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Money Management Effects and the Demand for Money: An Empirical Analysis

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An interesting explanation of the breakdown in the conventional money demand relationship recently has been advanced by Simpson and Porter (1980). Their approach gives interest rates a more crucial role in determining money demand than conventional specifications allow: "An increase in the opportunity cost of holding money balances--which is magnified by the prohibition on the payment of interest on demand deposits and noninterest-earning required reserve balances--encourages the public to economize on its holdings of these balances in the short run--characterized by a given set of money management techniques--but to respond more vigorously in the long run by investing in new money management techniques."[1/] It is this latter, long-run effect that Simpson and Porter argue is ignored by conventional analysis.

Simpson and Porter suggest the use of peak interest rates to capture this heretofore excluded effect. If interest rates follow a random walk, for example, then new interest rate peaks imply a higher level of future rates that encourage the money management techniques Simpson and Porter emphasize. Because the lag between peaks in interest rates and subsequent investment in money management techniques may be long and variable, however, Simpson and Porter develop a ratchet variable (as opposed to simple peak rates) to better capture the long-run effects of higher interest rates- cum-money management on money demand.

This paper compares the predictive ability of a conventional money demand equation with one that includes Simpson's Porter money management variable. Because it is widely recognized that the conventional relationship has undergone "some sort of shift," this specification is also compared to one that allows for only a one-time level shift. Doing so permits us to examine two alternative hypotheses about the mid-1970s difficulties: One is the Simpson-Porter contention that the increased use of money management techniques led to the breakdown. The other is that the function was subject to a level shift and that the marginal relationships embodied in the relationship remain intact.

Methodology

The basic equation used in the analysis is of the form

$$(1)\quad \ln(M/P)_t = \beta_0 + \beta_1 \ln y_t + \beta_2 \ln RCP_t + \beta_3 \ln(M/P)_{t-1} + \epsilon_t$$

where M is the narrow (M1) definition of money, P is the implicit GNP deflator (1972=100), y_t represents real GNP ($1972), RCP is the prime commercial paper rate, β_i (i=0, 1, 2, 3) are parameters to be estimated and ϵ_t is an error term.[2/]

To test the relative strength of the two hypotheses about the mid-1970s shift in money demand (a money management effect or a once-and-for-all shift), equation (1) is augmented by including either (a) the Simpson-Porter ratchet variable (RR_t) used to capture the advance of money management techniques or (b) a single once-and-for all shift variable (D1) that equals one for the period

II/1974-IV/1981 and zero otherwise.[3/] Thus, the alternative equations examined are:

$$(2)\quad \ln(M/P)_t = \beta_0' + \beta_1' \ln y_t + \beta_2' \ln RCP_t + \beta_3' \ln(M/P)_{t-1} + \beta_4 RR_t + \eta_t$$

and

$$(3)\quad \ln(M/P)_t = \beta_0'' + \beta_1'' \ln y_t + \beta_2'' \ln RCP_t + \beta_3'' \ln(M/P)_{t-1} + \beta_5 D1_t + \phi_t.$$

The preoccupation of recent money demand studies is to explain the equation's loss of predictive ability during the post-1974 period. The test described by Dufour (1980) is ideally suited to this purpose. This test is implemented by estimating equations (1), (2) and (3) for the period I/1960-IV/1981 with individual (0,1) dummy variables entered for each observation postdating the start of the forecasting horizon: each dummy variable takes on a value of one for only one period. The estimated coefficients for these dummy variables are useful as diagnostic checks in determining whether the realizations deviate significantly from what the equations predict.

Empirical Results

Table 1 reports ordinary least squares (OLS) estimates for equations (1), (2) and (3), as well as for an equation incorporating both the interest rate ratchet and one-time shift variables. The individual dummy variables are included for each observation after II/1974, the suspected shift point. Because the estimation includes dummy variables for every observation after II/1974, the coefficient estimates for β_0, β_1, β_2, β_3, β_4 and β_5 actually are the estimates for the sample period I/1960-II/1974.

