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AN ECONOMETRIC STUDY OF THE BRITISH MONETARY SYSTEM*

This econometric study, involving quarterly data from 1962.1 to 1974.4 inclusive, tries to explain the British money stock and to shed general light on the British monetary system. We shall treat money, bank loans, and privately held government securities as simultaneously determined. Since we assume the British monetary authorities to follow interest-rate objectives, we rule out any treatment of the monetary base as exogenous, and therefore any exclusive focus on the ratio of money to the base. But even though they pursue interest-rate objectives, the British authorities are supposed to impinge on the stock of money by affecting private choices between money and other financial assets. The money stock therefore does not depend strictly on popular preferences outside the banks and the authorities. Implicit in our treatment is an imperfect world capital market; as otherwise any increase in the interest rate by the monetary authorities would attract an indefinitely large demand for British government securities, and any reduction in the rate by the authorities would cause this demand completely to evaporate. In sum, we view the authorities, the banks, and the private sector as interacting in the determination of the stock of money.[1]

Since the model requires disequilibria in the stock of money to be resolved partly outside domestic financial markets, a choice of an equilibrating variable outside these markets is necessary. We make alternative use of official reserves and the price level in this role. When using official reserves as such, the model may be said to show how the British system works under full employment and fixed exchange rates. When using the price level as such, the model may be said to show how this system works under full employment and purely floating exchange rates. Of course, the model was estimated during a period covering both fixed and flexible, never purely floating, exchange rates, and occasionally less than full employment. Therefore simultaneous-equation bias is possible. But the only way to resolve this issue would be to enlarge the system and to treat official foreign reserves, the price level, the foreign exchange rate and output as simultaneously determined. Such an extension goes beyond our present ambitions, especially since we have already had our hands full using full information maximum likelihood in order to estimate a non-linear model,

* In preparing this work, we have benefited from the valuable help and advice of Charles Goodhart. We have also obtained very useful editorial comments, especially from one of the econometrics editors, and we are grateful to Pascal Mazodier, Michael Artis, William Branson, Mervyn King, and Lionel Price. The editors would have liked us to experiment with other possible specifications, and provide more tests and test statistics. The econometric work thus does not go as far as they would have wished.

[1] A similarly inspired, much more detailed econometric study of the British monetary system is under way at the British Treasury, and Malcolm Knight and Clifford Wymer (1976) are evidently engaged in a similar kind of effort.

which we happen to use. Thus the only guide to the seriousness of simultaneous-equation bias that we shall provide is the accuracy (or inaccuracy) of our quarterly predictions for the two years immediately following the sample period, 1975 and 1976.

I. THE MODEL

Contrary to the case in many continental countries, the British government is continually and heavily in debt to the banks. For all practical purposes, British banks also have no discount facilities at the central bank and hold a fixed ratio of legal reserves to deposits. Further, regulations do not permit the British banks to take an uncovered position in a foreign currency, and therefore to augment their domestic debt assets by borrowing abroad. As a result, these banks have no immediate control over their total domestic assets. Their basic policy variables are their interest rate on loans to private customers, and the rate of services that they provide on their deposits (inclusive of interest). The clearing banks did not even have as much latitude as this during much of our study period (i.e. prior to Competition and Credit Control in May 1971). But we view the banking system as going significantly beyond the clearing banks.

Let us begin the formal development with two accounting identities and two definitions.[1]

$$PBR+F = B+G = B_b+B_p+G_b+G_p \tag{1}$$

government accounting identity

$$B_b+G_b+L = D+NW_b \tag{2}$$

banking sector accounting identity

$$NW_p = B_p+G_p+D-L \tag{3}$$

definition of the net claims of the private sector against the government and the banking sector

$$M = B_p+D \tag{4}$$

definition of money

Symbols: PBR, public borrowing requirement; F, official foreign reserves; B, monetary base; G, government securities; B_b, monetary base held by the banks; B_p, monetary base held by the private sector; G_b, government securities held by the banks; G_p, government securities held by the private sector; L, bank loans; D, bank deposits; NW_b, net worth of the banks; NW_p, net claims of the private sector against the government and the banking sector; M, money.

We shall treat the government sector as including the post office (now the National Savings Bank, NSB) and the local authorities as well as the Bank of England and the Treasury. There will be no formal distinction between the Bank of England and the Treasury, though we shall refer to them separately. The monetary base, B, in the first accounting identity refers to all consolidated

[1] The best general guide to the British monetary system today is perhaps C. A. E. Goodhart (1973). See also E.E.C. Monetary Committee (1974), Part three, 'Monetary instruments in the United Kingdom' (which was prepared by the Bank of England); the special collection of articles from the Bank of England *Quarterly Bulletin* 1971–1975 (1975) dealing with Competition and Credit Control; the special March 1973 issue of *The Manchester School*; and Donald Hodgman (1974), ch. 7.

government liabilities except central government bonds and bills, or 'government securities' in this last sense. Therefore the base includes the various forms of national savings, giro accounts, deposits with the NSB, and local authorities' liabilities, as well as bank reserves and currency. From the viewpoint of bank behaviour, any inflow (outflow) of claims into (out of) the banking system against the NSB or the local authorities provokes the same asset expansion (contraction) as an equivalent movement of currency. The previous definition of the monetary base is therefore perfectly tenable, especially since the issue of central bank control, as opposed to wider government control, over the base is basically absent in this work.[1]

