INSTITUTIONAL CHANGE, SPECIFICATION ERROR, INFLATION AND THE STABILITY OF THE DEMAND FOR MONEY FUNCTION IN THE UNITED STATES 1901-1974

by

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No.12 February 1977†

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I. INTRODUCTION

In a recent study Khan (1974), using a cusum of squares technique developed by Brown and Durbin (1968), analyzed the stability of the U.S. money demand function over the period 1901-65. He concluded that the demand for real balances (M1 or M2) per capita was a stable function of real income or real permanent income per capita, an interest rate (either short or long-run), and a time trend. However there are several aspects of Khan's study which suggest that further study of the stability of money demand may be warranted.

Firstly a recent article by Brown, Durbin and Evans (1975) suggests that Khan's stability analysis is incomplete. They propose a combination of the following tests and techniques to identify the existence and timing of structural change or other sources of instability: (i) the homogeneity statistic; (ii) the cusum test; (iii) the cusum of squares test; (iv) progressive Betas; and (v) Quandt's log likelihood ratio. The homogeneity statistic is a generalisation of the well known Chow test\(^1\) using analysis of variance for 'p' equal non-overlapping periods. It suffers from the criticism that the selection of sub-periods is rigid and may conceal the existence of an unstable relationship. The cusum test involves the computation of the standardised sum of the recursive one period prediction errors. A test is available\(^2\) to ascertain whether this cusum statistic differs significantly from its expected value of zero, statistical significance indicating an unstable relationship. Generally such instability will become evident when one period prediction errors are consistently positive or negative over a significant portion of the sample. Brown, Durbin and Evans assert that the cusum of squares test "provides a useful complement to the cusum test, particularly when departure from constancy of the Betas is haphazard rather than systematic".\(^3\) It also is useful in detecting whether the variance of a relationship is constant over time. While a non-constant variance does not bias the ordinary least squares regression coefficients, it does produce inefficient estimates.\(^4\) The cusum of squares
test, like the cusum test, also involves the recursive one period prediction errors though in this case the errors are squared before they are summed. Essentially the test ascertains whether the errors are evenly distributed throughout the sample period, a change in variance being evident in a concentration of large errors within a portion of the sample. Analysis of progressive betas involves the recursive calculation of regression coefficients, lengthening the sample period by one observation in each step. Quandt's log-likelihood technique is useful for detecting an abrupt change in a regression relationship at an unknown time. As there are no statistical tests of significance associated with the progressive beta and log-likelihood techniques, their role is to assist in the identification of the timing of structural change.

Secondly, Quandt (1975) suggests that additional power may be gained by running the cusum and/or cusum of squares tests both forward and backward over the data series rather than merely forward as Khan appears to have done.

Thirdly, there is reason to believe that Khan has utilised unreliable data for M1 in the years 1901-14. The M1 data was obtained from Friedman and Schwartz (1970), the 1901-14 observations being derived by applying an estimate of the time deposit ratio to total bank deposits. In commenting on the estimates Friedman and Schwartz write: "It is clear that the margin of uncertainty in these estimates is very large indeed - far larger, in our opinion, than that which attaches to the estimates of total deposits ...... . In view especially of the uncertain economic meaning of the distinction between demand and time deposits before 1914, this seems to us much too small and uncertain a base on which to erect anything that could be described as a structure of economic analysis". As it was felt desirable to undertake the stability analysis on the most reliable data for the longest possible period we have limited our stability analysis to the M2 definition of money. It is interesting
to note, however, that when the cusum of squares test was applied to Khan's M1 formulations for the period 1916-65, all were found unstable at the 95% confidence level. 7

Finally, bearing in mind the nature of the cusum of squares test described earlier, it is evident from Khan's Figures 1A, 2A, 3A, 3B, 4A and 4B that the one period prediction errors are relatively small in the post Federal Reserve/Treasury Accord period (i.e. 1952-65). If these relatively small errors continue in 1966-74 it is conceivable that application of the stability tests for the extended period 1901-74 could indicate statistical instability.

