A Note on Foreign Commercial Bank Demand Deposits at U.S. Commercial Banks

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I. Introduction

Currently included in measurements of the narrowly defined money stock (M1) are demand deposits at U.S. commercial banks due to foreign commercial banks, foreign nonbanks (individuals, partnerships, and corporations), and foreign official institutions. In recent years these deposits have risen to nonnegligible levels, reaching about $16 billion, or nearly 5 percent of M1, in December 1976. Furthermore, the volatility of these deposits is high, and changes in these deposit levels have from time to time had an appreciable impact on the measured change in the growth rate of M1.

Since one aspect of the conduct of monetary policy is explicitly concerned with control of the growth of the money supply, the reasons for recent increased interest in these foreign-owned deposits are clear.[1/] From the point of view of control of M1, the monetary authority is concerned with control of its various components. This type of consideration implies a need to identify the factors determining movements in these foreign-owned deposits. Following this determination, controllability of the individual factors could assume a prominent role in the conduct of policy.

The questions of control of M1 and/or its proximate determinants are thorny ones, however. Alternatively, the monetary authority may not be able to control in any meaningful sense the movements in foreign-owned deposits, but it may find useful information in the predictability of those movements. Presumably the anticipation of movements in this component of the money supply could serve to reduce overall uncertainty associated with policy actions taken to set the course of the money supply.

The purpose of this note is to present some evidence bearing on the two types of questions asked above for the largest and most volatile component of foreign-owned demand deposits: those due to foreign commercial banks.

The organization of the paper is as follows: The next section provides a brief summary of the institutional considerations which serve as a foundation for the model studied in this paper. The following section presents a rather naive transactions model which seeks to explain the level and movements of these demand deposits. Following this formulation of the model, an empirical specification is made and the results are reported along with some interpretations of the estimates.

The empirical study employs a seldom-used variable to represent transactions through these accounts: the monthly average of daily dollar figures cleared through the Clearing House Interbank Payments Systems (CHIPS). Despite the naivete of the model, the results are viewed as being broadly consistent with its implications. The results are sensitive to specification of the transactions variable, and the mixed evidence does imply that one cannot reject out of hand the possibility of simultaneous equation bias in our estimates.

II. Institutional Considerations[2/]

Demand balances of foreign commercial banks at U.S. banks are the largest and most volatile of foreign deposits, having grown from about $3 billion in January 1971 to in excess of $8 billion in December 1976.[3/] These demand deposits are held as part of a broad commercial relationship; an appreciation of the institutional background is therefore important to the development of a model seeking to explain movements of these deposits over time. The largest U.S. banks have maintained in recent years between 1500 and 6000 demand deposit accounts for foreign commercial banks. At any time, from 100 to 200 of these accounts may be characterized as active; they are accounts due to the largest foreign commercial banks which are heavily involved in international transactions cleared through U.S.-based financial markets. The remaining large number of accounts are individually small and are characterized as relatively inactive. The majority of the major foreign commercial banks which maintain active demand deposit accounts in the U.S. hold such accounts at several U.S. money-center banks.

The accounts of major foreign banks which are characterized as active often may show a daily turnover of up to several hundred times the average end-of-day balance. Indeed, individual transactions are often many times the level of the average end-of-day balance. The largest type of transaction through these accounts is the clearing of Eurodollar transactions.[4/] There appear to be two primary reasons why these Eurodollar transactions are cleared through U.S. banks. First, U.S. commercial banks generally require that the large credit judgments often associated with these transactions be made at their head offices.[5/] Second, the proximity of U.S. financial markets (e.g., the federal funds market) provides opportunities for the market participants to acquire and to place large sums of dollars on short notice.

The second largest type of transaction in these accounts results from the settlement of foreign exchange contracts, an unknown portion of which is directly related to the financing of exports or imports of the U.S. Some of the foreign exchange transactions reflect third-country trade and the special role of the dollar as a settlement currency in international trade. Also, a proportion of the transactions reflects the attempts of foreign banks to achieve a desired position in foreign exchange markets, either for their own account or for their customers.

From discussions with market participants, we have inferred that the level of demand balances held in U.S. banks by foreign banks varies directly with foreign banks' transactions needs and inversely with their costs of obtaining the necessary funds in the market. U.S. banks indicate that they closely monitor these accounts and the costs of supplying them. That is, U.S. banks estimate the costs of servicing transactions through these accounts, including the cost of serving as a stand-by lender in the event that the foreign banks' demand balances are in deficit either during the day or following the close of business. From the viewpoint of U.S. banks, an important source of compensation for services provided is the value of the interest-free balances maintained on deposit by the foreign banks. This value is determined as an internal rate of return which reflects the cost savings from obtaining interest-free demand balances compared with the costs of obtaining funds in the market.[6/]

III. A Naive Model of Foreign Commercial Banks' Demand for Deposits

As indicated above, foreign banks maintain large, active demand deposit accounts at U.S. banks as part of a broad relationship. Such balances are used to clear dollar transactions as well as to secure lines of credit at U.S. banks. Based upon the institutional factors already noted, a naive transactions model is presented in this section to explain the level of deposits held.

The model is set out in a static, nonstochastic, partial equilibrium framework. Foreign banks are assumed to attempt to minimize costs associated with clearing dollar transactions in the U.S. For a typical foreign bank the total cost of clearing transactions, per time period, (TC) is given by:

(1) $$TC = A(T,D) + r_0 D + S,$$ 7/

where

A(T,D) = internal accounting and administrative costs incurred by the foreign bank in executing its dollar transactions,

T = dollar value of transactions through the account,

D = the level of demand deposits held,

r_0 = the opportunity cost per dollar to the foreign bank of deposits held, in terms of interest foregone, and

S = explicit service charges levied by the U.S. bank for clearing transactions minus any nonclearing services provided by the U.S. bank and not charged for explicitly.

Since data on the level of service charges (S) are not available, it is necessary to derive an expression for S in terms of observable variables. Consider the cost of servicing the deposits at the U.S. bank. Service charges are equal to the difference between the costs of servicing the foreign account, including profits to the U.S. bank, and the return which the U.S. bank can earn on funds made available from the deposit:

(2) $$S = C(T,D) + F(L) + \pi(D) - r_L L,$$ 8/

where

$C(T,D)$ = cost borne by the U.S. bank in clearing transactions through the foreign deposit account,

L = volume of loans (or other asset purchases) that can be made with the funds held on deposit by the foreign bank,

$F(L)$ = the cost of servicing the loans made with the deposit funds,

$\pi(D)$ = profits, and

r_L = loan rate at the U.S. bank.

Assume that the level of transactions costs, both for the foreign bank and U.S. bank, increases with the volume of transactions and that increases in deposit balances reduce clearing costs incurred by both the foreign bank and the U.S. bank. Also, assume that the costs of servicing loans increases with volume. That is,

$$A_T,\ C_T > 0,\ A_D,\ C_D < 0, \text{ and } F_L > 0,$$

where subscripts denote partial derivatives of the functions.