Equations (2) and (3) bring into focus the dividing line between banks and the rest of the economy. (Equation (3) may be said to define the net claims of the private sector against the government and banking sectors, and cannot be represented as the financial balance sheet of the private sector, because the equation excludes the foreign assets and liabilities of the private sector.) We shall take two alternative views of this dividing line. According to the first and more conventional one, the banking system includes only the London and Scottish clearing banks, the Northern Irish banks, the discount houses, the merchant banks, the overseas banks, and the officially listed 'other banks' (see the Bank of England, *Statistical Abstract*, 1975, no. 2, pp. 66–7). According to the second, the banking system also includes the finance companies and the building societies. This second view of the banking system obviously leads to broader measures of L, D, B_b, G_b, NW_b, and narrower measures of B_p, G_p and NW_p. Accordingly, the second view implies a broader measure of money in equation (4). Both views of money, in fact, are wider than the official M_3. The narrower one of the two, M_4, equals M_3 plus all national savings deposits and claims on the local authorities. The wider one, M_5, includes the preceding M_4 plus the very large deposits with the building societies and the small deposits with the finance companies (as well as a negative factor for consolidation).

In regard to the demand for money, M_4 is more appropriate than M_3 since the funds invested in national savings and with the local authorities are just as liquid as the term deposits of a certain maturity with the commercial banks. On this ground, however, M_5 is an even better measure than M_4 since the deposits with the building societies are also as liquid as the longer-term deposits with commercial banks.[2] But the Bank of England has never issued lending requests of the same rigour to the building societies as to the commercial banks

[1] Much of the professional literature on the British monetary system, especially in the 1960s, was concerned with the issue of potential central bank control over the monetary base (and thus involved a narrow measure of the base). For a good indication of this general preoccupation, see the collected reprints and bibliographical references in section III ('The Supply of Money') of H. G. Johnson and associates, eds. (1972). Whatever the potential control over the base (however defined) may be, if the base depends on market factors, then treating it as exogenous in econometric work is a mis-specification and may lead to statistical bias.

[2] M_3, M_4 and M_5 all include deposits of the Treasury with the commercial banks. This is objectionable in analysing the demand for money in so far as these deposits reflect an accumulation of tax receipts, but is not so in so far as the deposits reflect assets of the social security system and similar governmental bodies. The latter organisations may manage their money assets much as many private corporations do. Current statistics do not permit separating Treasury deposits into these two parts. We shall therefore follow everyone else in leaving the issue pending.

and has never required special deposits of the building societies and the finance companies. Furthermore, these two sets of financial intermediaries hold a widely different composition of assets from that of the commercial banks. On the latter grounds, the supply of bank loans associated with M_4 may be more stable and more pertinent than the one associated with M_5. It may be advisable then to consider both M_4 and M_5. There are thus four basic forms of the model in the analysis, involving the cross-products of the money measures M_4 and M_5, and the endogenous variables F and P.

Let us proceed next with the system of seven equations in Table 1 which is the basis of the econometric analysis. The first of these equations, (5), concerns the interest rate that the banks fix on their loans. This equation could be alternatively expressed as determining the banks' desired ratio of loans to total assets, $L/(D+NW_b)$. Viewed in this way, the equation would appear as a supply of bank loans. In fact, the easiest way to check the theoretical signs of the arguments in the equation (which we place above the variables) is first to

Table 1

$$i = f\left(\overset{+}{\frac{L}{D+NW_b}}, \overset{+}{i_R}, \overset{+}{r}, \overset{+}{CEIL}, \overset{-}{CCC}\right) \tag{5}$$

supply of bank loans

$$\frac{L}{P} = g(\overset{-}{i}, \overset{+}{i_b}, \overset{+}{i_e}, \overset{+}{i_f}, \overset{+}{\dot{P}_a}, \overset{-}{CEIL}, \overset{+}{CCC}, \overset{+}{Y}) \tag{6}$$

demand for bank loans

$$\frac{D}{M} = h(\overset{+}{i}, \overset{-}{r}, \overset{-}{CEIL}, \overset{+}{CCC}, \overset{\pm}{Y}) \tag{7}$$

deposits-to-money ratio

$$\frac{M}{P} = j(\overset{-}{i_g}, \overset{-}{i_b}, \overset{-}{i_e}, \overset{-}{i_f}, \overset{-}{\dot{P}_a}, \overset{+}{i}, \overset{-}{r}, \overset{-}{CEIL}, \overset{+}{CCC}, \overset{+}{Y}) \tag{8}$$

demand for money

$$\frac{G_p}{M} = k(\overset{+}{i_g}, \overset{-}{i_b}, \overset{-}{i_e}, \overset{-}{i}, \overset{+}{r}, \overset{+}{CEIL}, \overset{-}{CCC}, \overset{\pm}{Y}) \tag{9}$$

portfolio-demand for government securities

$$i_g = l(\overset{+}{i_R}, \overset{+}{i_f}, \overset{+}{\dot{P}_a}) \tag{10}$$

desired interest-rate-spread of the authorities

$$M+NW_b+G_p = PBR+L+F \tag{11}$$

accounting identity of the consolidated government and banking sectors

Additional symbols: CCC, Competition and Credit Control; $CEIL$, direct credit controls; i, interest rate on bank loans; i_b, interest rate on private securities; i_e, yield on equities; i_f, foreign interest rate; i_g, government bond rate; i_R, government bill rate; P, price level; $\dot{P}_a$, anticipated inflation; r, reserve requirement; Y, real income.

analyse it with $L/(D+NW_b)$ as the dependent variable. It then becomes evident, after reverting back to the present form with i on the left, that $L/(D+NW_b)$ theoretically has a positive sign, as do all of the other arguments except Competition and Credit Control, *CCC*. This reform of May 1971 encouraged banks to hold a higher ratio of private debts to total assets, therefore to charge a lower interest rate on loans.[1]

In equation (6), or the demand for bank loans, the variable *CEIL*, reflecting official restrictions on credit expansion, is a proxy for non-price credit rationing. Further, the variable *CCC* appears in the equation because of the possibility that this reform induced a fall in the price of bank loans that the other variables there do not reflect.