Consequently the plan of the paper is as follows. In Section II we show that all of Khan's formulations are statistically unstable, at the 95% confidence level, when estimated for the period 1901-74. Then in the remainder of the paper we examine various hypotheses to explain the observed instability. They include: (i) the effect of institutional factors on money demand (Section III); (ii) the existence of specification error (Section IV); and (iii) the effect of inflation on money demand (Section V).
II. U.S. MONEY DEMAND 1901-74

The NBER has recently revised its NNP in 1929 prices series. Our results utilize the revised data so that differences between Khan's results and ours reflect not only extension of the sample period but also differences in the underlying data. In addition, Khan is unclear as to the nature of the permanent income series utilised in his study. The series provided by the NBER is aggregate permanent real NNP or, in terms of the symbols utilised in this paper, $\frac{y^P}{P^P}$. To derive a per-capita series Khan appears to have deflated aggregate permanent real NNP by the actual population to obtain $\frac{y^P}{NP^P}$. However consistency would appear to demand that a permanent population deflator be utilized to obtain a series of permanent per-capita real income or $\frac{y^P}{NP^{PP}}$. For these reasons we include results corresponding to Khan's sample period as Regressions A1 to A4. Utilizing the revised data and modified permanent per capita real NNP produces a lower $R^2$ and lower interest elasticities than those of Khan. Application of the cusum of squares test to each of these estimates produced results similar to those of Khan as is evident in a comparison of Khan's Fig. 3A with our Fig. 1.9

Regressions B1 to B4 in Table 1 extend the sample period to 1974. A comparison of the corresponding A and B regressions reveals very little change in any of the estimated coefficients or summary statistics as a result of extending the sample period. Stability analysis of the B regressions produced varied results depending on the nature of the test applied. For example, of the 16 homogeneity statistics reported in Table 1 only two are significant at the 95% confidence level (corresponding to the p = 5 sub-period analysis and measured income formulations). Furthermore, application of the cusum test indicated that the null hypothesis of stability could not be rejected at the 95% confidence level in any of the four cases. On the other hand the cusum of squares test resulted in rejection of the null hypothesis of stability in all four cases. The plot for Regression B1 is reproduced as Figure 2.
Brown, Durbin and Evans (1975) discuss an example relating to telephone demand in which the cusum statistic is insignificant while the cusum of squares statistic is significant and suggest that the instability may be due to a shift in residual variance rather than to shifts in values of regression coefficients. However an apparent shift in residual variance may merely reflect a specification error, the omission of an important variable, or the failure to consider relevant institutional factors and changes. Such possibilities are examined in the following sections of the paper.
III. INSTITUTIONAL FACTORS AND THE DEMAND FOR MONEY

There appears little consensus as to how the World Wars should be treated in long-run money demand studies. For example Friedman (1959), Meltzer (1963) and Khan (1974) include these years while Laidler (1966) and Chow (1966) exclude them. In discussing the issue of the appropriate definition of money Meltzer argues that "the problem is one of defining money so that a stable money demand function can be shown to have existed under differing institutional arrangements, changes in the social and political environment, and changes in economic conditions, or to explain the effects of such changes on the function". Those who include the War years are eager to show stability of money demand across diverse experiences.

Although the plot of the cusum of squares statistic in Figure 2 crosses the 95% confidence line in 1948, in the period 1942-48 the statistic increased by approximately .3 suggesting that WW2 and the immediate post-war years may have contributed to the observed instability. During both World Wars the primary duty of the Federal Reserve was to establish an artificially low level of interest rates in order to assist the Government's borrowing program. Consequently control was lost over member bank reserves, and thus the money supply, so that the money supply curve became infinitely interest elastic at the pegged yield possibly giving rise to an econometric identification problem in these years. Furthermore with interest, wage and price controls, together with an acute shortage of goods in the market place the mechanism for removing excess supply or demand in the money market was severely impaired. Thus the observations for the war years could reflect considerable disequilibrium in the money market.