The OLS estimates of the standard equation show the speed of adjustment $(1-\hat{\beta}_3)$ and the short-run income elasticity $(\hat{\beta}_1)$ to be slightly smaller than usual. For example, Goldfeld's (1976) estimated speed of adjustment is 0.283 as opposed to 0.124 in table 1; his estimate of the short-run income elasticity is 0.193 as opposed to 0.074 in table 1. Because the long-run elasticity estimate is the ratio of the short-run elasticity to the speed of adjustment $(\hat{\beta}_1/(1-\hat{\beta}_3))$, and because both estimates in table 1 are proportionally smaller than Goldfeld's, the long-run income elasticity estimate derived from the standard equation in table 1 is, however, similar to Goldfeld's: 0.72 vs. 0.68.[4/] The estimates in table 1 indicate that the coefficient on the interest rate, income and lagged dependent variables are not greatly affected by the inclusion of either the ratchet rate variable or the one-time shift term.

Consider the relative predictive abilities of the three different equations, summarized in table 2. Because each dummy variable coefficient represents the out-of-sample forecast error based on I/1960-II/1974 sample period estimates, the individual dummy coefficient can be used to measure the residual at each respective point in time and to evaluate the size of the forecast error relative to past history. The fact that all the dummy coefficients for the standard equation are negative and that the majority of the estimates are significantly different from zero indicates that a shift has in fact occurred in the conventional equation. We see in table 2 that the standard equation's root-mean-squared-error (RMSE) is 0.01933, a value almost four times the equation's standard error ($\hat{\sigma}$ in table 1).

The coefficient on the Simpson-Porter ratchet variable (β_4) in the money management equation is negative, as their hypothesis suggests. Recall that this variable is capturing adjustments of transactions balances to interest rate developments <u>prior</u> to III/1974. Thus, the significance of the ratchet rate coefficient suggests the Simpson-Porter hypothesis was operative <u>prior</u> to the suspected shift point. Note that the coefficient estimates for the post-II/1974 dummy variables in this equation are uniformly smaller than those of the standard equation. This suggests that the ratchet variable aids in explaining the behavior of real money balances after II/1974. For example, while 12 dummy coefficients are significantly different from zero at the 5 percent level in the standard equation, only 9 are significant in the money management equation. The relevant forecast data in table 2 further indicate that including the ratchet variable reduces the post-1974/II RMSE by about 16 percent relative to the standard equation.

Although the money management equation does in fact represent an improvement over the standard equation, how does it fare relative to simply allowing for a once-and-for-all intercept shift? The results in table 1 indicate that the once-and-for-all intercept shift variable (β_5) is negative and significant. When compared with the other two specifications, the dummy variable coefficients are smaller, in general, for the shift-adjusted equation. Moreover, only 2 dummy terms are significantly different from zero at the 5 percent level, compared to 9 for the money management equation and 12 for the standard specification. The shift-adjusted equation results suggest localized instabilities only during the quarters I/1975 and II/1980.

Table 2 shows that the RMSE for the shift-adjusted equation is about 25 percent below that of the money management equation and 35 percent below the standard equation. The out-of-sample RMSE for the shift-adjusted equation is also less than twice its in-sample standard error, 0.0046. Thus, the empirical evidence indicates that, while including the money management ratchet variable represents an improvement over the standard equation, incorporating such a variable produces a specification that is generally inferior to an equation allowing for a once-and-for-all level shift.

Tables 1 and 2 also report results for a combined equation which includes both the ratchet rate variable and the one-time intercept shift. Both coefficients are negative as they were in the separate equation. The one-time shift coefficient is significantly different from zero at the 5 percent level, while the ratchet rate coefficient is not. The incorporation of the ratchet rate variable into the shift-adjusted equation does result, however, in some improvement in the fit over the post-II/1974 period as shown in table 2. For example, the RMSE is reduced from 0.01239 for the shift-adjusted equation to 0.01051 for the combined equation. This suggests the ratchet rate variable could be important in explaining the post-II/1974 period, a fact not inconsistent with its marginal significance in the combined equation in table 1.