The U.S. bank can use the deposited funds (D) to make loans of

(3) $$L = (1-\rho)D,$$

where ρ is the required reserve ratio. Using (3) to eliminate L from (2) and substituting the resulting expression for S in (1), then

(4) $$TC = C(T,D) + A(T,D) + F[1-\rho)D] + \pi(D) + [r_0-(1-\rho)r_L]D.$$

The foreign bank is assumed to hold the level of deposits that minimizes the costs of clearing their dollar transactions. The first-order condition for cost minimization is obtained from (4) as

$$(5) \qquad -(C_D+A_D) = [r_0-(1-\rho)(r_L-F_L)+\pi_D].$$ 9/

The cost-minimizing level of deposits is determined where the marginal cost savings per dollar of deposits $[-(C_D+A_D)]$ is equal to the difference between r_0, the opportunity cost of funds to the foreign bank, and r_D, the marginal value of funds to the U.S. bank, adjusted for profits, where

$$r_D = (1-\rho)(r_L-F_L) + \pi_D.$$

Implicit solution of (5) for D yields the minimum cost level of deposits

$$(6) \qquad D = H(T,r_0,r_D).$$

The demand for deposit balances (D) is a function of the volume of transactions (T), the opportunity cost of holding the demand balances (r_0), and the rate of return on the deposits (r_D). From the assumptions made above, the partial derivatives of H with respect to the interest rates have the following signs: $H_{r_0} < 0$, $H_{r_D} > 0$. Following standard transactions models, we would expect that for a given level of deposits the value of marginal deposits in reducing the transaction costs increases with the level of transactions, i.e., $(C_{DT}+A_{DT}) > 0$. This assumption implies that $H_T > 0$.

IV. Empirical Study

A. Implications of the Model and Data Used

The exact form of the deposit demand function, $H(\cdot)$, depends upon the specification of the cost function itself. In lieu of such complete specification here, the analysis is based upon the general implications of the model and some rather typical assumptions relating the variables in the model. In particular, the natural logarithm of deposits varies with the natural logarithm of the transactions variable and with the levels of interest rates.[10/] One interpretation of the model implies that the two interest rates enter the relationship with coefficients of unequal magnitudes and opposite signs. An alternative reasonable representation would suggest that the difference between the rates is a relevant variable. Consequently, tests are reported of the hypothesis that the coefficients on the two rates are equal in magnitude with opposite signs.

The figures for total foreign commercial bank demand deposits are estimated from reports of member and nonmember banks, agencies and investment companies of foreign banks in the U.S., and Edge Act Corporations. The resultant series is based primarily on a monthly average of Wednesday figures.[11/]

The data for the transactions variable represent essentially total foreign dollar transactions cleared through U.S. banks. In terms of the data employed, a unique feature of this analysis is the use of monthly averages of daily close-of-business total transactions figures for the Clearing House Interbank Payments System (CHIPS) to proxy for transactions.[12/] These averages are based on the number of business days in a month.

The simple model set out above implies that current deposit levels are in some way tied to current transaction needs. It is not difficult, however, to devise schemes under which past transactions also enter the demand for deposits in the current period. For instance, costs of adjustment in altering deposit levels due to variations in transactions assumed to be transitory imply that recent historical transaction levels may also determine current deposit needs. Alternatively, foreign banks might base current deposit decisions upon some notion of an "expected" or "permanent" level of transactions; one way of capturing this notion is to assume that expected transactions may be modeled as the best forecast of next period's level based on the information currently available.[13/]

In the partial equilibrium framework presented here, transactions are assumed exogenous. In this case, this forecast of expected transactions can be modeled as the projection of T(t+1) on current and past transaction levels, $E(T(t+1)|T(t),T(t-1),\ldots)$, where E is the mathematical expectation operator. Interpreting this projection as a linear least squares projection simply amounts then to a regression of T(t+1) on current and past T's.[14/]

Neither of the above formulations is explicitly adhered to in this model nor is any other particular justification for including past T's in the demand function specified. Given the simple nature of the model, it is sufficient to indicate that justification for modeling transactions as a distributed lag on current and past values of itself exists.

The opportunity cost r_0 is chosen from among the money market rates for markets which seem readily accessible to the foreign commercial banks. The results reported use the primary rate on 90-day U.S. certificates of deposit (RCD), the 90-day Eurodollar rate (RE90), the 180-day market yield on Eurodollars (RE180), the market yield on 90-day U.S. Treasury bills (RTB), and the 30-59-day commercial paper rate (RCP).

As indicated above, the rates are used in level form; this specification is testable, but such tests are not carried out.

The implicit rate of return on deposits (r_D) is the most difficult variable to define empirically. For banks accepting these foreign deposits, marginal reserve requirements (ρ) were essentially unchanged over the sample period. Under suitable assumptions, such as constancy of F_L and π_D, r_D can be considered a linear function of the loan rate r_L.[15/]

Although several different rates can be suggested for r_L, for the following reasons the prime lending rate (RP) charged by New York banks is used in this study. First, the prime lending market appears to be a very competitive market characterized by small administrative costs. This rate should, therefore, move closely with the true cost of funds to the U.S. banks.[16/] Second, it was reported and verified that overdrafts on accounts of foreign commercial banks are frequently charged at the prime rate. Assuming that U.S. banks actually perform their calculations as carefully as they imply, the rates charged on overdrafts in these accounts should reflect the marginal internal value of these deposits. Third, it is arguable that the federal funds rate and the rate on repurchase agreements are also plausible candidates for r_L. In early stages of the study, however, the performance of these rates in the analysis was clearly dominated by the prime rate. Indeed, the first two considerations suggest that this result should not be unexpected.

B. Empirical Results

All of the data used in the regressions reported below are assumed to be contaminated in some way by the presence of time trends of uncertain source. Specifically, the <u>observed</u> deposit levels $\hat{D}(t)$ and transaction levels $\hat{T}(t)$ are assumed to be related to the trend-uncontaminated levels D(t) and T(t), respectively, according to the relationships

$$\hat{D}(t) = D(t)e^{\alpha t}$$

and

$$\hat{T}(t) = T(t)e^{\beta t}.$$

Prior to estimation, the deposit and transactions variables are detrended according to these representations. The trends in interest rates are assumed additive with rate levels; those data are detrended according to that specification. All data are used as deviations from mean values in the regressions reported; deposits and transactions are in natural logarithms of levels. Each of the regressions reported also included a constant, linear trend, and seasonal dummy variables.[17/] The data are all monthly, seasonally unadjusted observations. The sample period is determined by the availability of CHIPS data and for this study includes monthly observations from January 1971 through December 1976.

The results reported are based on two estimation procedures: ordinary linear least squares and the Hannan Efficient (HE) procedure as an approximation to GLS.[18/] The HE procedure is implemented according to the following scheme. A first-stage regression (OLS) is run and the residual vector obtained. The frequency domain interpretation of the serial correlation in the residuals is then employed to obtain GLS estimates. The spectrum of the residual vector is estimated, and its square root at each frequency is divided into the Fourier transforms of the dependent and independent variables at the same frequency. The resultant series are inverse-Fourier transformed, and the second-stage regressions are obtained.

For this procedure to be even approximately valid for the relevant sample size, the first-stage residuals must be approximately white. Accordingly, an appropriate prefilter for the data is chosen by examining the properties of the first-stage residual vector in the time and frequency domains. Specifically, a search is made over first-order prefilters from (1-0.05L) to (1-0.95L) in steps of 0.05.[19/] Based on the null hypothesis (i.e., the specification of the form of the demand equation), the demand relationship is estimated. The prefilter for the regression with the residual vector most closely fulfilling the two criteria for whiteness specified below is the one chosen.

Two statistics are used in assessing the residual vector. In the time domain, the standard Durbin-Watson (DW) statistic is employed. However, a more useful criterion, since the model and methodology assume absence of not only first-order but also higher-order serial correlation, is the Kolmogorov-Smirnov statistic based on the cumulative periodogram of the residuals.[20/] In all cases reported, the prefilter chosen resulted in a residual vector which was not statistically significantly different from pure white noise residual vector at even the 20 percent level.