Regressions C1 to C4 in Table 2 exclude the years 1917-19 and 1942-46. Relative to regressions B1 to B4 it is evident that excluding the war years makes little difference to the income and interest elasticities. However the homogeneity statistics are much more significant when the war years are
excluded, suggesting considerable instability in the estimated functions. Such a conclusion is further supported by the results of the cusum of squares test which indicated that all four formulations were unstable. The plot for regression C1 is shown in Figure 3 and suggests a further possible source of instability in the period 1947-51.

Friedman and Schwartz (1970, Ch.12) have examined the post WW2 rise in the velocity of circulation of money. Their view is that changing expectations of macroeconomic stability may explain the decline in velocity from 1942-6 and its recovery from 1947-51. As the war drew to a close, fears grew of the danger of a postwar collapse leading to an increased demand for money. With the gradual decline of such fears in 1947-51 the demand for money declined to more normal levels with a consequent increase in velocity. Furthermore, prior to the Treasury-Federal Reserve Accord in March 1951 the Federal Reserve was obligated to support the Treasury borrowing program by means of a cheap money policy. By pegging bond yields, the Federal Reserve effectively increased the liquidity of the securities making them closer substitutes for money and thereby reducing the demand for money. Regressions D1 to D4 in Table 2 include a dummy variable, DC, taking a unitary value in 1947-51 and zero elsewhere. The coefficient of the dummy variable has the expected negative sign and is statistically significant. None of the homogeneity statistics are significant representing a considerable improvement relative to those of regressions C1 to C4. However the cusum of squares tests indicated that the instability problem had not been solved by adding the pre-Accord dummy and excluding the war years as the null hypothesis of stability was rejected in all four cases at the 95% confidence level.

The plot for Regression D1 which is shown in Figure 4, indicates that the remaining source of instability lies in the years of the Great Depression and specifically 1931-5. This result contrasts with a recent cross-section study of the Great Depression by Gandolfi (1974) who concluded that "there was no breakdown in the relationship between money and income from 1929 to 1933
and that the contraction did not destroy the foundation (a stable money-demand function) for an effective contracyclical monetary policy".

Much of the early Keynesian-Monetarist debate focused on the issue of the stability of money demand and the existence of a liquidity trap in severe contractions. Generally speaking, however, most empirical evidence has supported the Monetarist viewpoint so that the discovery of an unstable money demand function during the Great Contraction would be of considerable academic interest. However before heralding such a discovery it is important that we investigate, and if possible reject, the explanations that the observed instability arises from a specification error or from the omission of an important explanatory variable.
IV. SPECIFICATION ERROR IN THE PERMANENT INCOME FORMULATIONS

To this point we have endeavoured to replicate Khan's study as closely as possible, the exception being the use of permanent rather than actual population to obtain permanent per capita real income. However the astute reader should have noticed that each of Khan's permanent income formulations contains a specification error. If permanent income is divided by permanent prices and permanent population then the dependent variable should be similarly deflated.

Regressions E3 and E4 in Table 3 correctly specify the dependent variable. Relative to the incorrectly specified regressions, the coefficient of determination and the income and interest elasticities of E3 and E4 are somewhat higher. However the Durbin-Watson statistic indicates the possibility of serially correlated residuals. Stability analysis was performed on regressions E3 and E4 although it must be emphasised that the tests are, strictly speaking, not applicable in the presence of serial correlation. Correcting the specification error in the dependent variable resulted in a significant improvement relative to the misspecified formulation as the cusum of squares test indicated a reasonably stable relationship when run forward. However when the test was run backwards the instability in the 1930's was still evident.