The next three equations obtain after eliminating the service yield on bank deposits as an explanatory variable, and are therefore partially reduced forms. We conceive of this service yield as made up essentially of interest, liquidity, and cancelled charges on services provided in executing orders, furnishing records and information, etc. (The work of Benjamin Klein is relevant in this regard.) Evidently we could have included an interest rate on savings deposits as an important component of the service yield. But with i_R and i both present in the analysis in a critical way, and British institutional arrangements being what they are (the correlation between these two rates in the study period is 0·989), we then foresaw an acute problem of multi-collinearity. Therefore we simply postulate a positive influence of i (thus i_R) on the service yield on deposits generally without any attempt to treat the effect of i on the interest rate on deposits separately. We also view the service yield on deposits as a positive function of *CCC* (since the reform increased the competitive pressure on the commercial banks) and a negative function of r and *CEIL*. This is how i, *CCC*, r and *CEIL* then enter into the analysis. This same treatment explains why the former two variables, i and *CCC*, theoretically increase the desired deposit-to-money ratio (equation (7)), raise the demand for money (equation (8)) and lower the private sector's desired portfolio of government securities relative to money (equation (9)), while the latter two variables, r and *CEIL*, do the opposite.[2]

Real income in equation (7) reflects the possibility of different income-elasticities of demand for bank deposits and other forms of money. Because of the other measures of opportunity cost in equation (8), anticipated inflation should be interpreted there strictly as a reflection of the opportunity cost of not

[1] There have been at least three excellent studies of the portfolio selection of particular agents in the British monetary sector: Frank Brechling and George Clayton (1965); Michael Parkin (1970); and W. R. White (1972).

[2] Of course, the relation of i to the service yield on deposits varied during the study period; and in particular, the rate on certificates of deposits rose above i during a time in 1973–4 (thereby making it temporarily profitable to borrow in order to hold CDs). In so far as a general movement of i relative to the service yield on deposits was involved in these movements, this must be reflected in our treatment of the variables *CCC* and *CEIL*; otherwise we do not take account of it. It may also be observed that, contrary to possible impression, the service yield on bank deposits could not be considered as exogenous before May 1971 when the interest rate on deposits with the clearing banks was rigidly tied to Bank Rate. Not only is our concept of this yield too broad to permit such a view, but our analysis concerns the yield on the deposits of the entire banking sector, not only the clearing banks.

consuming. On similar grounds, anticipated inflation has no place in equations (7) and (9), which deal with desired composition of financial assets. No wealth restraint ties together the demand for money, the demand for bank loans, and the private demand for government securities because the demand for net foreign assets of the private sector is absent in the analysis and therefore serves as a residual (the foreign interest rate being explicitly present in these equations, of course, however).[1]

With regard to equation (10), requiring more discussion than the rest, first we must go back one step and explain the use of two prices of government securities: i_g, a bond rate, and i_R, a bill rate. Based on our model, i_R matters to the banks while the bond rate matters to the private sector. The importance of i_R to the banks reflects two aspects of British institutional arrangements: first, the fact that the discount houses guarantee the sale of all new issues of *bills* at the bill rate desired by the Bank of England, and second, the fact that the interest rate that the banks charge on advances and the interest rate that they pay on deposits are both very closely related to Bank Rate, thus bill rate. This last implicit relationship to bill rate may have been greater before *CCC*, but has remained important since. (Bank Rate is obviously not distinguished from bill rate in the model.) On the other hand, the private sector is much more sensitive to the yield on long-term government securities than to bill rate.

We assume, generally, that the government chooses to control both prices of government securities, i_g and i_R (this assumption obviously involving some simplification in the case of i_g). Equation (10) consequently stipulates that the authorities maintain a certain relationship between the two rates, varying the difference between the two on the basis of anticipated inflation ($\dot{P}_a$) and the foreign interest rate (i_f). More specifically, the authorities supposedly let i_g rise relative to i_R as $\dot{P}_a$ and i_f go up. Why would the government behave in this way?