To obtain efficient estimates, the spectrum of the residual vector from this first-stage regression is obtained by smoothing the estimated periodogram. The width of the smoothing window is chosen roughly by examining the autocovariance function of the residuals obtained by inverse Fourier-transforming the estimated periodogram. In all cases reported, the spectrum is computed over the interval $[-\pi,\pi]$ at 132 evenly spaced ordinates. The smoothing window is a triangular shaped one of width approximately $\pi/11$.

One final note on methodology is relevant. The distributed lag on current and past transaction levels is estimated as an unconstrained one. On the one hand, the formulation of the demand function presented is far too vague to suggest any specific lag distribution. Alternatively, if the transaction variable is interpreted as some sort of expected level of current and/or future needs and if it is an exogenous variable (as assumed in this analysis), then a rational forecast would, in fact, be a choppy, unconstrained lag distribution on past values of the variable.[21/]

The regressions reported below are estimates of the demand function posited in the form

$$\ln D_t = \sum_{i=0}^{M} \alpha_i \ln CH_{t-i} + \beta RP_t + \gamma r_{0,t}.$$ [22/]

Tables 1A through 1E, Sections (A) and (B) on each table, report the inefficient and efficient estimates, respectively, of the demand relation for the various rates used to represent the opportunity cost r_0 under the null hypothesis. The truncation point M of the lag distribution (M=15 for each relationship reported) is chosen at the point where the coefficients on additional lags are not, as a group, statistically significantly different from 0 at less than the 0.30 level <u>and</u> where the coefficients become small in absolute value relative to the other estimated lag coefficients. The largest and smallest standard errors on the coefficients of the distributed lag, as well as those on the interest rate coefficients, are shown in parentheses. Because the sample size yields only 22 degrees of freedom (or 23, in the cases of no prefilters), t-statistics and the associated marginal significance levels are reported for significance levels $\alpha \leq 0.30$. The Durbin-Watson (DW) and Kolmogorov-

Smirnov (KS) statistics are reported in addition to $\bar{R}^2$ and the standard error of estimate, adjusted. F-statistics and their marginal significance levels are reported for two groups of coefficients: those on current and lagged transactions plus the two rates and those on current and lagged transactions only. The final F-statistic and marginal significance level represents a test of the hypothesis that $\beta = -\gamma$.

First consider the least squares inefficient estimates in column (A), Tables 1A through 1E. In all cases the fit of the data to the model is quite good; the DW statistic lies within the ambiguous range, while the KS statistic implies that whiteness cannot be rejected at even the 20 percent level.[23/] The largest standard error is always on current CH, the smallest on the fifteenth lag. With the single exception of the regression for r_0 = RCP, no coefficient in the lag distribution is significant at less than the 0.20 level before the eighth lag. In all five cases, the majority of significant coefficients are grouped between the eighth and fourteenth lag. If this result were characterized by the appearance of only one or two significant coefficients, it might be attributed to spurious causes, implying an unduly long estimated lag distribution. In these cases, however, the number and size of the significant coefficients relative to the coefficients at shorter lags suggest that such a conclusion might be premature. In all five tables, the F-statistic on current and lagged coefficients of CH are significant at less than the 0.30 level, but only when r_0 = RCD(1A) or RCP(1E) is it strongly significant (at about the 0.015 level in each case).

In each of these cases, the coefficients on both RP and r_0 have the expected signs and each is highly statistically significant.

With the exception of the case for r_0 = RTB, the restriction $\beta = -\gamma$ can be rejected at the 0.00 level. Even for this one case (1D), it can be rejected at the 0.09 level. This regression is also characterized by the "strongest" evidence against the hypothesis about γ; it is statistically significant at the 0.07 level and therefore is statistically significantly <u>less</u> than zero at the 0.035 level.[24/]

The efficient estimates for these same regressions are reported in column (B), Tables 1A through 1E, respectively. First, consider the differences between these results and the inefficient estimates presented in column (A). In all cases, the goodness of fit increases and, as expected, the standard errors of all estimated coefficients fall. In virtually every case, the largest standard error for estimated coefficients on the distributed lag for the efficient regressions is about the same size as the smallest standard error for the inefficient estimates. The pattern of estimated coefficients is essentially unchanged. The DW statistics remain in the inconclusive range, while the KS statistic falls in every case, indicating that whiteness of residuals can be rejected only at marginal significance levels far in excess of 0.20. Virtually all t-statistics on estimated coefficients increase, but more significantly the entire distributed lag on CH becomes more significant. In all cases, the first coefficient having a marginal significance of less than 0.2 occurs no later than at the second lag. In addition, the number of individual coefficients having a marginal significance level of less than 0.3 increases, differences being from six to eight coefficients for r_0 = RE180 to eight to twelve coefficients for r_0 = RCP. The F-statistic for coefficients on current and lagged CH increases in all cases, the marginal significance level never exceeding 0.0005 (for r_0 = RTB).

The same pattern of results holds for the two interest rates. Coefficients in all cases have the expected signs, standard errors of the estimates are lower, and all t-statistics correspondingly greater. Only for the use of r_0 = RTB is a single coefficient, γ, characterized by a marginal significance level in excess of 0.01, and its significance level is only 0.05. Furthermore, except for this same case, the restriction $\beta = -\gamma$ can be rejected at the 0.00 level, and for RTB it can be rejected at the 0.016 level.

In general, the results conform quite well to the predictions of the simple model. For the efficient regressions reported, the data fail to provide any strong evidence for rejecting the form of the model proposed. For the inefficient regressions, the transactions data provide evidence less strongly consistent with the model, but, in view of the sample size, these results may also be considered not terribly strong evidence counter to the model's predictions.

A Short Digression on the Effects of Length of the Lag Distribution

As indicated above, examination of the inefficient regressions could raise some questions about the length, or even the specification, of the distributed lag. Although the considerations raised then plus the subsequent results of the efficient regressions suggest that no serious problems exist here, perhaps some observations on the effects of the lag length are in order.

Without regard to the above criteria for determining lag length, both inefficient and efficient estimates for $M = 9$ were obtained and compared, over a slightly different sample period, to results for $M = 15$ (Tables 3A and 3B).[25/]

The inefficient regressions for M = 9 show little change in the significance of the coefficients on CH. On the other hand, in all cases β and γ have the expected signs and are more significant then when M = 15. The standard errors in individual coefficients are lower for M = 9, while the standard error of estimate, adjusted, is higher in all cases for M = 9.

The results of the efficient regressions produce some interesting comparisons. In all cases, β has the expected sign and is more significant when M = 9. On the other hand, γ is more significant (and therefore more significantly negative) for M = 9 only where r_0 = RE90 or RE180. For the other three cases, γ is essentially unchanged and, for r_0 = RTB or RCP, is essentially zero. The restriction $\beta = -\gamma$ is rejected more strongly in all cases for M = 9. The lag distribution is statistically more significant for M = 9 when r_0 = RE90 or RE180; it attains approximately the same marginal significance level for r_0 = RCD and RCP. The lag distribution is somewhat less significant for r_0 = RTB where M = 9. Essentially, then, the marginal significance of the entire lag distribution as well as that of γ seem to depend on the lag length specified. It is important to note that in all cases for M = 9, the lag distribution is statistically significant for groups of coefficients in the tail as well as by individual coefficients. In the face of these results as well as the earlier comments on methodology, the truncation point for all results reported is M = 15.

Comments on Consistency, Exogeneity, and Interpretations of Results

The regressions reported in Tables 1A through 1E, Section (B), represent efficient estimates of what is supposed to be a demand function.