A feature of the formulations used by Khan is the implicit assumption that real money balances per capita have a zero price elasticity of demand with respect to the price level. If such an assumption is incorrect then "the demand for real balances will also depend upon the level of prices, and the omission of this variable should show itself in instability and poorness of fit in any test that uses data measured in real terms".13 Regressions F3 and F4 in Table 3 provide very strong evidence in support of the zero price elasticity assumption as the unconstrained coefficient of permanent prices is not significantly different from unity. Thus it would appear most unlikely that the observed instability would arise from this source.14
Regressions E3, E4, F3 and F4 each suffer from serially correlated residuals. A possible explanation for the serial correlation lies in the interpretation of the permanent income elasticity as being a long-run or secular elasticity. If the demand for money is also dependent on transitory income, or income variation within the business cycle which is not captured in a systematic way by the interest rate, the omission of the cyclical variable would be suggested by a low Durbin-Watson statistic. Such a hypothesis is tested in regressions G3 and G4 which include a cyclical variable, the ratio of permanent to actual income. In the early stages of a recession, permanent income declines less than actual income thereby increasing $\frac{Y^D}{Y}$ while in the early stages of the cyclical upswing the ratio declines. Given that money demand varies directly with transitory income, we would anticipate a negative coefficient on the variable $\frac{Y^D}{Y}$. A statistically significant negative coefficient is indeed found in regressions G3 and G4, though it would appear to be at the expense of lower permanent income and interest elasticities. As the inclusion of $\frac{Y^D}{Y}$ also improved the Durbin-Watson statistic the stability tests were applied both forwards and backwards with the result that no evidence of instability could be detected at the 95% confidence level. The forward cusum of squares plot for regression G3 is shown as Figure 5.

Thus the evidence presented in this section suggests that the instability observed in the 1930's in Khan's permanent income formulations is due to the misspecification of the dependent variable and the omission of a transitory income variable. However the question arises as to whether the correctly specified permanent income formulation with the transitory income variable will retain its stable property when the war years are included in the sample period. Results including the war years are shown as regressions H3 and H4 and indicate a much lower elasticity of demand with respect to transitory income than regressions G3 and G4. Application of the stability tests indicated that the short-run interest form was unstable especially during WW2 while the long-run form was stable. The cusum of squares plot for H3 is shown as Figure 6.
V. INFLATION AND THE CURRENT INCOME FORMULATION

Following Friedman's (1956) restatement of the quantity theory economists generally accept the theoretical argument that the demand for real balances varies negatively with the expected rate of inflation. Until recently, however, empirical studies have found little evidence of any such influence except under conditions of hyperinflation. The failure to find a significant inflation effect is generally explained by the inclusion of a nominal interest rate in the estimated equation. To some extent, the nominal yield contains the market's estimate of the expected rate of inflation. Recent studies of short-run money demand by Smith and Winder (1971) using Canadian data, Shapiro (1973) using U.S. data, and Juttner and Tuckwell (1974) using Australian data have each identified a significant relationship between expected inflation and money demand. The success of these recent studies suggests the hypothesis that the observed instability in the current income formulations could be due to the omission of expected inflation as a determinant of money demand.

Regressions I1 and I2 in Table 4 include one plus the current inflation rate, or \( \frac{P_t}{P_{t-1}} \), in log form as an explanatory variable. Relative to regressions D1 and D2, inclusion of the current inflation term significantly increases the coefficient of determination, increases the income elasticities, but lowers the interest elasticities. Furthermore application of the stability tests indicated no evidence of instability as is evident in the cusum of squares forward plot for regression I1 in Figure 7.

The question arises as to whether the highly significant coefficient of the current inflation variable is due to spurious correlation with the price level in the dependent variable. To test this proposition we remove the constraint that real money balances per capita have zero price level elasticity by introducing the price level as a dependent variable. The results shown as J1 and J2 in Table 4 indicate firstly that we cannot reject the null hypothesis
of a zero price level elasticity of real money balances per capita at the 95% confidence level. Secondly, the coefficient of the inflation rate in J1 and J2 is only marginally less than the corresponding coefficient in I1 or I2. Thus our finding of a significant effect of current inflation on money demand cannot be explained by spurious correlation with the dependent variable.