The British banks absorb a lot of national debt at levels of i_R which if also applicable to i_g would induce the private sector to absorb practically no government securities, or would provide no such inducement to the private sector unless there was a general anticipation of a fall in interest rates. This leads the government to keep i_g above i_R in order to reconcile low interest

[1] If we hold income and the demand for goods and services constant, the wealth constraint in the private sector may be written as

$$\Delta[NFA+M+G_p+B+E+(-B-E)-L]_d = 0$$

where $\Delta[\ \ ]_d$ means a 'desired variation', *NFA* is the value of net foreign assets, *B* and *E* relate to private bond and equity assets respectively, and $(-B-E)$ is the sum of private (inclusive or corporate) liabilities to the private sector. $B+E$ and $(-B-E)$ must be shown separately, as above, even though $B-B$ and $E-E$ equal zero since an excess demand (or supply) of *B* and *E* in the private sector is obviously not a violation of Walras' Law. The system thus lends itself to a reasonable reduced-form equation for desired net foreign assets of the form:

$$NFA = m(\overset{+}{i_f}, \overset{-}{i}, \overset{-}{i_b}, \overset{-}{i_e}, \overset{-}{\dot{P}_a}, \overset{+}{Y})P.$$

Without a series for *NFA*, it is impossible to provide an R^2 relating to this value in our work, and our estimates can provide at best – that is, if we make the appropriate auxiliary assumptions – the errors in the implicit estimates of *NFA*.

charges on a portion of the national debt with adequate inducement to ordinary firms and households to hold government securities. The same desire to reconcile these two objectives explains the government's willingness to let i_g rise relative to i_R as anticipated inflation and the foreign interest rate go up. Implicit in this formulation, of course, is some basic concern of the authorities with the monetary base and therefore the quantity of money; for the only possible objection that the authorities could have to low private inducements to hold government securities is that the Bank of England then would be compelled to buy more of these securities, thus raising the base and money.

Accounting identity (11) obtains simply by summing up equations (1) and (2). This identity necessitates measuring government securities at book value instead of market value even though market value is preferable in analysing the demand for government securities, Another drawback of the identity is that the net worth of the banks, NW_b, then becomes essential in the analysis. This second drawback, however, is mitigated by the fact that on either of our two measures of the banking sector (associated with M_4 or M_5), NW_b is dominated by a regular upward trend, except for 1971 when a forward leap in the NW_b series took place, which is, however, reflected in *CCC*.

The following general picture of the model then emerges, which in describing we shall consider at first for the case where P is endogenous. The banks set the interest rate on their loans and the private sector determines the level of these loans at given commodity prices. In the same way, the government sets the prices of government securities, while the private sector determines how large a ratio of these securities to money to hold. Once bank loans and the ratio of private holdings of government securities to money are known, then, based on additional (exogenously given) knowledge of the public borrowing requirement, official reserves, and the net worth of the banks, an accounting identity determines the stock of money. Further, the public's desired ratio of bank deposits to money determines bank deposits. (The accounting identity (2) would also yield $B_b + G_b$ in case this were wished to be known.) The values of bank deposits and bank loans together imply a particular ratio of deposits to loans. This ratio then has a reciprocal effect upon the interest rate that the banks wish to set on loans, which means that the system is not recursive (as it might seem otherwise from this description). To be specific, if L/D is higher than the banks wish, they raise i, thereby discouraging the demand for loans and encouraging the demand for their deposits (mostly via a higher interest rate to their depositors), and inversely. Finally, the demand for money serves to determine the price level, thereby affecting all of the nominal values in the system. The seven endogenous variables corresponding to equations (5) to (11) are then i, L, i_g, G_p, M, D and P. The two central links between public, bank and private behaviour are evidently the interest rate i and the price level. Since these two values are simultaneously determined with the rest, all of the endogenous terms are interdependent.

In the case where P is exogenous but F endogenous, the only basic changes are that the demand for money serves to determine M and the accounting identity (11) to determine F. Since F does not enter in any of the behavioural equations, i is then the only central link between equations.

It may be observed that the supply of money and the supply of bank loans both lend themselves to a statement in terms of the product of a multiplicand ('base') and a multiplier. But the multiplicand ('base') in this case must be properly understood as the sum of the public borrowing requirement and official reserves. Let d equal D/M, g equal G_p/M, l equal L/D and NW_b be zero. Then after some rearrangement of equation (11), we have

$$M = \frac{(PBR+F)M}{M+G_p-L};$$

therefore
$$M = \frac{(PBR+F)}{1+g-ld}$$

and
$$L = \frac{(PBR+F)ld}{1+g-ld}.$$

If we view F as an exogenous variable, this system has a very conventional aspect. An increase in the demand for loans raises both multipliers whereas a rise in i_R and i_g reduces them.[1] The authorities therefore can alter the stock of money at any given *PBR*, that is, independently of fiscal policy. In fact, the higher the negative impact of i_R and i_g on both multipliers, the more independent monetary policy is from fiscal policy, since the monetary impact of a rise in *PBR* then can be more easily offset through increases in i_R and i_g. Even apart from any changes in i_R and i_g, the authorities can exercise monetary restraint through official restrictions on loan expansion, since r and *CEIL* also have a negative effect on both multipliers. (Note that the influence of a rise in r or *CEIL* on the multipliers depends largely on the dampening effect of r or *CEIL* on bank incentives to attract depositors, without which either instrument would act on ld only by lowering l.)