One major consideration in interpreting these results is that of consistency of the estimated coefficients. As a consequence of two theorems by Sims [1972], an operational test for statistical exogeneity, and hence for simultaneous equation bias, exists. Sims shows that for a bivariate covariance stationary stochastic process, [Y X]', X is statistically exogenous with respect to Y if, in a regression of Y against future, current, and past values of X, future coefficients on X are significantly different from zero.

A natural and legitimate procedure here is a direct extension to the multivariate process [D CH RP r_0]'. That is, efficient estimates under the null hypothesis (a distributed lag on current and fifteen past values of CH and current values of RP and r_0) are obtained, and the restriction that coefficients on future values of CH, RP, and r_0 are all zero is tested. The procedure is a test of the hypothesis that the variables (CH,RP,r_0) are jointly statistically exogenous with respect to deposits. It is emphasized that this procedure is neither trivial nor vacuous. Whether or not our estimates are consistent is an important question, especially in this case where the estimated relation is assumed to represent a behavioral relationship.

Estimates which are efficient under the null hypothesis are presented for regressions including three future values of CH and two future values each of RP and r_0 in Section (C), Tables 1A through 1E.[26/] A first glance at the summary statistics suggest few significant changes from the results without future variables. Very little change is noted in any of the adjusted coefficients of determination. Except for the case of r_0 = RE90, where the standard error or estimate, adjusted, changes from 2.003 to 2.943, the change in the standard error of estimate is less than 10 percent. Furthermore, while the F-statistics on the group of coefficients $(\alpha_0,\alpha_1,\ldots,\alpha_{15},\beta_0,\gamma_0)$ do decrease, the largest marginal significance level reported is 0.0255. This result, for r_0 = RE90, still fails to show any strong evidence against the null hypothesis. Similar comments apply to the F-statistic for the group of coefficients $(\alpha_0,\alpha_1,\ldots,\alpha_{15})$, the case for r_0 = RE90 again producing the statistic with the largest marginal significance level, 0.0467.

A more thorough examination of the results produces some less clear evidence about exogeneity, however. The F-statistics and their associated marginal significance levels for testing the restrictions that the future coefficients in Tables 1A through 1E are zero are reported in Table 2. The F-statistics for coefficients on all future variables are characterized by marginal significance levels of barely less than 0.30 only for the cases where r_0 = RE90 and r_0 = RCP. For r_0 = RE90, coefficients on future CH and RP are, as separate groups, characterized by significance levels of less than 0.30. However, an alternative test including leads only for CH and RP resulted in F-statistics significant at greater than the 0.30 level. When r_0 = RCP, future coefficients on each variable are significant at less than the 0.30 level, the coefficients (β_{-2},β_{-1}) being significant at the 0.085 level. A subsequent test, including leads only on RP and RCP, resulted in statistics significant at levels between 0.30 and 0.50, however.

In the tests reported above, the past values included are those for CH. It is possible, however, to construct models in which the interest rates should enter with a lag. Under such conditions, the current specification could result in biased estimates $(\hat{\beta}_{-2},\hat{\beta}_{-1},\hat{\beta}_0,$ $\hat{\gamma}_{-2},\hat{\gamma}_{-1},\hat{\gamma}_0)$ due to premature lag truncation. Given these considerations as well as the fact that use of the CHIPS data represents an interesting and unique feature of this study, separate tests including leads on CH only have been conducted. The F-statistics for the coefficients (γ_{-2}, γ_{-1}, γ_0) were characterized by significance levels ranging from 0.561 for r_0 = RCP to 0.891 for r_0 = RE180. In all cases, the residual vector remained essentially unchanged, as characterized by the KS statistic. These results, taken alone, are therefore strongly suggestive of exogeneity of CH, the transactions variable.

The F-statistics reported cannot be considered in isolation, however. The estimated coefficients in future levels of CH are in all cases large relative to the coefficients in current and lagged CH. (The same result holds for regressions with only CH entering as future variables.) In some cases, individual coefficients are statistically significant; e.g., α_{-2}, α_{-1} for r_0 = RE90, α_{-1} for r_0 = RTB, and α_{-2} for r_0 = RCP. The estimated distributed lag on CH, with the exception of the case for r_0 = RE90, does not change shape dramatically, although in some cases some coefficients on recent lags become insignificant. In all cases, β_0 and γ_0 have the expected signs, but in three cases the data do not strongly reject the notion $\beta_0 = -\gamma_0$. In each of these three cases, either coefficients on future RP and/or r_0 are either statistically significant or large in absolute value.

A final set of observations is obtained by examining the properties of the residual vector. Only for r_0 = RCD and r_0 = RE90 does the DW statistic change dramatically. The KS statistic, however, indicates departure from whiteness in three cases: at between the 0.10 and 0.05 levels for RCD and for RCP, and at between the 0.05 and 0.01 levels for RE90. When only future CH are included, no KS statistic is significant at even the 0.20 level, although the statistic for RCD is significant at close to this level.

To summarize the results noted above is to say that the evidence on exogeneity of the right-hand-side variables has ambiguous implications. The F-statistics on coefficients when all variables include leading terms provide some evidence which does not strongly reject exogeneity. Furthermore, the F-statistic on coefficients of future CH above provide no evidence at all against the exogeneity assumption. On the other hand, significant changes in the KS and DW statistics for r_0 = RCD, RE90, and RCP in the presence of leads are suggestive of the failure of exogeneity to obtain. Additionally, estimated coefficients on leads are mostly large, whether they are statistically significant or not. In this case, it may be that the data fail to reject exogeneity simply because the estimated coefficients are too noisy to provide any real evidence on the issue; the test is passed by default. Thus, while no strong evidence against exogeneity is found, the results are sufficiently cloudy as to imply at least the possibility of simultaneous equation bias. Unfortunately, the nature of these results are probably not definitive enough to change one's mind from any priors held regarding feedback in this case.

Final Estimates Over the Entire Sample Period

Estimates of the demand equation have been presented for a slightly truncated sample period in order to facilitate the exogeneity tests described. While admitting the possibility of simultaneous equation bias, the failure of the data to strongly reject exogeneity provides some justification for assuming that the estimates under the null hypothesis are indeed consistent. For this model, that view also implies that the data are consistent with a behavioral interpretation of the estimated regressions. Under the assumption then that the same form of the model obtains over the entire sample period, estimates over the extended period are shown in Tables 3A and 3B.[27/]

The first obvious difference between these results and those in Tables 1A through 1E is that of the optimal prefilter; (1-.25L) appears to be the best first-order prefilter for all regressions over the entire sample. Comparing Tables 1A through 1E, Section (A), with Table 3A shows that although few dramatic changes in the estimated lag distribution are obvious, all estimated coefficients in Table 3A are statistically less significant than those in Tables 1A through 1E. Indeed, in Table 3A, the lag distribution is never significant at a level less than about 0.40. Additionally, r_0 is not very significant in the absolute value sense, although it is still statistically negative at between the 0.085 and 0.132 marginal significance levels.

The efficient estimates for the sample period are shown in Table 3B. Comparison of these results with those in Tables 1A through 1E shows some noticeable changes in the estimated lag distribution, especially for r_0 = RE90, RE180, and RCP. The lag distribution is, in all cases, less statistically significant than in Tables 1A through 1E, but still very significant (at marginal significance levels of between 0.0012 and 0.0211). While β and γ have the expected signs in all cases, γ is significant at less than the 0.30 level only for r_0 = RCD and RE180. Only for r_0 = RCD is γ strongly significantly negative. A final observation is that the residuals from the regressions in Table 3B are in all cases whiter, as reflected in the KS statistic, than are those in Tables 1A through 1E.