Finally, in regressions K1 and K2 we include the war years in the sample. Application of the stability tests generally indicated unstable relationships with the cusum of squares test showing the short-run interest formulation to be clearly unstable (see Figure 8 for the K1 cusum of squares forward plot) while the long-run interest formulation was marginally unstable at the 95% confidence level. Thus the evidence strongly suggests that the war years contributed significantly to the observed instability of money demand 1901-74.
VI. CONCLUSION

Khan's result that the U.S. long-run real money demand per capita is a stable function of a time trend, real income or permanent income per capita, and either a long or short-run interest rate has been reexamined in the context of an extended sample period. For each of Khan's formulations evidence of statistical instability was found in the years 1931-5 and 1942-51. Further investigation suggested the following possible sources of the observed stability in 1931-5:-

(a) Khan's misspecification of the dependent variable in the permanent income formulations;
(b) The omission of a transitory income variable in the permanent income formulations; and
(c) The omission of an expected inflation variable in the current income formulations.

When the money demand function was specified as suggested by (a), (b) and (c) above, and the war years included in the sample, three of Khan's formulations remained unstable. However when the war years were excluded and a pre-Accord dummy variable added all formulations were found to be stable.

Tests were also conducted to ascertain whether the imposition of the zero price level elasticity constraint could have contributed to the instability. However this possibility was rejected when it was found that the unconstrained estimate of the price level elasticity of demand for real money balances per capita was insignificantly different from zero.

Thus the years 1942-51 remain as the primary unexplained source of instability. Several qualitative explanations for this instability were considered in the text but our attempts to incorporate an appropriate explanatory variable (or variables) have, to this time, been unsuccessful. Until such a variable is found, Laidler's (1966) and Chow's (1966) approach of excluding the war years in U.S. long-run money demand studies would seem appropriate.
FOOTNOTES

5. The tests of significance of the cusum and cusum of squares statistics assume that the regression residuals are normal independent variables with zero means. This imposes some restrictions on the use of the tests as they are clearly not appropriate when there are auto-regressive error schemes or where autocorrelation adjustments are made or need to be made. Also the zero mean assumption implies that the tests would be biased in equations which omit the constant term because in such cases the regression residuals will not necessarily sum to zero.
7. For space reasons these results are not reported here.
8. See the Data Appendix for an explanation of its derivation.
9. Although Khan (1974, p.1210) states explicitly that he is utilising a two-sided significance test, examination of his Figures 1 to 4 reveals that he has in fact incorrectly used a one-sided test. See Brown, Durbin and Evans (1975, p.155).
12. Regressions C1, C2 and C4 were unstable forwards and backwards while C3 was only unstable backwards.
14. Tests were also conducted of the zero constraint on the population elasticity of demand for real balances per capita. However, because of the high correlation between the constant term and the rate of growth of population, implausible results were obtained.
DATA APPENDIX

M2 = currency plus demand and time deposits at commercial banks (U.S. Bureau of the Census 1975 (a) and 1975 (b)).


P = net national product deflator 1929 = 100.0 (Unpublished NBER series).

LR = Moody's Corporate Aaa bond yield (U.S. Bureau of the Census 1975 (a) and 1975 (b)).

SR = 4-6 month commercial paper rate (U.S. Bureau of the Census 1975 (a) and U.S. Board of Governors of the Federal Reserve System 1976).

N = population (U.S. Bureau of the Census 1975 (a) and 1975 (b)).

\(\frac{\dot{y}}{NP} \) = permanent real income per capita derived as follows: To obtain the permanent estimate in 1879, sum the products of the per capita real income series of 1879 times .33, of 1878 times .22, of 1877 times .15, and so on back to 1869 using weights of .10, .07, .05, .03, .02, .01, .01, .01. To obtain the 1880 figure, multiply the 1879 permanent estimate by .67032 and add the product of 1880 actual per capita real income times .32968. And so on for all subsequent years. To allow for trend each result is multiplied by 1.04.

NP = permanent population derived in identical manner as permanent real income per capita except that no adjustment is made for trend.

FP = permanent prices derived as for permanent real income per capita.

DC = dummy variable taking a unitary value in 1947 to 1951 and zero elsewhere.