Correcting for First-Order Autocorrelation in Residuals

The most disturbing aspect of the results reported in table 1 is the uniformly high Durbin-h statistics. In each of the four cases considered, the h-statistic is large enough to reject the hypothesis of independent residuals. This finding is disturbing because the coexistance of serially correlated residuals and a lagged dependent variable means that OLS estimates may be neither efficient or consistent.[5/] To correct this problem, each equation was reestimated with a generalized least squares (GLS) procedure based on the presumption that first-order autocorrelation in the residuals is present.[6/] Coefficient estimates and summary statistics obtained for the three separate equations using this estimation procedure are reported in table 3.

The first noticeable feature is the change in the estimated β_0, β_1, ..., β_5 coefficients. The greatest change in the estimates is the increase in the short-run income elasticity and the estimated speed of adjustment. In the standard equation, for example, the short-run income elasticity increases from 0.074 to 0.121 after adjusting for serial correlation. Similarly, the estimated speed of adjustment goes from 0.103 using OLS to 0.277 using GLS. As a result of changes in both of these coefficient estimates, the long-run income elasticity declines sharply from 0.72 to 0.44.

The second feature that clearly differentiates the estimates in table 3 from those in table 1 is the size of the individual post-II/1974 dummy variable coefficients. With few exceptions, the dummy variable coefficients in table 3 are much larger than their counterparts in table 1. This difference is made more evident by the summary statistics for the GLS equations' forecasting performance, given in table 4. There, the RMSE's for the standard and money management equations increase by almost 60 percent after adjusting for serial correlation. In the case of the shift-adjusted and combined equations, the increase in the RMSE is even larger; more than 100 percent. Thus, regardless of the equation considered, if the error process is assumed to be AR(1) and the relationship is estimated accordingly, the post-sample forecasts are consistently worse than those resulting from assuming an independent error process. This finding suggests that the error process may have changed after II/1974.

Before investigating such a hypothesis in more detail, however, consider the comparative performance of the four different equations. Both the money management equation and the shift-adjusted equation do better than the standard equation in terms of in-sample fit and out-of-sample predictive performance. There is, however, little difference between them now: the shift-adjusted equation has a slightly better in-sample fit as evidenced by a smaller $\hat{\sigma}$, while its out-of-sample RMSE is a little worse. The performance of the money management equation is marred, however, by the fact that the coefficient on the ratchet variable is not significantly different from zero at the 5 percent level in either the money management or the combined equations. In terms of the out-of-sample forecasting performance, the combined equation remains superior to all alternatives.

A Change in the Error Structure?

Inspecting the dummy coefficients in table 1, which again are simply ex-post measures of the residuals, suggests the absence of any positive first-order autocorrelation. Indeed, statistical tests confirm this supposition. Table 5 presents autocorrelation coefficients for the dummy variables in each of the three separate equations along with the Ljung-Box Q-statistic.[7/] In all cases, the hypothesis of independent residuals can not be rejected at conventional significance levels. This indicates that even the standard equation appears to have residuals across the post-II/1974 period that are not significantly autocorrelated. Moreover, all first-order correlation coefficients, while individually insignificant, are negative, as opposed to the positive autocorrelation observed in the early period. This suggests that the disturbance process changed after 1974, and that a possible source of the poor forecasting results in table 3 is the presumption that the pre-1974 error process would continue.

