

7. Monetary Base Control III

The British Banking System's Demand for Cash Reserves

Pages 21 - 39

TABLE 4

2SLS Estimates of Equation (9)

| <u>Variable</u> | <u>Estimated Coefficient</u> | <u>t-ratio</u> |
|------------------|------------------------------|----------------|
| r_{TB} | -0.2165 | -3.846 |
| $(1-\lambda)$ | 0.0531 | 6.937 |
| λr_{TB} | 0.5440 | 3.584 |
| $(D/P)^{-1}$ | 378.70 | 2.800 |
| (CTB/D) | -0.0262 | 1.929 |
| DUM | 0.0065 | 3.768 |
| T | -0.00019 | 8.855 |
| JAN | -0.0035 | 3.908 |
| FEB | -0.0058 | 5.956 |
| MAR | -0.0052 | 5.401 |
| APR | -0.0034 | 3.643 |
| MAY | -0.0040 | 4.266 |
| JUN | -0.0028 | 3.068 |
| JUL | -0.0017 | 1.741 |
| AUG | -0.0036 | 4.050 |
| SEP | -0.0033 | 3.769 |
| OCT | -0.0039 | 4.477 |
| NOV | -0.0032 | 3.742 |
| <hr/> | | |
| R^2 | 0.83 | |
| SE | 0.0015 | |
| DW | 2.288 | |
| n | 72 | |

Notes: See notes to Table 1. In order to allow fully for seasonal effects, a constant term was included in a preliminary regression. However the constant term was not significant and so the regression was run again without the constant. The results of the second regression are reported in this Table.

TABLE 5

Estimates of Individual Parameters in Equation (9)

| <u>Parameter</u> | <u>Estimate</u> | <u>t-ratio</u> |
|------------------|-----------------|----------------|
| α | 378.70 | 2.800 |
| β_1 | 0.3275 | 3.366 |
| δ_0 | 0.0531 | 6.937 |
| δ_1 | -0.2165 | 3.846 |
| ϕ | -0.0262 | 1.929 |

TABLE 6

Estimates of Partial Derivatives of Equation (4)

| <u>Derivative</u> | <u>Expression</u> | <u>Estimated Value</u> | <u>t-ratio</u> |
|-----------------------------------|--|------------------------|----------------|
| $\partial(XR/D)/\partial r_{TB}$ | $(\beta_1 - \delta_1)\lambda + \delta_1$ | -0.0237 | 2.089 |
| $\partial(XR/D)/\partial(D/P)$ | $-\alpha(D/P)^{-2}$ | -8×10^{-7} | 2.800 |
| $\partial(XR/D)/\partial P$ | α/D | 0.0122 | 2.800 |
| $\partial(XR/D)/\partial \lambda$ | $(\beta_1 - \delta_1)r_{TB} - \delta_0$ | 0.00093 | 0.095 |
| $\partial(XR/D)/\partial(CTB/D)$ | ϕ | -0.0262 | 1.929 |

Notes: The expressions are evaluated using the mean values of λ , (D/P) , D , and r_{TB} during the sample period. The average value of (XR/D) during the sample period was 0.0357.

As can be seen by examining Table 4, equation (9) performs very well in explaining the behavior of the excess-cash-reserves ratio and all of the coefficients are statistically significant. The results indicate that there is a significant downward trend in the reserves ratio and a definite seasonal pattern in the behavior of the ratio. (In order to put the seasonal effects in perspective it should be noted that the average value of XR/D during the sample period was 0.0357.) The estimates reported in Table 5 indicate that each of the remaining individual parameters of most analytical interest in the banks' demand-for-cash-reserves equation -- equation (3) -- is statistically significant.