### Table 1

**U.S. Money Demand - O.L.S. Estimates**

(Sample period A1 to A4 1901-65, B1 to B4 1901-74)

| REG # | DEPENDENT VARIABLE | CONST. | $\Delta \log \left( \frac{Y}{NP} \right)_t$ | $\Delta \log \left( \frac{Y^P}{NP^P} \right)_t$ | $\Delta \log \text{SR}_t$ | $\Delta \log \text{LR}_t$ | $r^2$ | SEE | D-W | HOMOGENEITY STAT
|-------|-------------------|--------|--------------------------------|---------------------------------|-----------------|-----------------|------|-----|-----|------------------
|       |                   |        |                                 |                                 |                 |                 |      |     |     | S=2 S=3 S=4 S=5 |
| A1    | $\Delta \log \frac{M2}{NP}$ | .017   | .233 (2.85)                     | $\ldots$ (2.16)                | $\ldots$ .122   | .047            | 1.67 |     |     | $\ldots \ldots \ldots \ldots$ |
| A2    | $\ldots$          | .019   | .172 (2.11)                     | $\ldots$ (2.09)                | $\ldots$ .118   | .047            | 1.80 |     |     | $\ldots \ldots \ldots \ldots$ |
| A3    | $\ldots$          | .007   | .891 (5.42)                     | $\ldots$ (3.57)                | $\ldots$ .326   | .042            | 2.05 |     |     | $\ldots \ldots \ldots \ldots$ |
| A4    | $\ldots$          | .012   | .682 (4.21)                     | $\ldots$ (2.56)                | $\ldots$ .265   | .043            | 2.09 |     |     | $\ldots \ldots \ldots \ldots$ |
| B1    | $\ldots$          | .018   | .248 (3.24)                     | $\ldots$ (2.43)                | $\ldots$ .140   | .045            | 1.68 | .42 | 1.12 | 1.04 2.73* |
| B2    | $\ldots$          | .021   | .188 (3.74)                     | $\ldots$ (2.24)                | $\ldots$ .130   | .045            | 1.77 | .64 | .65 | .60 1.95* |
| B3    | $\ldots$          | .007   | .905 (5.84)                     | $\ldots$ (3.96)                | $\ldots$ .334   | .040            | 2.03 | .39 | 1.09 | 1.00 1.23 |
| B4    | $\ldots$          | .012   | .701 (4.61)                     | $\ldots$ (2.92)                | $\ldots$ .273   | .041            | 2.07 | 1.43| .89 | .58 1.35 |

**Note:** 't' values are given in parentheses below coefficients.

* Homogeneity statistic significant at 95% confidence level.