Full sample, OLS estimation of the combined equation, excluding all individual Dufour dummy variables, supports the hypothesis of serially independent residuals. For example, estimating the combined equation for the I/1960-IV/1981 period yields the following results (absolute values of t-statistics in parentheses):

$$(4)\quad \ln(M/P)_t = \underset{(2.15)}{0.236} + \underset{(5.86)}{0.102} \ln y_t - \underset{(5.66)}{0.017} \ln RCP_t + \underset{(22.29)}{0.834} \ln (M/P)_{t-1} - \underset{(2.59)}{0.0005} RR_t - \underset{(5.55)}{0.017} D1$$

$$\bar{R}^2 = 0.985 \qquad \hat{\sigma} = 0.0059 \qquad h = -0.40$$

The coefficients on the income, interest rate and lagged dependent variables are very similar to the OLS estimates in table 1, suggesting a stable equation. Performing a Chow test for a break in the relationship between IV/1970 and I/1971 supports the stability hypothesis.[8/] The F-statistic (with 6,76 degrees of freedom) is 1.78, which is not sufficient to reject the hypothesis of equal coefficients in both regimes. This equation includes significant coefficients on both the ratchet rate term and the one-time shift variable. Thus, both variables appear to explain some of the puzzle concerning the poor record of estimating money demand functions across the 1970s.

Conclusion

Two observations result from our analysis. First, the ratchet rate variable developed by Simpson and Porter to capture recent money management effects yields some success in explaining the demand for real money balances. The coefficient on this variable is always negative, as their theory suggests, and usually is significantly different from zero. The inclusion of the ratchet rate variable, however, does not alter the magnitude or the significance of the one-time level shift variable, so that the money management hypothesis does not fully explain the anomalous behavior of real balances after 1974. When both variables are included, however, the money demand function is stable, a result that is contrary to many previous findings.

The second observation is an empirical one. Estimating and forecasting with an equation where the residuals are not presumed to be autocorrelated yields forecasting results clearly superior to those obtained where a first-order autocorrelation correction is imposed. This indicates that at least part of the forecast errors in recent money demand analyses (e.g., Goldfeld (1976)) may be attributable to the estimation procedure. This is clearly an avenue of further research.

Footnotes

1/ Simpson and Porter (1980), p. 170.

2/ Equation (1) differs slightly from previous specifications in that the commercial bank passbook rate variable is excluded. This omission is justified, we feel, on two significant points: First, previous investigations that have included the passbook rate have found its significance to be affected by the sample period used. Indeed, recent evidence suggests that much of the variable's significance may well come from merely including pre-1960 observations. For example, when estimated from I/1955-IV/1973, the passbook rate variable obtains a t-statistic of -2.96. If the sample period begins in I/1960, however, the t-statistic falls to -2.08. If the sample period runs from I/1960-IV/1979, the variable does not achieve statistical significance with a t-statistic of only -1.79. (See Hafer and Hein, 1982b).

Second, and more important, Simpson and Porter (1980 Appendix B) report that the simple correlation between their ratchet variable and the passbook rate is over 0.90 for the period from 1959 to 1980. Moreover, they find that when the passbook rate variable is included in a specification that incorporates the cash management term, the estimated interest elasticity for the passbook rate varies substantially across the 1959-1980 sample period. Thus, as they note, the passbook rate is, in part, a proxy for the cash management effect they are attempting to isolate. Consequently, ommitting it from the present analysis seems quite sensible.

3/ The selection of the shift point for D1 was based on evidence in Wenninger, et. al. (1981), and Hafer and Hein (1982a). The ratchet rate variable (RR_t) is based on current and lagged values of the relevant interest rate r_t. (Simpson and Porter use the five-year Treasury bond rate):

$$RR_t = \sum_{j=1}^{t} \left(r_j - \frac{1}{n} \sum_{i=j-n+1}^{j} r_i\right)^+, \text{ where } (\ )^+ \text{ represents}$$

the non-negative values of ( ). RR_t is seen to be the cummulated sum of t non-negative values, where each term is the difference between the current interest rate and the N-period moving average of current and past interest rates.

Simpson and Porter also consider an increasing elasticity functional relationship by including (RP_t*$\ln RP_t$) as the appropriate variable measure. We also tried this measure, but the results did not vary significantly from those reported below where the variable RP_t in included. Thus, we report only these latter results.