The theoretical predictions discussed in section II of this paper can now be tested. In Table 6 the relevant expressions are evaluated. The t-ratios indicate that the demand for cash reserves is interest-sensitive in the predicted direction [i.e., $\partial(XR/D)/\partial r_{TB} < 0$], that there are economies of scale in the holding of real reserves as real deposits increase [i.e., $\partial(XR/D)/\partial(D/P) < 0$ and $\partial(XR/D)/\partial P > 0$], and that U.K. Treasury bills and certain other bills are substitutes for cash reserves in bank portfolios [i.e., $\partial(XR/D)/\partial(CTB/D) < 0$].^{17/} However, it is also found that the demand for reserves is not significantly sensitive to changes in the ratio of demand deposits to total deposits, although the computed effect is in the predicted direction.

Nevertheless, despite the finding that $\partial(XR/D)/\partial \lambda$ is not significantly different from zero, there is a way in which the proportion of deposits consisting of demand deposits is important in the banks' demand for reserves: the ratio of demand deposits to total deposits has a significant effect on the interest-sensitivity of the demand-for-reserves function. In order to see this, note that

$$\partial^2(XR/D)/\partial r_{TB} \partial \lambda = \beta_1 - \delta_1 = 0.5440 ,$$

and that the t-ratio of $(\beta_1 - \delta_1)$ is 3.584. Thus an increase in λ -- i.e., an increase in the proportion of deposits consisting of demand deposits -- decreases

the interest-sensitivity of the banks' demand for excess cash reserves [that is, it makes $\partial(XR/D)/\partial r_{TB}$ less negative].^{18/} There are two possible explanations for this effect on the interest-sensitivity of demand. First, banks may be thought of as having two reserve "funds", one backing up demand deposits and the other backing up time deposits. Assuming that demand deposits are more subject to withdrawal, the banks may be less willing to alter the size of the demand-deposit reserve fund when the opportunity cost of the fund changes, hence the larger is the ratio of demand deposits to total deposits the less interest-sensitive is the demand for cash reserves. The second reason, which can be complementary to the first, is that interest-sensitivity of demand differs across banks and that the banks specializing in demand deposits -- that is, retail banking -- are more cautious in managing their reserves in that their demand for reserves is less interest-sensitive. Thus when the proportion of total deposit liabilities consisting of the liabilities of these banks increases, for example, which would probably show up as an increase in λ , the interest-sensitivity of the demand for cash reserves by the entire banking system declines.

As noted above, the sign of the interest-sensitivity of the demand for reserves and the sign of the coefficient on the (CTB/D) variable indicate that U.K. Treasury bills and certain other bills are substitutes for cash in banks' portfolios. However the relatively small size of ϕ -- the coefficient of (CTB/D) -- implies that cash reserves and bills definitely are not interchangeable and that cash reserves are not just part of a larger aggregate called liquid-asset reserves. On the contrary, the results reported in this paper indicate that cash reserves are a distinct asset and therefore the estimation of a demand function for them alone is justified and, indeed, to be preferred to aggregating them with other liquid assets.

V. Policy Implications

In order for the monetary authorities to be able to control monetary growth by controlling the growth of the monetary base, it is necessary (but not sufficient) that the banks' demand for the monetary base be related to the level of bank liabilities in a predictable and well-defined way. In terms of equation (1), the reserve ratio -- R/D -- must be a well-defined function of known and observable variables. The empirical evidence reported in this paper indicates that there is a well-defined and well-behaved banks' demand-for-cash-reserves function in the United Kingdom and that the function includes as an argument deposit liabilities, among other variables.^{19/} Thus, one of the necessary conditions for the feasibility of controlling money growth by controlling the growth of the (conventionally defined) monetary base is fulfilled.^{20/} Another variable in the demand-for-reserves function is the rate of interest on U.K. Treasury bills; therefore a policy of controlling interest rates by means of manipulating the supply of the monetary base also appears to be feasible.^{21/}

A monetary-base-oriented policy would involve the explicit recognition and use of the monetary base as an instrument of monetary policy, the formal adoption of a monetary-base growth target, and the explicit abandonment of interest-rate targets. The conclusion of this paper is that no institutional changes -- other than the obvious changes in the Bank of England's operating procedures -- appear to be necessary before a monetary-base-oriented policy can be adopted in the United Kingdom, assuming that the (PC/D) function in equation (1) is well-defined.^{22/}