These observations are somewhat surprising, in view of the magnitude of changes in results found for the few observations added. While the pattern of the estimated lag distributions differ in some ways between the two periods estimated, the statistical significance of the distributed lag as a whole is much more sensitive to the efficiency of the estimates over the longer period. Over the longer period, the coefficient on each rate has the expected sign, but that on r_0 is virtually insignificant. Indeed, for the inefficient estimates, essentially all explanatory power is due to RP alone. Whether these observed differences are due to some structural change or to some other factors is at this point a matter for conjecture.

IV. Summary and Concluding Remarks

A simple transactions model based upon cost-minimizing behavior of a commercial bank has been advanced to explain why foreign commercial banks hold demand deposits at U.S. banks. Despite the naivete of the model, with issues such as aggregation over banks and the stochastic nature of observed transactions being swept away, the data are broadly consistent with the major implications of the model.

Some of the interesting results are garnered vis-a-vis the empirical methodology. The Hannan Efficient (HE) estimator is used as an approximation to GLS and appears to give reasonable results. Although the justification for the procedure is asymptotic, prewhitening of the residuals, as evidenced by the KS test for higher-order serial correlation, is obtained with appropriate prefilters at a reliable enough level to justify the procedure and to ensure reasonable accuracy in inversion of the spectral density matrix.

Under these conditions, a seldom-used data series on foreign transactions, the daily transactions through the Clearing House Interbank Payments System, performs reasonably well as the transactions proxy in the model. The significance of a distributed lag on this variable is sensitive, however, to the specification of the lag length and the efficiency of the estimates. Likewise, the two interest rates behave roughly as expected, being sensitive also to the length of the estimated lag distribution and efficiency of the estimates.

Tests for statistical exogeneity within the multivariate framework of the model are conducted. The data provide no strong evidence against exogeneity, but they yield estimates sufficiently noisy as to be interpreted as providing little information on the question. On the one hand, then, the possibility of simultaneous equation bias cannot be dismissed outright. Alternatively, priors biased strongly in favor of exogeneity are not likely to be dismissed easily.

Accepting the null hypothesis (and its accompanying exogeneity aspects) implies that the reported estimates are consistent and, in this case, could represent a behavioral relation. Over at least one period studied, the data appear quite consistent with the model, which may therefore provide a pretty good explanation for the movements in deposits. Any sort of "control" by the Federal Reserve then boils down to a question of "controlling" the determinants of deposits. To the extent that foreign transactions are primary determinants of these deposits <u>and</u> that these transactions are exogenous with respect to Federal Reserve policy, these results are consistent with the view that the deposits do not follow Federal Reserve policies systematically.[28/] The issue is further clouded by the roles of the two short-term interest rates, "control" of which is often a major issue itself.

Even without reference to control, the model can provide some basis for forecasting movements in these deposits. If each variable is exogenous, forecasting exercises pose few problems. On the other hand, the possible simultaneity in the system could complicate the problem; this is one potential area for future research.

Footnotes

1/ See the comments in Improving the Monetary Aggregates [1976].

2/ This section has been aided by discussions with representatives of U.S. and foreign commercial banks.

3/ These deposits include neither balances owed by U.S. banks to their foreign branches nor those owed by U.S. agencies and branches of foreign banks to their head offices.

4/ It is often the case that neither the delivering nor the receiving bank is a U.S. bank.

5/ For example, during the course of a business day the payment orders from an account may exceed the funds received in that account, and the U.S. banks must decide whether or not to honor the orders, thus extending credit (sometimes in large amounts) to the foreign commercial bank. These intrabusiness day extensions of credit are often termed "daylight" overdrafts.

6/ U.S. banks often maintain complex relationships with foreign commercial banks of which the demand deposit relationship is only one part. Various interactions include *inter alia* participation in joint ventures, correspondent relationships, introduction to clients, and the provisions of various information and training services. In some cases, a U.S. bank might reduce its demand balance requirements to a foreign bank as a "loss leader" to develop a more profitable relationship in other business areas.

7/ In principle, equation (1) and subsequent equations should be in terms of price deflated magnitudes. This has not been done because of problems in choosing the appropriate deflators for the different nominal magnitudes. Also, costs should probably be related separately to the number of transactions and the average value of a transaction. Data limitations prevent this. In the empirical work we use a time trend in the regressions to proxy for, among other things, secular changes in the average value of a transaction.

Note that all the terms in this and subsequent equations are in dollars per time period.

8/ The level of service charges (S) may be positive or negative. If the level of deposits is such as to provide abnormal profits with zero explicit charges, the U.S. bank is assumed to provide other banking services at less than full costs. S is variable as a necessary result of the assumption that the U.S. bank pays a competitive rate on the deposit in the face of the prohibition on explicit interest payments.

9/ We assume that T, ρ, r_0, and r_L do not depend on D. The second-order condition is that

$$C_{DD} + A_{DD} + (1-\rho)^2 F_{LL} + \pi_{DD} > 0,$$

where double subscripts denote second-order partial derivatives.

If the U.S. bank maximizes profits, then $\pi_D = 0$. While the rest of this section is consistent with profit maximization by the U.S. bank, only the slightly weaker assumption that π_D is constant is needed.

10/ This formulation can be viewed as assuming an interest elasticity of demand varying directly with the level of the rate. One reasonable alternative specification would be to assume constant interest elasticity, implying that the natural logarithms of all variables appear in estimated relations. These alternative specifications are, in principle, testable; in this study, however, only results based upon the first assumption are reported.

11/ For a more complete discussion of the construction of the deposit series, see Farr et al., Appendix A.

12/ These data are used in Farr et al. in the earlier study referenced. CHIPS is an electronic transfer system established in 1971 by the large New York banks to clear their international dollar transactions. The daily figures were provided by the Federal Reserve Bank of New York.

13/ For an example of this approach to bank asset management, see Morrison [1966].

14/ Thus, for an information set limited to the history of transactions levels, one interpretation of the expected level of transactions is that it is a forecast conditioned on that information and is formed rationally in the sense of Muth [1961]. The formulation assumes the stochastic process underlying the exogenous transaction variable can be represented as the autoregression

$$T(t+1) = \sum_{i=0}^{\infty} A_i T_{t-i} + u(t+1),$$

where u_t is a serially independent random variable with zero mean.

15/ Several U.S. banks indicated that they use an average of several rates to calculate a "treasure's rate" for internal use in determining the profitability of customer relationships. See Klein [1974] and Barro and Santomero [1972] for work that tries to measure r_D directly.

16/ Borrowing at the prime rate normally carries a compensating balance requirement. To the extent that the compensating balance requirement is a result of the implicit payment of interest on deposits by lending at a favorable rate, the prime rate will be less than the pure lending rate and may be less than or greater than the implicit deposit rate. Assuming zero intermediation costs, the relationship between the prime rate and the implicit deposit rate depends on the reserve ratio and the compensating balance ratio. For example, if the marginal reserve requirement is 17 percent with a 20 percent compensating balance requirement, the implicit deposit rate is .996 of the prime lending rate.

17/ Effects of a deterministic seasonal are taken into account, but no attempt has been made to remove the effects of any nondeterministic seasonal factors.

18/ A discussion of the HE methodology may be found in Hannan [1963]. Of course, asymptotically the procedure is exactly, not approximately, the same as GLS.

19/ Here L is the lag operator, i.e., $L^n X_t \equiv X_{t-n}$. The case of no prefilter is also examined for each specification of the demand equation.

20/ See Lindgren [1968].

21/ See the remarks in Nerlove [1972] and in Sims [1974], especially, footnote 1.

22/ Here D_t represents current demand deposits held, CH_t is current transactions through CHIPS, RP_t is the current prime lending rate, and $r_{0,t}$ is the current opportunity cost. Again, each regression also includes a constant, trend, and monthly dummy variables.