4/ The difference between the estimates in table 1 and those of others comes, at least partially, from the fact that no correction for first-order autocorrelation in the residuals has been made there. If, as the Durbin-h statistics suggests, there exists significant autocorrelation in the residuals, and if no correction in estimating the equation is implemented, then the estimated coefficient for the lagged dependent variable will be biased upwards (see Theil, 1971). This explains much of the difference in results. We will have more to say about correcting for serial correlation in the residuals below, but for now we emphasize that the inclusion of the individual dummy variables for III/1974-IV/1981 makes the residuals for all these observations zero. Thus, any observed autocorrelation is solely attributable to the I/1960-II/1974 period.

5/ See Bentacourt and Kelejian (1981) for further discussion.

6/ This is equivalent to a maximum likelihood procedure if there exists a global minimum residual sum of squares, which the GLS procedure estimates for a given rho.

7/ We report the results for only three equations since the dummy variables for the shift-adjusted and combined equations are almost identical.

8/ This break point represents the mid-point of the sample and was chosen to maximize the power of the Chow test. See J. Farley, M. Hinich and T. McGuire, (1975).

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Table 1
OLS Estimates
I/1960-IV/1981

	Standard Equation	Money Management Equation	Shift-Adjusted Equation	Combined Equation
β_0	0.189 (0.67)	0.106 (0.38)	0.318 (1.16)	0.235 (0.86)
β_1	0.074 (2.65)	0.094 (3.28)	0.084 (3.15)	0.100 (3.63)
β_2	-0.022 (6.28)	-0.021 (6.30)	-0.019 (5.67)	-0.019 (5.73)
β_3	0.879 (10.20)	0.869 (10.38)	0.840 (10.07)	0.836 (10.23)
β_4		-0.0004 (2.07)		-0.0003 (1.82)
β_5			-0.013 (2.54)	-0.011 (2.32)
III/1974	-0.012 (2.06)*	-0.010 (1.75)	-0.001 (0.20)	-0.001 (0.11)
IV	-0.018 (3.09)*	-0.016 (2.69)*	-0.008 (1.12)	-0.007 (0.98)
I/1975	-0.027 (4.36)	-0.024 (3.88)*	-0.016 (2.24)*	-0.014 (2.05)
II	-0.011 (1.54)	-0.008 (1.17)	-0.001 (0.16)	-0.000 (0.03)
III	-0.012 (1.58)	-0.009 (1.24)	-0.002 (0.30)	-0.001 (0.14)
IV	-0.026 (3.30)*	-0.023 (2.99)*	-0.016 (1.91)	-0.015 (1.77)
I/1976	-0.016 (1.74)	-0.013 (1.52)	-0.006 (0.66)	-0.005 (0.56)
II	-0.012 (1.40)	-0.010 (1.18)	-0.003 (0.31)	-0.002 (0.21)
III	-0.211 (2.51)*	-0.019 (2.30)*	-0.011 (1.27)	-0.010 (1.19)
IV	-0.020 (2.28)*	-0.018 (2.10)*	-0.010 (1.09)	-0.009 (1.03)
I/1977	-0.015 (1.63)	-0.013 (1.50)	-0.005 (0.52)	-0.005 (0.48)
II	-0.021 (2.43)*	-0.020 (2.35)*	-0.011 (1.23)	-0.011 (1.24)
III	-0.019 (2.17)*	-0.018 (2.13)*	-0.010 (1.07)	-0.010 (1.11)
IV	-0.013 (1.50)	-0.012 (1.44)	-0.004 (0.44)	-0.004 (0.47)
I/1978	-0.011 (1.32)	-0.010 (1.25)	-0.002 (0.24)	-0.002 (0.26)
II	-0.021 (2.38)*	-0.020 (2.37)*	-0.012 (1.31)	-0.012 (1.37)
III	-0.018 (1.92)	-0.017 (1.88)	-0.009 (0.98)	-0.009 (1.01)
IV	-0.017 (1.71)	-0.016 (1.65)	-0.009 (0.91)	-0.009 (0.91)
I/1979	-0.021 (2.07)*	-0.020 (1.96)	-0.013 (1.32)	-0.013 (1.28)
II	-0.010 (0.95)	-0.008 (0.78)	-0.003 (0.26)	-0.002 (0.16)
III	-0.010 (0.96)	-0.008 (0.76)	-0.003 (0.28)	-0.002 (0.16)
IV	-0.015 (1.39)	-0.012 (1.11)	-0.008 (0.75)	-0.006 (0.56)
I/1980	-0.016 (1.39)	-0.011 (1.01)	-0.009 (0.85)	-0.006 (0.57)
II	-0.045 (4.05)*	-0.040 (3.55)*	-0.038 (3.47)*	-0.034 (3.10)*
III	-0.008 (0.57)	-0.002 (0.15)	-0.002 (0.14)	-0.003 (0.19)
IV	-0.008 (0.56)	-0.001 (0.07)	-0.002 (0.17)	-0.003 (0.23)
I/1981	-0.026 (1.87)	-0.018 (1.31)	-0.020 (1.54)	-0.014 (1.08)
II	-0.005 (0.34)	-0.004 (0.26)	-0.000 (0.02)	-0.007 (0.47)
III	-0.031 (2.11)*	-0.020 (1.35)	-0.026 (1.85)	-0.017 (1.21)
IV	-0.023 (1.47)	-0.012 (0.77)	-0.018 (1.23)	-0.010 (0.64)
h	5.90	5.08	6.03	5.41
$\hat{\sigma}$	0.0049	0.0047	0.0046	0.0045
$\bar{R}^2$	0.990	0.990	0.990	0.991