The empirical results reported in this paper indicate that there already exists a well-defined banks' demand-for-cash-reserves function that can be used for monetary policy purposes. Thus, no change in cash-reserve requirements appears to be necessary for monetary control. Furthermore, since the

reserves function behaves well even though the requirement for banks' cash deposits at the Bank of England is not really a constraint on any particular day^{23/} and applies only to part of the banking system (the London clearing banks), and since there is no legal requirement on vault cash at all, one might well conclude that no mandatory reserve requirement is necessary for monetary control.^{24/} As long as the banks have a well-defined demand for the liabilities of the Bank of England, the Bank can use open-market operations in its liabilities to affect the monetary base and bank deposit liabilities.^{25/} Thus what is necessary for a monetary-base approach to monetary control to be feasible is that there be an incentive for the banks to use Bank of England liabilities as their reserve asset; a mandatory reserve requirement is just one way of providing such an incentive.

The discussion in this paper has not addressed the question of what the appropriate monetary policy regime is for the United Kingdom. It would appear that the present monetary system could be used to achieve a target path for monetary-base growth which is chosen as being consistent with some desired growth in the money stock or nominal income or even as being desirable in its own right for that matter. Alternatively, the system could be used in connection with feedback rules or reaction functions, where monetary developments -- money-stock growth or interest-rate changes -- elicit automatic or discretionary changes in the base. Other policy regimes -- e.g., pegging the price of Bank of England liabilities in terms of a particular commodity, group of commodities, a particular currency, or group of currencies -- are also possible. It must be noted, however, that any change in the U.K.'s monetary policy regime would very likely bring about a response in the private sector.^{26/} For example, strict adherence to a money-supply-growth target by means of a monetary-base-oriented policy would represent a rather dramatic change in the way in which the monetary system is used by the

authorities, and changes in certain empirical relationships would be likely to occur -- for instance, the banks' demand for cash reserves would probably increase under such a policy regime. Thus any change in the monetary policy regime must be undertaken cautiously, perhaps gradually, and certainly only after careful consideration of the alternatives and implications.^{27/}, ^{28/}

VI. Conclusion

In this paper, a model of the British banking system's demand for cash has been developed and estimated. It was ascertained that the model performs well empirically and that the banking system's demand for cash reserves is thus a well-defined and well-behaved relationship involving a few observable variables, including bank deposit liabilities. Therefore a policy aimed at achieving a monetary growth target by manipulating the monetary base as conventionally defined appears to be feasible. Furthermore it was concluded that such a policy would not require institutional change before being implemented.

Appendix: Data

Monthly data for the period 1973-1978 are used in this study.

All data are from the Bank of England's Quarterly Bulletin and its Statistical Abstract unless otherwise indicated. The data are not seasonally adjusted. Most monetary statistics are reported for a Wednesday near the middle of the month; this date is referred to in this study as "mid-month".

Interest rates. The U.K. Treasury bill rate is the average rate of discount for three-month bills after the weekly tender, expressed as a yield, prevailing on the Friday before mid-month. The U.S. Treasury bill rate is the market selling rate in New York for 91-day bills, expressed as a yield, prevailing on the Friday before mid-month. The variable r_{LD} is defined as:

$$r_{LD} \equiv [r_{MD}/(1-\rho)] - [\rho r_{\rho}/(1-\rho)] ,$$

where r_{MD} is the rate of interest paid by the bank on a marginal deposit, ρ is the ratio of required investment in defined reserve assets to total liabilities, and r_{ρ} is the rate of interest paid on the assets fulfilling the bank's ρ requirement. ^{29/} Because the cash requirement for the London clearing banks counts toward their liquid-asset reserve requirement, the required ratio relevant to the equation is just the 12-1/2 percent liquid-asset ratio requirement. In addition, all banks are obliged to meet any call for special deposits. In fact, special deposits can be thought of as the variable component of required liquid-asset reserves. Thus, $\rho \equiv .125 + \rho_{SD}$. ^{30/} The rate of interest paid on special deposits is r_{TB} , and that on liquid-asset reserves other than cash balances at the Bank of England is close to r_{TB} . Thus the specification that $r_{\rho} \equiv r_{TB}$ is a reasonable simplification. Taking r_{MD} to be the rate of interest on a certificate of deposit (r_{CD}), one obtains the following specification for r_{LD} :

$$r_{LD} \equiv [r_{CD}/(.875 - \rho_{SD})] - [(.125 + \rho_{SD})r_{TB}/(.875 - \rho_{SD})].$$