On the other hand, in the event that F is endogenous, as under fixed exchange rates, the system has an unconventional aspect since increases in i_R and i_g then can theoretically raise F enough to offset the fall in the money multiplier, thus raising M. This possibility of a rise in M is explained by the possible increase in the demand for real money balances stemming from the associated rise in the yield on bank deposits. Any rise in desired real money balances when F is endogenous implies a rise in money (since P then is exogenous), hence implies a rise in F which more than offsets the fall in the money multiplier.[2]

[1] Further, a rise in the demand for bank loans raises ld, thus raising the loan-multiplier more than the money-multiplier, and a rise in i_R and i_g lowers ld, thus lowering the loan-multiplier more than the money multiplier. C. A. E. Goodhart (1973), pp. 479–83, 490, questions the necessary negative effect of a rise in bill rate on bank loans and money. He points to the positive impact of bill rate on the yield on bank deposits, which in turn increases D, thus lowers g. However, the rise in the yield on D also accentuates the fall in ld, thereby contributing to the fall in both multipliers. In terms of equation (11) we can see that if $PBR+F$ is fixed, a positive effect of bill rate on M requires a larger reduction in G_p than L. This condition seems too strenuous to hold, especially when we consider that the concomitant rise in i_g mitigates the fall in G_p. Goodhart's point would be more reasonable, of course, in the case of a rise in i_R without any change in i_g. Cf. Brechling and Clayton (1965), pp. 307–14.

[2] A similar rise in bank loans is impossible because the induced rise in i must lower the demand for real loans. Conformably, as footnote 1 above says, the loan-multiplier necessarily falls more than the money-multiplier.

Of course, demand for real money balances need not rise with the rise in i_R and i_g since the increase in i_g tends to lower this demand. But in the British example where the interest rate on deposits is highly sensitive to Bank Rate, the positive effect of the yield on bank deposits on the demand may prevail. Thus, the traditional method of tightening money – raising Bank Rate – may have the opposite effect of raising it.

Viewing matters in real terms but retaining the simplifying assumption of $NW_b = 0$, it makes no difference whether F or P is endogenous since neutrality conditions are satisfied. There is no money illusion; anticipated inflation is independent of the price level; and the ratio of official reserves to the public borrowing requirement has no effect on any real value (basically because the supply of bank loans is independent of this ratio). Hence real money, real loans, privately held real government securities (and interest rates) are the same whether F or P is endogenous; only nominal values are affected. Furthermore, monetary policy (changes in i_R, i_g, r and $CEIL$) can affect real values, but fiscal policy (changes in PBR) cannot.

Stated differently, the system could be viewed as one of seven equations in the seven unknowns i, L/P, D/M, M/P, G_p/M, i_g and $(PBR+F)/P$. It is only by virtue of the treatment of PBR and F or PBR and P as exogenous that we obtain the nominal values in the system.

II. STATISTICAL MEASURES AND THE ESTIMATED FORM OF THE SYSTEM

Virtually all of the financial data necessary to test the model are available on a quarterly basis since 1963 in the Bank of England, *Quarterly Bulletin*, the Bank of England, *Statistical Abstract* (no. 1, 1970; and no. 2, 1975), and the Central Statistical Office (C.S.O.), *Financial Statistics*. Many of the series in these sources are first-differences from one end-of-quarter to the next. But this never produced a difficulty, since we were always able to find an appropriate stock-level at a relevant point in time in order to convert first-differences into stocks. Much to our advantage, the publications of the Bank of England explicitly use the identity $\Delta PBR + \Delta F = \Delta G_p + \Delta(G_b + B_b) + \Delta B_p$ in reporting. Note that $\Delta PBR + \Delta F$ in our treatment corresponds to the 'public borrowing requirement' of the statistical sources. What we term ΔPBR therefore is this 'public borrowing requirement' minus the change in official reserves. In order to derive the stock series for $PBR+F$ we used a report of the outstanding public debt (for one calendar date) found in the March 1973 issue of the Bank of England *Quarterly Bulletin*. Regarding ΔF, we used the column 'total official financing' of the table 'balance of payments' of the *Quarterly Bulletin*. Once we knew $PBR+F$ and ΔF, we encountered no need for a separate stock figure for F for any purpose in the econometric analysis (compare note 1 on p. 888 below).

In regard to commercial bank statistics, we calculated NW_b in exact conformity with equation (2), that is, by finding $L+B_b-D$. Sterling loans to foreigners and sterling deposits held by foreigners are retained in our series for L and D. The passage from M_4 to M_5 was done on the basis of balance-sheet information concerning finance houses and building societies in the C.S.O., *Financial Statistics* (tables 66, 68 and 69 of recent issues).[1] The data for quarterly real income (GDP at factor cost: expenditure side) and the price level (the implicit price of GDP, 1970 = 100) come from the C.S.O., *Economic Trends*.

Our stock series are end-of-quarter, but we used quarterly averages for interest rates. We measured i_R as the rate of discount on allotments for 91-day bills at the weekly tender. To measure i_g, we first experimented with the rate on $2\frac{1}{2}$% consols, but eventually decided in favour of the rate on 5-year government securities.[2] On the critical issue of the measure of i – the marginal cost of bank loans – we needed an interest rate series reflecting variable market conditions for bank loans outside the cartelised clearing banks, especially during the period prior to *CCC*. Our two basic choices were the interest rate of the local authorities on temporary loans and the discount market's buying rate on three-month traded private bills. After wide experiments, we selected the latter. With regard to the private bond rate, i_b, we used the redemption yield on 20-year debenture and loan stocks. Our series for i_e is the ratio of corporate earnings to the price of equities, or the so-called earnings yield on shares. Finally, in the case of i_f, we used the sum of (1) the interest rate on three-month Eurodollar deposits in London, and (2) the three-month forward premium on the dollar in London.[3]

As to the measure of anticipated inflation, we experimented with the Parkin–Sumner–Ward (1976) quarterly time series resting on a sophisticated use of information drawn from questionnaires.[4] (The particular Parkin–Sumner–Ward series that we used concerns the anticipated rate of growth of retail prices.) But this series gave much less satisfaction than a naive distributed-lag of past rates of inflation based on the formula

$$\dot{P}_{a,t} = 0{\cdot}10 \sum_{i=1}^{\infty} (0{\cdot}9)^{i-1} \dot{P}_{t-i}$$

where P is the price of *GDP*. The one-period lag in this formula is useful in permitting a treatment of $\dot{P}_a$ as a predetermined variable in the case where P (therefore $\dot{P}$) is endogenous. In applying this formula, we went back in time with the series for observed inflation until going back any further no longer affected $\dot{P}_a$ during the sample period. This meant going back ten years.