23/ The Durbin-Watson statistics are compared with the upper and lower bounds given in the extended tables in Savin and White [1977].

24/ The marginal significance levels reported in the tables for the t-statistics are based on a two-tailed test.

25/ Results for M = 9 are available on request from the authors. The regressions for fifteen lags are reported in Tables 3A and 3B in the text.

26/ The number of future coefficients has been limited primarily due to sample size and degrees of freedom considerations. The number of future coefficients should be investigated in a manner consistent with that used in choosing the optimal truncation point M. Therefore, it is possible that the future coefficients estimated are biased due to premature lag truncation.

27/ Because of the very few additional observations used to complete the sample, no rigorous tests for structural change are made. However, it is usually the case that exogeneity tests of the type described here are not carried out, and estimation is performed over the entire sample period. This procedure is not always a good one, the potential pitfalls being suggested by the results for this model.

28/ See Improving the Monetary Aggregates [1976].

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Table 1A

Estimates for r_0 = RCD

Period: 4/72-9/76 Prefilter: None

		Inefficient Regression (A)			Efficient Regressions (B)			Efficient Regressions (C)		
Variable	Lag	Coefficient	t	Sig.	Coefficient	t	Sig.	Coefficient	t	Sig.
CH	-3							-.0459 (.0598)		
	-2							.0368		
	-1							.0419		
	0	.0115 (.0603)			.0103			.0183		
	1	.0761	1.27	.2158	.0791	2.21	.0373	.0420		
	2	-.0509			-.0490 (.0332)	-1.47	.1544	-.0865	-1.62	.1247
	3	.0190			.0162			.0398		
	4	-.0121			-.0107			.0094		
	5	-.0059			-.0415 (.0393)	-1.06	.3021	-.0445		
	6	.0316			.0431	1.10	.2832	.0232		
	7	.0449			.0496	1.27	.2157	.0254		
	8	.0893	1.69	.1052	.1058	2.94	.0074	.1341	2.97	.0091
	9	-.0799	-1.52	.1424	-.0806	-2.22	.0367	-.1063	-2.29	.0361
	10	.0949	1.79	.0872	.0834	2.17	.0408	.1109	2.37	.0310
	11	-.0817	-1.69	.1037	-.0844	-2.49	.0206	-.0787	-1.65	.1178
	12	-.0583	-1.21	.2387	-.0726	-2.16	.0417	-.0687	-1.58	.1342
	13	-.0361			-.0083			-.0166		
	14	.0594	1.28	.2123	.0429	1.50	.1480	.0347		
	15	.0102 (.0371)			.0100			.0105 (.0303)		
RP	-2							.0077		
	-1							-.0142 (.0215)		
	0	.0820 (.0110)	7.47	.0000	.0816 (.0075)	10.93	.0000	.0924 (.0151)	6.12	.0000
RCD	-2							-.0050		
	1							.0150 (.0132)	1.13	.2754
	0	-.0406 (.0104)	-3.90	.0007	-.0386 (.0077)	-4.99	.0000	-.0503 (.0112)	-4.51	.0004
$\bar{R}^2$		.9430			.9870			.9850		
s.e.		.0255			1.9420			2.0920		
D.W.		1.8970			2.0160			2.4040		
K.S.		.0607			.0584			.1126*		
F(18,23)		41.8500 (.0000)			195.5000 (.0000)			F(18,16)=4.9480 (.0012)		
F(16,23)		2.6990 (.0148)			7.6410 (.0000)			F(16,16)=4.1330 (.0036)		
F(1,23)		63.5600 (.0000)			132.5000 (.0000)			F(1,16)=7.3090 (.0157)		

*Significant at 0.10 level.

Table 1B
Estimates for r_0 = RE90

Period: 5/72-9/76 Prefilter: (1=.05L)

Variable	Lag	Inefficient Regression (A) Coefficient	t	Sig.	Efficient Regressions (B) Coefficient	t	Sig.	(C) Coefficient	t	Sig.
CH	-3							.1549 (.1109)	1.40	.1830
	-2							.1291	1.25	.2296
	1							-.1080	-1.12	.2806
	0	-.0258 (.0795)			-.0053			-.1856	-1.94	.0709
	1	.0451			.0433	1.23	.2322	-.0617		
	2	-.0445			-.0653	-1.69	.1045	.0025		
	3	.0113			.0218			.0108		
	4	-.0124			.0116			-.0441		
	5	.0026			-.0203			-.0343		
	6	.0231			.0020 (.0444)			.0457		
	7	.0567			.0441	1.11	.2793	.1161	1.71	.1084
	8	.0790	1.38	.1802	.0972	2.63	.0152	.0847	1.25	.2291
	9	-.0751	-1.29	.2112	-.0513	-1.32	.1972	-.0810	-1.29	.2164
	10	.0788	1.40	.1753	.0807	2.19	.0397	.0155		
	11	-.0437			-.0556	-1.39	.1774	-.1032	-1.39	.1848
	12	-.0661	-1.20	.2439	-.0719	-2.11	.0469	-.0753	-1.21	.2466
	13	-.0159			-.0190			.0193		
	14	.0488			.0392	1.33	.1967	.0685	1.14	.2708
	15	.0020 (.0406)			.0124 (.0230)			-.0090 (.0462)		
RP	-2							.0315 (.0243)	1.30	.2142
	-1							.0220 (.0349)		
	0	.0737 (.0115)	6.43	.0000	.0698 (.0079)	8.86	.0000	.1019	4.11	.0009
RE90	-2							.0033 (.0116)		
	-1							.0078		
	0	-.0304 (.0110)	-2.76	.0114	-.0258 (.0081)	-3.19	.0042	-.0252 (.0149)	-1.69	.1110
$\bar{R}^2$		.9250			.9800			.9570		
s.e.		.0278			2.0030			2.9430		
D.W.		1.8180			2.0340			1.3290		
K.S.		.0537			.0414			.1296*		
F(18,22)		30.2000 (.0000)			116.9000 (.0000)			F(18,15)=2.7800 (.0255)		
F(16,22)		1.3860 (.2352)			5.8460 (.0001)			F(16,15)=2.4270 (.0467)		
F(1,22)		40.9800 (.0000)			75.9400 (.0000)			F(1,15)=8.2280 (.0117)		

*Significant at 0.05 level.

Table 1C
Estimates for r_0 = RE180

Period: 5/72-9/76 Prefilter: (1-.1L)