The certificate-of-deposit rate used in this study is the mean of the range of rates on the Friday before mid-month on a three-month sterling certificate of

deposit. The rate of call for special deposits is a mid-month rate. The PBMLR variable is the product of the MLR times the ratio of outstanding discount house borrowing from the Bank of England to total banking system's cash reserves. The MLR used in this study is the one announced or in effect on the Friday before mid-month. The data on discount house borrowing from the Bank, which in this study amount to data on borrowing by the banking system from the Bank, represent amounts owed to the Bank of England by the discount houses as of mid-month. The data do not measure the total amount of borrowing from the Bank by the banking system during the preceding month. The data on banks' cash reserves are discussed below.

Supplementary special deposits. There were three different episodes in which the corset was in force during the sample period: December 17, 1973 through February 28, 1975; November 18, 1976 through August 11, 1977; and June 8, 1978 through the end of the sample period. Binary variables are used to represent these episodes.

Cash reserves. Data on notes and coin held by U.K. banks are available for the period May 1975 through the end of the sample period. For earlier months, banks' deposits at the Bank of England must be subtracted from data on banks' total holdings of notes, coin, and balances with the Bank in order to obtain data on vault cash. Cash deposits at the Bank of England of both banks and discount houses are mid-month data, as are the other data mentioned in this paragraph. Required reserves are equal to 1-1/2 percent of the previous month's eligible liabilities of the London clearing banks.

Liquid-asset reserves. Data on banks' cash-balances at the Bank and their money at call are subtracted from data on banks' total reserve assets, i.e., liquid-asset reserves, in order to obtain a series on banks' holdings of Treasury bills and other bills eligible as reserve assets. To these data on banks' holdings of bills are added data on discount houses' holdings of U.K.

and Northern Ireland Treasury bills, local authority bills, other public sector bills, and other bills in order to obtain the amount of Treasury bills and other eligible bills (CTB) held by the banking system as defined in this study. All of the data used in the preceding calculation refer to mid-month dates. British government stocks with less than one year to maturity count as reserve assets, but data on discount houses' holdings of such assets are not available before May 1975. Therefore the variable CTB omits discount houses' holdings of these assets. (Between May 1975 and December 1978 the average amount of such assets held by the discount houses was £6 million, ranging between zero and £72 million.)

Money stock. Data on the money stock and bank deposit liabilities are for mid-month dates. The specification of DD includes all sterling sight deposits held by the U.K. private sector and thus some interest-bearing money-market bank liabilities are included in this paper's definition of demand deposits. TD includes certificates of deposit as well as time deposits.

Prices. The retail price index (January 1974 = 100) is used as the price level variable and is taken from the Department of Employment Gazette.

Income. As a proxy for real income, this study uses the index of industrial production (all industries, 1975 = 100) taken from the Central Statistical Office's Monthly Digest of Statistics.

Exchange rate. The exchange rate data are for the U.S. dollar/sterling spot exchange rate prevailing on the Friday before mid-month.

