in the VPR procedure) to 0.86 with a standard error of .2.
10. The estimation period coincides with the availability of M2 data in Gordon's data set. All estimates in Table 1 employ the VPR technique developed by Cooley and Prescott (1976). Estimates in Table 2 use TSP (Time Series Processor) regression package.
11. Serial correlation coefficients which are statistically different than zero are sometimes interpreted as being an indication of equation misspecification. To the extent that our subperiod equations generally have rho values which are not statistically different from zero, and given the high R^2's, the results reported in Table 2 are consistent with Friedman's (1956) observation that a well-specified, stable function of a relatively small number of variables is needed to provide substantial empirical content to the theory of money demand since "there is indeed little if any difference between asserting that the demand for money is highly unstable and asserting that it is a perfectly stable function of an indefinitely large number of variables."

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