		Inefficient Regression (A)			Efficient Regressions (B)			(C)		
Variable	Lag	Coefficient	t	Sig.	Coefficient	t	Sig.	Coefficient	t	Sig.
CH	-3							-.0085		
	-2							.0437 (.1054)		
	-1							-.0662		
	0	-.0422 (.0818)			-.0339			-.0112		
	1	.0252			.0296			.0326		
	2	-.0633			-.0814	-2.21	.0381	-.0579		
	3	.0326			.0504	1.30	.2078	.0361		
	4	.0033			.0270			-.0080		
	5	.0097			-.0092			.0226		
	6	.0115			.0004 (.0411)			-.0103		
	7	.0483			.0352			.0374		
	8	.0823	1.45	.1624	.1001	2.90	.0084	.1127	2.59	.0205
	9	-.0609	-1.06	.2996	-.0550	-1.49	.1506	-.0631	-1.34	.1990
	10	.0764	1.36	.1863	.0860	2.41	.0248	.0809	1.46	.1655
	11	-.0643	-1.13	.2710	-.0596	-1.55	.1347	-.0707		
	12	-.0647	-1.18	.2514	-.0779	-2.34	.0287	-.0588	-1.24	.2334
	13	-.0289			-.0193			-.0147		
	14	.0619	1.27	.2178	.0456	1.63	.1166	.0452		
	15	.0196 (.0411)			.0240 (.0234)			.0167 (.0332)		
RP	-2							.0095		
	-1							-.0115 (.0313)		
	0	.0662 (.0102)	6.49	.0000	.0675 (.0082)	8.25	.0000	.0743 (.0205)	3.63	.0025
RE180	-2							-.0128 (.0188)		
	1							.0183		
	0	-.0263 (.0108)	-2.43	.0238	-.0280 (.0098)	-2.86	.0091	-.0381 (.0199)	-1.91	.0755
$\bar{R}^2$		.9160			.9680			.9620		
s.e.		.0281			1.9310			2.1100		
D.W.		1.8100			2.1420			2.1020		
K.S.		.0613			.0560			.0759		
F(18,22)		26.5100 (.0000)			71.4500 (.0000)			F(18,15)=3.7960 (.0061)		
F(16,22)		1.2660 (.2989)			5.3420 (.0002)			F(16,15)=2.7320 (.0292)		
F(1,22)		27.0600 (.0000)			42.1400 (.0000)			F(1,15)=1.1500 (.3005)		

Table 1D

Estimates for r_0 = RTB

Period: 5/72-9/76 Prefilter: (1-.15L)

		Inefficient Regression (A)			Efficient Regressions (B)			(C)		
Variable	Lag	Coefficient	t	Sig.	Coefficient	t	Sig.	Coefficient	t	Sig.
CH	-3							-.0102		
	-2							.0652		
	-1							-.0880	-1.20	.2500
	0	.0925 (.0933)			.0663 (.0545)	1.22	.2367	.0874 (.0811)	1.08	.2981
	1	.0598			.0701	1.96	.0628	.0776	1.30	.2146
	2	-.1107	-1.49	.1499	-.1082	-2.71	.0129	-.1072	-1.77	.0970
	3	-.0097			-.0005			-.0090		
	4	-.0174			-.0169			-.0382		
	5	.0036			-.0038			-.0078		
	6	.0358			.0229			.0092		
	7	.0430			.0291			.0347		
	8	.0918	1.58	.1283	.0971	2.57	.0176	.1092	2.34	.0334
	9	-.0576			-.0471	-1.19	.2461	-.0744	-1.54	.1433
	10	.0785	1.36	.1863	.0848	2.13	.0450	.1046	2.07	.0560
	11	-.1036	-1.95	.0646	-.1003	-2.71	.0127	-.1211	-2.28	.0374
	12	-.0515			-.0593	-1.62	.1185	-.0510		
	13	-.0180			-.0112			-.0010		
	14	.0579	1.17	.2547	.0526	1.82	.0826	.0449		
	15	.0287 (.0435)			.0197 (.0269)			.0133 (.0396)		
RP	-2							.0108 (.0160)		
	-1							-.0257 (.0221)	-1.16	.2630
	0	.0583 (.0091)	6.42	.0000	.0579 (.0069)	8.36	.0000	.0735	4.42	.0005
RTB	-2							-.0114 (.0175)		
	1							.0277 (.0194)	1.42	.1737
	0	-.0332 (.0175)	-1.90	.0705	-.0274 (.0134)	-2.05	.0520	-.0309	-1.73	.1042
$\bar{R}^2$		.9020			.9700			.9660		
s.e.		.0288			2.0550			2.1870		
D.W.		1.7900			1.9030			1.8630		
K.S.		.0653			.0395			.0643		
F(18,22)		22.4500 (.0000)			76.1300 (.0000)			F(18,15)=2.9650 (.0193)		
F(16,22)		1.3090 (.2745)			4.7100 (.0005)			F(16,15)=2.8630 (.0240)		
F(1,22)		3.0610 (.0941)			6.7590 (.0164)			F(1,15)=2.8120 (.1142)		

Table 1E
Estimates for r_0 = RCP

Period: 4/72-9/76 Prefilter: None

		Inefficient Regression			Efficient Regressions					
		(A)			(B)			(C)		
Variable	Lag	Coefficient	t	Sig.	Coefficient	t	Sig.	Coefficient	t	Sig.
CH	-3							.0289 (.0674)		
	-2							.0739	1.26	.2274
	-1							.0385		
	0	.0601 (.0663)			.0766	1.98	.0598	.0153		
	1	.1084	1.73	.0967	.1482	3.66	.0013	.1003	1.86	.0814
	2	-.0692	-1.19	.2467	-.0738	-2.10	.0467	-.0941	-1.83	.0856
	3	-.0197			-.0443			-.0177		
	4	-.0374			-.0508	-1.25	.2241	-.0461		
	5	.0019			-.0195			-.0314		
	6	.0529			.0517 (.0439)	1.18	.2506	.0405		
	7	.0796	1.45	.1592	.0841	1.96	.0625	.0603	1.24	.2328
	8	.0728	1.35	.1894	.0951	2.36	.0269	.1295	3.04	.0078
	9	-.0908	-1.69	.1045	-.0837	-2.07	.0501	-.0786	-1.84	.0840
	10	.0668	1.28	.2140	.0781	1.93	.0666	.0744	1.62	.1256
	11	-.0392			-.0466	-1.21	.2384	.0013		
	12	-.0654	-1.34	.1931	-.0805	-2.20	.0379	-.1138	-2.46	.0256
	13	-.0013			.0061			.0135		
	14	.0613	1.31	.2030	.0338	1.11	.2769	.0062		
	15	-.0097 (.0382)			-.0072 (.0239)			.0064 (.0335)		
RP	-2							.0359	2.40	.0292
	-1							-.0075 (.0187)		
	0	.0900 (.0130)	6.86	.0000	.0963 (.0096)	10.08	.0000	.1013 (.0135)	7.49	.0000
RCP	-2							-.0281 (.0136)	-2.06	.0562
	-1							.0171 (.0169)		
	0	-.0571 (.0151)	-3.77	.0010	-.0647 (.0109)	-5.95	.0000	-.0883	-5.87	.0000
$\bar{R}^2$		.9410			.9920			.9930		
s.e.		.0258			2.1440			2.0250		
D.W.		1.9100			1.8990			2.4560		
K.S.		.0591			.0486			.1110*		
F(18,23)		40.7900 (.0000)			326.9000 (.0000)			F(18,16)=8.5430 (.0000)		
F(16,23)		2.7080 (.0145)			10.2700 (.0000)			F(16,16)=7.5250 (.0001)		
F(1,23)		26.9800 (.0000)			70.3700 (.0000)			F(1,16)=0.8800 (.3622)		

*Significant at 0.10 level.

Table 2
F-Tests for Exogeneity

Coeff. Tests \ r_0 (df)	RCD (16)	RE90 (15)	RE180 (15)	RTB (15)	RCP (16)
All Leads F(7,df)	0.546 (.7878)	1.484 (.2459)	0.490 (.8272)	0.630 (.7268)	1.397 (.2727)
Leads on CH F(3,df)	0.542 (.7192)	2.031 (.1527)	0.440 (.7279)	0.598 (.6260)	1.907 (.1691)
Leads on RP F(2,df)	0.238 (.7907)	1.375 (.2830)	0.124 (.8843)	0.722 (.5019)	2.891 (.0847)
Leads on r_0 F(2,df)	0.639 (.5409)	0.288 (.7542)	1.090 (.3615)	1.246 (.3158)	2.120 (.1525)

Tests are based on periods indicated in Tables 1A through 1E.