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Footnotes

- */ International Finance Division, Federal Reserve Board. This paper represents the views of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff. I would like to thank Richard Berner, Peter Clark, Warren Coats, Dale Henderson, Karen Johnson, Larry Promisel, Edwin Truman, and Douglas Waldo for helpful comments and suggestions on the research reported in this paper.
- 1/ See, for example, the papers by Nigel Duck and David Sheppard and by M. Foot, C. Goodhart, and A. Hotson, as well as the consultation paper on monetary control issued by the U.K. Treasury and the Bank of England.
- 2/ In December 1978, London clearing banks accounted for about half of the U.K. banking system's sterling deposits and three quarters of the system's sight deposits.
- 3/ Examples of studies in which the monetary base and/or the money multiplier figure prominently are the studies by Milton Friedman and Anna Schwartz and by Karl Brunner and Allan Meltzer.
- 4/ Special deposits are not treated as bank reserves in this study for three major reasons. First, special deposits are not clearing balances and therefore do not qualify in any way as cash. Second, even if they could be interpreted as cash reserves, the analysis would be unaffected since both total reserves and required reserves would increase by the same absolute amount, leaving the demand-for-excess-reserves function -- the function estimated in this paper -- unchanged. (All special deposits would be required reserves.) Finally, since in terms of equation (1), (R/D) and B would change by offsetting amounts if special deposits were treated as bank reserves,

movements in B would be more difficult to interpret. The exclusion of special deposits from the definition of B means that in effect the monetary base series is expressed in terms of constant reserve requirements, which facilitates interpretation of its movement over time.

5/ The reserve requirements in the United Kingdom are not statutory. Rather, the requirements are those agreed upon by the banks and the Bank of England in 1971 when the present system was adopted. Nevertheless they will be treated as if they were legal requirements in this paper.

6/ Recall that the MLR is a penal rate set above the interest rate on U.K. Treasury bills.

7/ Liquid-asset reserves -- as defined by the authorities -- include cash balances at the Bank of England, U.K. Treasury bills and certain commercial bills, call money in the discount market, and some other assets. Cash balances are already included in R and call money is not an asset of the consolidated banking system, which includes the discount houses, used in this paper. Thus the relevant liquid-asset variable must exclude both cash balances at the Bank and call money. The variable denoted here as CTB consists primarily of the banking system's holdings of commercial and U.K. Treasury bills.

8/ The justification for expressing the behavioral function as a demand for excess reserves is that required reserves do not represent usable reserves and are not directly a choice variable for the banks. Excess reserves are the actual banking reserves of the banking system in that they are held for prudential and transactions purposes and, as such, represent a choice variable, the demand for which, in principle, is sensitive to the variables included on the right-hand side of equation (3). At this point it should be clear why it is not very important to this paper whether special deposits are included or excluded

from R and RR. In either case, the same behavioral function results after θ is set equal to unity and (RR/P) is subtracted from both sides of the equation.

9/ Note that D/P is held constant when interpreting the sign of ϕ .

10/ The adjustment equation used in this paper is in nominal terms, which implies that adjustment to price changes is also partial. See Stephen Goldfeld, pp. 691-92. Partial adjustment is a common assumption in empirical studies of the demand for money.

11/ The implicit transmission mechanism involved is that monetary developments affect interest rates contemporaneously and real income and prices with a lag.

12/ Foot, Goodhart, and Hotson (p. 150) have characterized British monetary policy as follows: "The Bank of England has chosen -- through its open-market operations and lender of last resort facilities -- to concentrate on influencing short-term interest rates, being prepared always to provide funds requested by the banking system but on interest-rate terms of its own choosing."

13/ The τ_i in equation (5) are not observable and are not used in the estimation procedure.

14/ In this paper a two-tailed test of statistical significance at the 10 percent level of significance is used.

15/ A further test of the significance of δ_2 , for example, is to set $\beta_2=0$ in order to obtain the equation:

$$XR/D = \alpha(D/P)^{-1} + (\beta_0 - \delta_0)\lambda + (\beta_1 - \delta_1)\lambda r_{TB} + \delta_2(r_{LD} - \lambda r_{LD}) + \delta_0 + \delta_1 r_{TB} + \phi(CTB/D) + \epsilon,$$

and examine the t-ratio of the resulting estimate of δ_2 . Such t-ratios for δ_2 , δ_3 , δ_{41} , δ_{42} , and δ_{43} are, respectively, 1.445, 0.080, 0.075, 0.631, and 0.075, none of which is significant, where δ_{41} , δ_{42} , and δ_{43} are the coefficients of the variables representing the three separate episodes in which the supplementary-special-deposits scheme was in effect during the sample period.