Our measure of r is the ratio of the sum of vault cash and bank deposits at the Bank of England to bank deposits. While automatically incorporating special deposits, this measure has the drawback of also including the ratio of

[1] Specifically, first we added all sterling loans by these two sets of institutions to L and deducted all sterling loan liabilities of these institutions to the listed banks from L; second we added all of the credits of these institutions to the government to G_b and deducted the same value from G_p; third we added all of the deposit liabilities of these institutions to D and subtracted their deposit assets with the listed banks from D; similarly fourth we deducted their deposit assets with the government sector from B_p; and finally we recalculated NW_b based on the same principle as previously.

[2] Our use of the accounting value of G_p may have something to do with the better performance of the 5-year rate than the consol rate, since changes in the 5-year rate induce smaller capital gains and losses, therefore render the accounting measure of G_p more adequate.

[3] Michael Hamburger (1977) makes a case for neglecting the forward premium in analysing the British demand for money.

[4] See also the subsequent work of J. A. Carlson and Parkin (1975).

excess legal reserves. However, this ratio is very small and any effort to eliminate it (never attempted thus far) would have no mentionable effect on the series for r. *CCC* is a dummy variable. As regards *CEIL*, we used the Artis–Meadows (n.d.) index of direct controls on bank lending, which ranks the intensity of controls on a 0–1–2 scale on the basis of the lending requests of the Bank of England.[1]

Our early estimates of the theoretical equations (5) to (9) necessitated several modifications before passing to the final estimation forms. First, a problem of multi-collinearity confronted us because of the multiplicity of interest rates in the analysis. Consequently, we removed i_b and i_e everywhere. We were also unable to distinguish either the negative influence of i_g from the positive influence of i in the demand for money (8), or the negative influence of i from the positive influence of i_g in the portfolio demand for government securities (9). Both variables entered positively in both equations. Theoretical considerations then led us to remove i_g from equation (8) and i from equation (9). We also dropped r everywhere, since this variable underwent no major change during the estimation period except for one important fall coinciding with Competition and Credit Control. Accordingly, r was completely dominated by *CCC* in the analysis. Similarly, we did not retain *CEIL* in the supply equation (5), where it was insignificant. Since *CEIL* is highly significant in the demand for loans (as well as equations (7), (8) and (9)), at least in the case of M_4, there is evidence of credit rationing. Hence, it is not surprising that *CEIL* would not enter significantly on the supply side: if credit controls yield credit rationing, they cannot have much effect on the interest rate i (though the controls then might still exercise an important influence in equations (7), (8) and (9) via the impact they may have on the service yield on deposits). We added seasonal dummy variables in the demand for bank loans and the demand for money (X_1, X_2, X_3 standing for the first, second and third quarter respectively).

With regard to the timing of influences, distributed lags were included everywhere except equations (5) and (10), dealing with the behaviour of the banks and the authorities respectively. Theoretical considerations argue for a long adaptation process in the demand for bank loans. After many trials we selected a 12-quarter Almon lag polynomial of the second degree in this demand equation. As concerns equations (7), (8) and (9), where shorter lags seem appropriate, we experimented with varying lengths and forms of lags, but eventually settled in favour of a simple hypothesis of a four-quarter linear decay in the influence of all the explanatory variables except one: i_g in equation (9).[2] In this last case, we estimated the influence with the same 12-quarter Almon lag as in the demand for bank loans. As a general qualification, however, we uniformly assumed a linearly declining, four-quarter effect of the introduction of *CCC* and an unlagged influence of *CEIL*.

[1] The Artis–Meadows index is not published in the memo (n.d.), but has circulated widely. R. F. G. Alford (1972) has constructed a similar index before.

[2] In his study of the quarterly demand for money in Great Britain, involving strictly M_1, Hamburger (1977) reports good results without any lagged adjustment. Thereby he goes counter to the rest of the literature on this demand, even as regards M_1, where his position is theoretically most persuasive. For references to this literature, see Hamburger (1977) and Graham Hacche (1974).

III. THE ECONOMETRIC ANALYSIS

According to the model, if NW_b is zero, no structural parameter depends upon the choice of P or F as endogenous: only the nominal values are affected. Consequently, the use of a method of estimation involving direct estimation of the structural equations, such as full information maximum likelihood (FIML) as opposed to two-stage least squares (which involves the reduced form), would guarantee that the estimates of the structural equations would be independent of the choice of P or F as endogenous. In this work we use FIML. Consequently, had NW_b been zero in equation (5), our parametric estimates would have been independent of the choice of P or F as endogenous.