Table 3A
Inefficient Estimates Under the Null Hypothesis
Period: 5/72-12/76   Prefilter: (1-.25L)

r_0		RCD			RE90			RE180		
Variable	Lag	Coefficient	t	Sig.	Coefficient	t	Sig.	Coefficient	t	Sig.
CH	0	.0250 (.0827)			.0151 (.0839)			.0019 (.0845)		
	1	.0655			.0517			.0391		
	2	-.0650			-.0694			-.0762		
	3	.0227			.0111			.0250		
	4	-.0098			-.0090			-.0006		
	5	-.0059			.0018			.0049		
	6	.0076			.0019			-.0015		
	7	.0287			.0325			.0298		
	8	.0866	1.51	.1437	.0788	1.36	.1862	.0824	1.43	.1646
	9	-.0598			-.0557			-.0525		
	10	.0779	1.36	.1860	.0702	1.23	.2319	.0718	1.26	.2178
	11	-.1061	-2.02	.0545	-.0896	-1.52	.1419	-.0925	-1.64	.1134
	12	-.0537			-.0549			-.0568		
	13	-.0157			-.0076			-.0138		
	14	.0691	1.45	.1592	.0646	1.31	.2015	.0684	1.42	.1667
	15	-.0015 (.0430)			-.0057 (.0437)			.0031 (.0434)		
RP	0	.0648 (.0140)	4.63	.0001	.0605 (.0132)	4.57	.0001	.0596 (.0118)	5.05	.0000
r_0	0	-.0201 (.0142)	-1.42	.1693	-.0140 (.0123)	-1.14	.2643	-.0155 (.0120)	-1.30	.2067
$\bar{R}^2$		.8740			.8710			.8730		
s.e.		.0295			.0298			.0296		
D.W.		1.8100			1.7490			1.8120		
K.S.		.0838			.0886			.0814		
F(18,25)		17.3600 (.0000)			16.8700 (.0000)			17.1300 (.0000)		
F(16,25)		1.0710 (.4273)			.9140 (.5646)			.9450 (.5356)		
F(1,25)		25.5000 (.0000)			28.4500 (.0000)			23.1000 (.0001)		

r_0		RTB			RCP		
Variable	Lag	Coefficient	t	Sig.	Coefficient	t	Sig.
CH	0	.0833 (.0941)			.0528 (.0877)		
	1	.0643			.0781	1.16	.2562
	2	-.1014	-1.38	.1803	-.0865	-1.17	.2531
	3	.0019			-.0047		
	4	-.0170			-.0176		
	5	-.0006			.0032		
	6	.0206			.0082		
	7	.0272			.0376		
	8	.0908	1.57	.1286	.0770	1.33	.1957
	9	-.0531			-.0570		
	10	.0782	1.36	.1858	.0655	1.17	.2548
	11	-.1122	-2.16	.0405	-.0963	-1.72	.0982
	12	-.0535			-.0515		
	13	-.0068			-.0024		
	14	.0616	1.26	.2177	.0707	1.47	.1537
	15	.0160 (.0449)			-.0093 (.0439)		
RP	0	.0559 (.0097)	5.74	.0000	.0647 (.0157)	4.16	.0004
r_0	0	-.0250 (.0179)	-1.40	.1751	-.0220 (.0184)	-1.19	.2435
$\bar{R}^2$		.8740			.8710		
s.e.		.0295			.0298		
D.W.		1.8060			1.7840		
K.S.		.0836			.0837		
F(18,25)		17.3200 (.0000)			16.9600 (.0000)		
F(16,25)		1.1070 (.3990)			1.0330 (.4585)		
F(1,25)		4.0490 (.0551)			18.6800 (.0000)		

Table 3B
Efficient Estimates Under the Null Hypothesis
Period: 5/72-12/76   Prefilter: (1-.25L)

r_0 Variable	Lag	RCD Coefficient	t	Sig.	RE90 Coefficient	t	Sig.	RE180 Coefficient	t	Sig.
CH	0	.0111			.0110			.0078		
	1	.0845	2.24	.0340	.0721	1.96	.0618	.0682	1.87	.0738
	2	-.0550	-1.44	.1637	-.0584	-1.51	.1434	-.0651	-1.67	.1065
	3	.0310 (.0481)			.0293 (.0488)			.0307 (.0484)		
	4	-.0087			-.0065			-.0014		
	5	-.0174			-.0177			-.0100		
	6	.0167			.0109			.0043		
	7	.0147			.0170			.0162		
	8	.0888	2.20	.0370	.0846	2.14	.0421	.0824	2.06	.0497
	9	-.0624	-1.60	.1217	-.0582	-1.51	.1434	-.0545	-1.40	.1748
	10	.0673	1.66	.1098	.0597	1.49	.1490	.0626	1.53	.1395
	11	-.1104	-2.96	.0066	-.0994	-2.60	.0154	-.1060	-2.82	.0093
	12	-.0641	-1.68	.1054	-.0629	-1.66	.1101	-.0595	-1.57	.1280
	13	.0070			.0132			.0082		
	14	.0616	2.22	.0359	.0610	2.18	.0389	.0683	2.50	.0194
	15	.0156 (.0271)			.0116 (.0269)			.0113 (.0267)		
RP	0	.0557 (.0112)	4.99	.0000	.0511 (.0104)	4.93	.0000	.0515 (.0101)	5.11	.0000
r_0	0	-.0132 (.0089)	-1.49	.1498	-.0077 (.0077)	-1.00	.3273	-.0084 (.0074)	-1.14	.2655
$\bar{R}^2$		.9340			.9350			.9420		
s.e.		2.0150			1.9730			1.9920		
D.W.		1.9230			1.9130			1.8600		
K.S.		.0408			.0335			.0457		
F(18,25) (Sig. Level)		32.2000 (.0000)			32.4400 (.0000)			36.8100 (.0000)		
F(16,25)		3.4560 (.0027)			3.6190 (.0020)			3.8520 (.0013)		
F(1,25)		22.1500 (.0000)			21.7100 (.0000)			23.5800 (.0000)		

r_0 Variable	Lag	RTB Coefficient	t	Sig.	RCP Coefficient	t	Sig.
CH	0	.0331 (.0527)	2.38	.0254	.0207		
	1	.0847	-2.03	.0528	.0787	1.92	.0663
	2	-.0772			-.0607	-1.53	.1377
	3	.0186			.0238 (.0502)		
	4	-.0174			-.0140		
	5	-.0110			-.0177		
	6	.0166			.0109		
	7	.0195			.0260		
	8	.0844	2.23	.0347	.0805	1.96	.0609
	9	-.0598	-1.62	.1175	-.0602	-1.50	.1449
	10	.0699	1.77	.0886	.0541	1.37	.1838
	11	-.1161	-3.20	.0037	-.1078	-2.82	.0092
	12	-.0599	-1.66	.1101	-.0557	-1.43	.1658
	13	.0083			.0142		
	14	.0604 (.0261)	2.31	.0293	.0671	2.38	.0251
	15	.0182			.0082 (.0275)		
RP	0	.0505 (.0094)	5.37	.0000	.0506 (.0125)	4.05	.0004
r_0	0	.0108 (.0112)	-0.97	.3435	-.0074 (.0121)	-0.61	.5477
$\bar{R}^2$		.9430			.9300		
s.e.		1.9770			2.0010		
D.W.		1.8870			1.8680		
K.S.		.0383			.0463		
F(18,25)		36.1900 (.0000)			29.8400 (.0000)		
F(16,25)		3.9140 (.0012)			2.4620 (.0211)		
F(1,25)		12.0000 (.0000)			19.1800 (.0000)		