16/ Further work on the role of MLR in the demand for cash reserves might be useful. During most of the sample period the MLR and r_{TB} were closely linked by means of a formula and so were not independent of each other. The use of PBMLR is a way of severing the link as well as capturing the effects of the Bank of England's policy concerning the form of the assistance (funds) supplied to the discount houses and the tone of any moral suasion undertaken by the Bank. There may well be better empirical specifications for the variable PBMLR than the one used in this study and further research on the specification of this variable would be useful. Similarly more research on the role of r_{LD} would also be useful.

17/ The sign of $\partial(XR/D)/\partial r_{TB}$ is evidence of this substitutability also.

18/ Note also that a change in r_{TB} will affect $\partial(XR/D)/\partial \lambda$.

19/ The stability of the function over time is not examined in this paper. In fact there are reasons for thinking that the 1973-78 period is bounded by two structural changes: the reform -- usually referred to as "competition and credit control" -- of the financial system implemented in late 1971, the effects of which probably lasted well into 1972, and the termination of

exchange and capital controls which took place in 1979. These two events are the main reasons for choosing the particular sample period used in this study.

20/ Another important necessary condition is the existence of a well-defined non-bank demand for Bank of England liabilities. The nature of this nonbank demand-for-cash function is beyond the scope of the present paper. It is assumed that the Bank of England can control the total supply of its liabilities; such control is, of course, another necessary condition for the feasibility of achieving monetary control by means of manipulation of the monetary base.

21/ In fact, such a policy of interest-rate control by means of open-market operations in the monetary base has been the Bank of England's policy in recent years. See footnote 12, above.

22/ Duck and Sheppard maintain that institutional change is necessary before a system of effective monetary control can be adopted in the United Kingdom. The empirical results reported in the present paper do not support Duck and Sheppard's claim.

23/ According to Foot, Goodhart, and Hotson (p. 150, n. 5), "there is no requirement that the [1-1/2 percent cash] ratio be maintained strictly on a day-to-day basis; daily deviations from the 1-1/2 percent ratio can be averaged over the banking month and shortfalls or excesses carried forward."

24/ Recall that the equation estimated in this paper is the demand for reserves in excess of those required to be held and that the equation performs very well.

25/ These open-market operations can be in short-term financial assets such as Treasury bills as well as long-term government bonds ("gilts"). It has long been accepted that open-market operations in gilts affect the money supply; this paper indicates that such operations in bills will also affect the money supply.

26/ See the discussions in Foot, Goodhart, and Hotson and in the consultation paper.

27/ The 1971 financial reform referred to in footnote 19 included inter alia, a reduction in required cash reserves of the banking system. It appears from the data that the authorities did not offset the resulting increase in excess cash reserves through open-market operations. Thus one perhaps unintended product of the 1971 financial reform apparently was a sharp increase in excess monetary base, which may well have had a causal role in the subsequent acceleration in money growth and price inflation.

28/ It is important to note that the coefficients of the equation estimated here may very well no longer be accurate now that there are no longer exchange and capital controls in effect, although no test for this type of structural change has been done in this study. (There were insufficient data for a meaningful test for structural change when this paper was written.) Thus the coefficients cannot be trusted completely to predict the precise effects of changes in the supply of bank reserves, for example, in the post-exchange-control monetary system.

29/ The definition of r_{LD} may require some explanation. In order to raise one pound of funds to invest freely, a bank must raise $1/(1-\rho)$ in funds. The gross cost to the bank therefore is $r_{MD}/(1-\rho)$. If the reserves bear interest, the cost is reduced to $[r_{MD}/(1-\rho)] - [\rho r_p/(1-\rho)]$.

30/ Actually, in the accounting system used in this paper, some of the liquid-asset reserves are bank liabilities and so more than $(1-\rho)$ of every pound raised by the banks is invested freely. Nevertheless the definition $\rho = .125 + \rho_{SD}$ will be used as a simplification.