*Dummy variable coefficient significantly different from zero at five percent level

Table 2
Summary of Forecasting Performance
OLS Estimates

	Standard Equation	Money Management Equation	Shift-Adjusted Equation	Combined
Mean Error	-0.01760	-0.01433	-0.00927	-0.00810
Mean Squared Error	0.00037	0.00026	0.00015	0.00011
Root Mean Squared Error	0.01933	0.01625	0.01239	0.01051

Table 3
GLS Estimates
I/1960-IV/1981

	Standard Equation	Money Management Equation	Shift-Adjusted Equation	Combined Equation
β_0	0.690 (1.89)	0.535 (1.50)	0.868 (2.47)	0.732 (2.10)
β_1	0.123 (3.49)	0.142 (3.76)	0.136 (4.05)	0.149 (4.13)
β_2	-0.022 (4.55)	-0.021 (4.50)	-0.018 (3.67)	-0.017 (3.71)
β_3	0.723 (6.57)	0.729 (6.83)	0.672 (6.38)	0.682 (6.60)
β_4		-0.0005 (1.55)		-0.0004 (1.22)
β_5			-0.012 (2.75)	-0.012 (2.55)
III/1974	-0.008 (1.61)	-0.007 (1.35)	-0.005 (0.92)	-0.004 (0.69)
IV	-0.019 (3.14)*	-0.017 (2.69)*	-0.013 (2.07)*	-0.011 (1.75)
I/75	-0.031 (4.54)*	-0.027 (3.90)*	-0.023 (3.18)*	-0.020 (2.77)*
II	-0.020 (2.32)*	-0.016 (1.82)	-0.012 (1.34)	-0.009 (0.99)
III	-0.022 (2.39)*	-0.017 (1.93)	-0.014 (1.52)	-0.011 (1.20)
IV	-0.036 (3.86)*	-0.031 (3.41)*	-0.027 (2.96)*	-0.024 (2.65)*
I/76	-0.029 (2.64)*	-0.024 (2.29)*	-0.020 (1.91)	-0.017 (1.66)
II	-0.025 (2.35)*	-0.021 (2.00)*	-0.016 (1.58)	-0.014 (1.34)
III	-0.033 (3.24)*	-0.029 (2.91)*	-0.024 (2.39)*	-0.021 (2.17)*
IV	-0.032 (3.07)*	-0.028 (2.76)*	-0.023 (2.23)*	-0.021 (2.02)*
I/77	-0.028 (2.54)*	-0.024 (2.28)*	-0.019 (1.74)	-0.016 (1.56)
II	-0.033 (3.18)*	-0.030 (2.97)*	-0.024 (2.34)*	-0.022 (2.21)*
III	-0.032 (2.97)*	-0.029 (2.82)*	-0.024 (2.24)	-0.002 (2.13)*
IV	-0.026 (2.41)*	-0.023 (2.24)*	-0.018 (1.70)	-0.016 (1.56)
I/78	-0.023 (2.24)*	-0.021 (2.07)*	-0.016 (1.52)	-0.014 (1.39)
II	-0.033 (3.12)*	-0.031 (3.00)*	-0.026 (2.46)*	-0.024 (2.37)*
III	-0.031 (2.75)*	-0.029 (2.61)*	-0.024 (2.21)*	-0.023 (2.10)*