In fact, however, the presence of NW_b really makes little difference since NW_b enters only in the ratio $L/(D+NW_b)$ of equation (5). If we express this ratio as

$$\frac{L/D}{1+NW_b/D}$$

we can see that the term NW_b/D in this last expression must depend on the use of P or F as endogenous, since NW_b is the same in both cases, whereas D necessarily depends on the estimate of P if P is endogenous but not otherwise, or if F is so. Yet the subsequent differences in the estimates of $L/(D+NW_b)$ cannot be great in the two cases, as they depend on the differences in the estimates of D, the impact of these differences on NW_b/D and the consequent effect on $L/(D+NW_b)$ (where NW_b/D is only about 15 % of $(D+NW_b)/D$ for M_4 or M_5). In fact, none of the parameter estimates of equation (5) differ by more than 4 % depending on whether P or F serves as endogenous. Further, there are no noticeable changes in the estimates of the structural parameters of any other equation depending on this choice of P or F. Hence, with the possible exception of equation (5), we have only one set of parameter estimates to report for either one of our two measures of money.

If we think in terms of the structural estimates, there is thus little to distinguish our system from a more general one, to which we have already alluded, in which the endogenous term would be considered $(PBR+F)/P$ instead of P or F. As regards the reduced form of the system, however, our interpretation of the model as involving P or F as endogenous has much practical econometric significance. If F is endogenous, the relevant series for P in the reduced-form equations is the observed one, whereas if P is endogenous, this series for P is the fitted one. Thus the estimates, the R^2s, and the standard errors of the estimates of the nominal values of L, D, M and G_p will differ, possibly a lot, with P or F as endogenous. Furthermore, major differences can arise in our post-sample predictions depending on this choice of P or F as endogenous. From a theoretical perspective, it should be added that the basis for interpreting P or F, but not $(PBR+F)/P$, as endogenous is clear.

The FIML estimates with M_4 and M_5 are shown in Tables 2 and 3, where we include the estimates of equation (5) based on F as endogenous. The ones

Table 2*

FIML estimates with M_4 1963–1974 (48 observations)

Equation		R^2	σ
(5)	$i = 3{\cdot}68 + 4{\cdot}53 \ln \dfrac{L}{D+NW_b} + 1{\cdot}05 i_R - 0{\cdot}71 CCC$ (4·43) (3·34) (31·9) (3·01)	0·985	0·17
(6)	$\ln \dfrac{L}{P} = -0{\cdot}08 - 0{\cdot}056 i + 0{\cdot}012 i_f + 0{\cdot}027 \dot{P}_a - 0{\cdot}0188 CEIL + 0{\cdot}185 CCC + 3{\cdot}74 \ln Y + 0{\cdot}03 X_1 + 0{\cdot}037 X_2 + 0{\cdot}011 X_3$ (0·41) (4·03) (2·29) (2·80) (3·46) (7·10) (0·72) (6·21) (8·77) (2·79)	0·999	0·08
(7)	$\ln \dfrac{D}{M} = -2{\cdot}54 + 0{\cdot}005 i - 0{\cdot}014 CEIL + 0{\cdot}052 CCC + 0{\cdot}82 \ln Y$ (30·16) (3·29) (3·66) (5·73) (21·16)	0·999	0·68
(8)	$\ln \dfrac{M}{P} = 2{\cdot}98 - 0{\cdot}022 i_f - 0{\cdot}016 \dot{P}_a + 0{\cdot}029 i - 0{\cdot}0075 CEIL + 0{\cdot}125 CCC + 0{\cdot}152 \ln Y - 0{\cdot}024 X_1 - 0{\cdot}005 X_2 - 0{\cdot}009 X_3$ (32·3) (13·1) (5·66) (17·5) (2·30) (10·4) (3·53) (6·11) (1·35) (2·46)	0·998	0·14
(9)	$\ln \dfrac{G_p}{M} = 2{\cdot}05 + 0{\cdot}051 i_g + 0{\cdot}028 CEIL - 0{\cdot}117 CCC - 1{\cdot}22 \ln Y$ (10·7) (7·75) (2·53) (7·41) (12·4)	0·979	0·34
(10)	$i_g = 1{\cdot}44 + 0{\cdot}60 i_R + 0{\cdot}14 i_f + 0{\cdot}20 \dot{P}_a$ (8·08) (8·60) (3·71) (7·63)	0·974	0·34

Lag weights for equation (6):

	t	−1	−2	−3	−4	−5	−6	−7	−8	9	−10	−11
i	0·0041	0·0013	0·0012	−0·0032	−0·0049	−0·0063	−0·0072	−0·0078	−0·0081	−0·0080	−0·0075	−0·0066
i_f	−0·0003	0·0005	0·0012	0·0016	0·0019	0·0020	0·0020	0·0017	0·0013	0·0008	0	−0·0008
$\dot{P}_a$	−0·008	−0·004	−0·002	0·0007	0·0026	0·0042	0·0053	0·0060	0·0062	0·0060	0·0053	0·0042
$\ln Y$	0·15	0·19	0·22	0·25	0·28	0·31	0·34	0·36	0·38	0·40	0·42	0·43

Lag weights for equation (9):

	t	−1	−2	−3	−4	−5	−6	−7	−8	−9	−10	−11
i_g	0	0·0004	0·0009	0·0014	0·0022	0·0030	0·0040	0·0051	0·0063	0·0076	0·0091	0·0107