+ S = number of equal sized sub-periods.
### TABLE 2

**U.S. MONEY DEMAND - O.L.S. ESTIMATES**

*(Sample period 1901-74 excluding war years†)*

<table>
<thead>
<tr>
<th>REG #</th>
<th>DEPENDENT VARIABLE</th>
<th>CONST.</th>
<th>Δ log ( \frac{M2}{NP} )</th>
<th>Δ log ( \frac{y}{NP} )</th>
<th>Δ log ( \frac{y}{P} )</th>
<th>Δ log ( \frac{SR}{NP} )</th>
<th>Δ log ( \frac{LR}{NP} )</th>
<th>DC</th>
<th>( R^2 )</th>
<th>SEE</th>
<th>D-W</th>
<th>HOMOGENEITY STAT. *</th>
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<td>C1</td>
<td>Δ log ( \frac{M2}{NP} )</td>
<td>0.014</td>
<td>0.293</td>
<td>...</td>
<td>-0.049</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0.219</td>
<td>0.038</td>
<td>1.86</td>
<td>3.58<em>1.53 2.06</em>1.74</td>
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<td></td>
<td></td>
<td>(2.82)</td>
<td>(4.16)</td>
<td>(2.50)</td>
<td>(1.03)</td>
<td>(1.47)</td>
<td>(1.70)</td>
<td>0.39</td>
<td>1.83</td>
<td>2.81<em>1.27 1.85 2.21</em></td>
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<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td>0.016</td>
<td>0.230</td>
<td>...</td>
<td>-0.071</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0.368</td>
<td>0.034</td>
<td>2.28</td>
<td>2.48*1.15 1.40 1.15</td>
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<td></td>
<td></td>
<td>(3.14)</td>
<td>(3.10)</td>
<td>(3.88)</td>
<td>(3.62)</td>
<td>(3.88)</td>
<td>(3.62)</td>
<td>0.27</td>
<td>2.13</td>
<td>3.11*1.29 1.91 1.63</td>
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<tr>
<td>C3</td>
<td></td>
<td>0.006</td>
<td>...</td>
<td>0.924</td>
<td>-0.071</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0.368</td>
<td>0.034</td>
<td>2.28</td>
<td>2.48*1.15 1.40 1.15</td>
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<td>(1.16)</td>
<td>(6.02)</td>
<td>(3.88)</td>
<td>(3.62)</td>
<td>(3.88)</td>
<td>(3.62)</td>
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<td>2.13</td>
<td>3.11*1.29 1.91 1.63</td>
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<tr>
<td>C4</td>
<td></td>
<td>0.011</td>
<td>...</td>
<td>0.698</td>
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<td>...</td>
<td>...</td>
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<td>0.037</td>
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<td>(2.08)</td>
<td>(4.54)</td>
<td>(2.33)</td>
<td>(2.33)</td>
<td>(2.33)</td>
<td>(2.33)</td>
<td>0.27</td>
<td>2.13</td>
<td>3.11*1.29 1.91 1.63</td>
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<td>D1</td>
<td></td>
<td>0.018</td>
<td>...</td>
<td>0.283</td>
<td>...</td>
<td>-0.033</td>
<td>-0.061</td>
<td>...</td>
<td>0.345</td>
<td>0.035</td>
<td>2.18</td>
<td>1.72*1.36 0.84 1.55</td>
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<td>(4.00)</td>
<td>(4.37)</td>
<td>(1.79)</td>
<td>(3.63)</td>
<td>(1.79)</td>
<td>(3.63)</td>
<td>0.35</td>
<td>2.18</td>
<td>1.72*1.36 0.84 1.55</td>
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<tr>
<td>D2</td>
<td></td>
<td>0.021</td>
<td>...</td>
<td>0.233</td>
<td>...</td>
<td>-0.094</td>
<td>-0.067</td>
<td>...</td>
<td>0.336</td>
<td>0.035</td>
<td>2.24</td>
<td>1.83*0.90 0.87 1.70</td>
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<tr>
<td></td>
<td></td>
<td>(4.44)</td>
<td>(3.51)</td>
<td>(1.50)</td>
<td>(4.09)</td>
<td>(1.50)</td>
<td>(4.09)</td>
<td>0.34</td>
<td>2.24</td>
<td>1.83*0.90 0.87 1.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td></td>
<td>0.010</td>
<td>...</td>
<td>0.818</td>
<td>-0.057</td>
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<td>2.37</td>
<td>0.85*0.88 0.59 1.01</td>
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<td>(5.26)</td>
<td>(3.05)</td>
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<td>(3.05)</td>
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<td>0.85*0.88 0.59 1.01</td>
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<tr>
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<td>...</td>
<td>0.378</td>
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<td>2.40</td>
<td>0.95*0.99 0.72 1.24</td>
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<td>(2.43)</td>
<td>(3.33)</td>
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<td>2.40</td>
<td>0.95*0.99 0.72 1.24</td>
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</tbody>
</table>

**Note:** 't' values are given in parentheses below coefficients.

* Homogeneity statistic significant at 95% confidence level.

+ S = number of equal sized sub-periods.