IV	-0.031 (2.57)*	-0.028 (2.42)*	-0.025 (2.18)*	-0.023 (2.05)*
I/79	-0.036 (2.86)*	-0.032 (2.66)*	-0.031 (2.55)*	-0.028 (2.38)*
II	-0.026 (1.99)	-0.022 (1.70)	-0.021 (1.67)	-0.018 (1.44)
III	-0.026 (1.98)	-0.022 (1.68)	-0.021 (1.69)	-0.018 (1.44)
IV	-0.031 (2.29)*	-0.025 (1.91)	-0.026 (2.08)*	-0.022 (1.76)
I/80	-0.033 (2.30)*	-0.025 (1.80)	-0.029 (2.17)*	-0.024 (1.75)
II	-0.062 (4.48)*	-0.053 (3.80)*	-0.057 (4.37)*	-0.051 (3.79)*
III	-0.030 (1.75)	-0.020 (1.19)	-0.027 (1.65)	-0.019 (1.17)
IV	-0.028 (1.68)	-0.018 (1.06)	-0.026 (1.66)	-0.018 (1.12)
I/81	-0.053 (2.73)*	-0.035 (2.02)*	-0.045 (2.78)*	-0.036 (2.15)*
II	-0.048 (1.52)	-0.015 (0.78)	-0.027 (1.56)	-0.017 (0.92)
III	-0.053 (2.92)*	-0.038 (1.97)	-0.052 (3.04)*	-0.040 (2.18)*
IV	-0.048 (2.46)*	-0.032 (1.57)	-0.047 (2.55)*	-0.035 (1.77)
RHO	0.50	0.46	0.50	0.47
h	1.89	1.88	1.76	1.77
$\hat{\sigma}$	0.0044	0.0044	0.0042	0.0042
$\bar{R}^2$	0.969	0.973	0.972	0.975

*Coefficient significantly different from zero at the five percent level.

Table 4
Summary of Forecasting Performance
GLS Estimates

	Standard Equation	Money Management Equation	Shift-Adjusted Equation	Combined
Mean Error	-0.03200	-0.02563	-0.02540	-0.02137
Mean Squared Error	0.00116	0.00073	0.00077	0.00054
Root Mean Squared Error	0.03402	0.02695	0.02781	0.02322

Table 5
Autocorrelation Coefficients for OLS Dummy Variables*

Model	p_1	p_2	p_3	p_4	p_5	p_6	p_7	p_8	p_9	p_{10}	p_{11}	p_{12}	Q(12)**
Standard Equation	-0.28	-0.22	0.12	-0.38	0.23	0.17	0.09	-0.03	-0.19	0.00	0.02	0.00	14.76
Money Management Equation	-0.22	-0.11	0.19	-0.33	0.20	0.12	0.07	0.03	-0.14	-0.02	-0.02	-0.02	10.59
Shift-Adjusted Equation	-0.23	-0.19	0.17	-0.34	0.24	0.20	0.01	-0.03	-0.19	0.00	0.05	0.01	13.94

* Standard error of autocorrelation coefficients is approximately 0.18

** Ljung-Box Q-statistic, distributed chi-square with 12 degrees of freedom. 95 percent critical level is 21.03.