† Excludes 1917-9 and 1942-6.
TABLE 3
U.S. MONEY DEMAND - CORRECTLY SPECIFIED PERMANENT INCOME FORMULATIONS
(Sample period 1901-74; E3, E4, F3, F4, G3 and G4 exclude war years*)

<table>
<thead>
<tr>
<th>REG #</th>
<th>DEPENDENT VARIABLE</th>
<th>CONST.</th>
<th>Δ log ((\frac{M^P}{P^P}))t</th>
<th>Δ log SRt</th>
<th>Δ log LRt</th>
<th>DC</th>
<th>Δ log ((\frac{Y^P}{P^P}))t</th>
<th>Δ log P^P_t</th>
<th>R²</th>
<th>SEE</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td>E3</td>
<td>Δ log (\frac{M^2}{N^P})</td>
<td>.002</td>
<td>1.304</td>
<td>-.071</td>
<td>...</td>
<td>-.026</td>
<td>...</td>
<td>...</td>
<td>.658</td>
<td>.028</td>
<td>1.50</td>
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<td></td>
<td>(.42)</td>
<td>(9.99)</td>
<td>(4.49)</td>
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<td>(1.87)</td>
<td>...</td>
<td>...</td>
<td></td>
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<td></td>
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<tr>
<td>E4</td>
<td>...</td>
<td>.010</td>
<td>1.038</td>
<td>...</td>
<td>-.225</td>
<td>-.045</td>
<td>...</td>
<td>...</td>
<td>.669</td>
<td>.027</td>
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<td>(8.87)</td>
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<td>...</td>
<td>...</td>
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<td>Δ log (\frac{M^2}{N^P})</td>
<td>.002</td>
<td>1.313</td>
<td>-.069</td>
<td>...</td>
<td>-.025</td>
<td>...</td>
<td>.959</td>
<td>.739</td>
<td>.028</td>
<td>1.50</td>
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<td></td>
<td>(.49)</td>
<td>(9.62)</td>
<td>(4.18)</td>
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<td>(1.64)</td>
<td>...</td>
<td>(6.15)</td>
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<td></td>
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<tr>
<td>F4</td>
<td>...</td>
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<td>1.017</td>
<td>...</td>
<td>-.233</td>
<td>-.047</td>
<td>...</td>
<td>1.058</td>
<td>.748</td>
<td>.028</td>
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<td>(7.75)</td>
<td>(4.21)</td>
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<td>...</td>
<td>(6.60)</td>
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<td>G3</td>
<td>Δ log (\frac{M^2}{N^P})</td>
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<td>...</td>
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<td>(4.75)</td>
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<td>.821</td>
<td>...</td>
<td>-.162</td>
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<td>...</td>
<td>-.283</td>
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<td>-.038</td>
<td>...</td>
<td>-.160</td>
<td>.624</td>
<td>.031</td>
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NOTE: 't' values are given in parentheses below coefficients.
* Excludes 1917-9 and 1942-6.
<table>
<thead>
<tr>
<th>REG #</th>
<th>DEPENDENT VARIABLE</th>
<th>CONST.</th>
<th>$\Delta \log \left( \frac{M_2}{NP} \right)_t$</th>
<th>$\Delta \log S_R_t$</th>
<th>$\Delta \log L_R_t$</th>
<th>DC</th>
<th>$\Delta \log \left( \frac{P_t}{P_{t-1}} \right)$</th>
<th>$\Delta \log P_t$</th>
<th>$R^2$</th>
<th>SEE</th>
<th>D-W</th>
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<td>$\Delta \log \frac{M_2}{NP}$</td>
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<td>(7.88)</td>
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<td>(7.42)</td>
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<td>I2</td>
<td>$\Delta \log \frac{M_2}{NP}$</td>
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<td>0.322</td>
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</table>

**NOTE:** *t* values are given in parentheses below coefficients.

* Excludes 1917-9 and 1942-6.
FIG 2
REG # BI  CUSUM OF SQUARES FORWARD PLOT
FIG 3

REG # C1  CUSUM OF SQUARES FORWARD PLOT

[Graph showing data points and annotations for WW1 Gap and WW2 Gap]
FIG 4

REG # D1 CUSUM OF SQUARES FORWARD PLOT
FIG 5

REG # G3 CUSUM OF SQUARES FORWARD PLOT
FIG 6
REG # H3 CUSUM OF SQUARES FORWARD PLOT
FIG 8

REG # KL  CUSUM OF SQUARES FORWARD PLOT

1.0

0.75

0.5

0.25

0.0

1905  1915  1925  1935  1945  1955  1965
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