Variable		i	L	D	M	G_p	i_g	F
F endogenous	R^2	0·989	0·999	0·997	0·998	0·980	0·974	0·822
	ρ	0·05	0·09	0·56	0·21	0·28	0·34	0·26
	S.E.	0·254	0·01254 (0·162)	0·02079 (0·349)	0·01084 (0·324)	0·0199 (0·349)	0·344	0·59
	$\bar{X}$	8·43	12·88	16·61	28·75	17·41	7·68	

Variable		i	L	D	M	G_p	i_g	P
P endogenous	R^2	0·989	0·996	0·995	0·997	0·996	0·974	0·994
	ρ	0·05	0·28	0·50	0·29	0·43	0·34	0·27
	S.E.	0·250	0·02323 (0·302)	0·02413 (0·406)	0·01347 (0·390)	0·00919 (0·161)	0·344	0·01646

* The R^2 is one minus the sum of the squared residuals divided by the total variance; the ρ is the coefficient of autocorrelation in the residuals; the S.E. is the standard error of the estimate; and the $\bar{X}$ is the average value of the variable during the study period. The $\bar{X}$ values of L, D, M and G_p are stated in billions of pounds. Since equations (6), (7), (8) and (9) are logarithmic, the S.E. values of these four variables are then logarithms of billions of pounds. We also provide the S.E. of these four variables in terms of billions of pounds (around the means) in parentheses. The S.E. of F is in billions of pounds.

Table 3*

FIML estimates with M_5 1963–1974 (48 observations)

Equation		R^2	σ
(5)	$i = \underset{(4.35)}{3.12} + \underset{(3.10)}{4.72} \ln \dfrac{L}{D+NW_b} + \underset{(33.7)}{1.06} i_R - \underset{(2.57)}{0.48} CCC$	0.985	0.19
(6)	$\ln \dfrac{L}{P} = -\underset{(7.22)}{1.13} - \underset{(3.82)}{0.041} i + \underset{(2.64)}{0.011} i_f + \underset{(3.27)}{0.25} \dot{P}_a - \underset{(0.52)}{0.002} CEIL + \underset{(3.51)}{0.07} CCC + \underset{(3.16)}{13.38} \ln Y + \underset{(2.39)}{0.008} X_1 + \underset{(6.64)}{0.023} X_2 + \underset{(1.60)}{0.005} X_3$	0.999	0.27

	t	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11
i	0.0015	−0.0011	−0.0033	−0.0049	−0.0060	−0.0066	−0.0066	−0.0062	−0.0052	−0.0037	−0.0017	0.0009
i_f	0.00027	0.00076	0.0011	0.0014	0.0016	0.0016	0.0015	0.0014	0.0011	0.0007	0.0001	−0.0005
$\dot{P}_a$	−0.004	−0.003	−0.001	0.0002	0.0014	0.0025	0.0034	0.0042	0.0048	0.0053	0.0056	0.0058
$\ln Y$	0.49	0.53	0.76	0.89	1.00	1.11	1.21	1.30	1.39	1.46	1.53	1.59

Equation		R^2	σ
(7)	$\ln \dfrac{D}{M} = -\underset{(33.14)}{2.77} - \underset{(0.72)}{0.001} i - \underset{(1.65)}{0.006} CEIL + \underset{(0.14)}{0.001} CCC + \underset{(26.3)}{1.01} \ln Y$	0.999	0.86
(8)	$\ln \dfrac{M}{P} = \underset{(16.7)}{1.53} - \underset{(11.5)}{0.016} i_f - \underset{(7.60)}{0.017} \dot{P}_a + \underset{(10)}{0.017} i - \underset{(1.85)}{0.0065} CEIL + \underset{(4.49)}{0.092} CCC + \underset{(21.5)}{0.91} \ln Y - \underset{(4.96)}{0.016} X_1 + \underset{(0.15)}{0.0005} X_2 - \underset{(1.66)}{0.005} X_3$	0.998	0.47
(9)	$\ln \dfrac{G_p}{M} = \underset{(17)}{4.01} + \underset{(5.96)}{0.046} i_g + \underset{(3.56)}{0.029} CEIL - \underset{(4.49)}{0.09} CCC - \underset{(18.3)}{2.21} \ln Y$	0.949	0.60

	t	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11
i_g	0.0063	0.0044	0.0029	0.0019	0.0013	0.0011	0.0014	0.0022	0.0034	0.0050	0.0071	0.0096

Equation		R^2	σ
(10)	$i_g = \underset{(8.10)}{1.45} + \underset{(8.61)}{0.60} i_R + \underset{(3.72)}{0.14} i_f + \underset{(7.56)}{0.20} \dot{P}_a$	0.974	0.34

Variable		i	L	D	M	G_p	i_g	F
F endogenous	R^2	0.989	0.999	0.997	0.998	0.980	0.974	0.821
	ρ	0.06	0.28	0.76	0.49	0.39	0.34	0.27
	S.E.	0.259	0.01026 (0.220)	0.02443 (0.643)	0.01295 (0.497)	0.02103 (0.340)	0.344	0.54
	$\bar{X}$	8.43	21.30	26.00	38.13	16.00	7.68	

Variable		i	L	D	M	G_p	i_g	P
P endogenous	R^2	0.989	0.997	0.996	0.995	0.996	0.974	0.994
	ρ	0.06	0.42	0.75	0.55	0.57	0.34	0.28
	S.E.	0.254	0.01727 (0.377)	0.02397 (0.628)	0.01321 (0.507)	0.01566 (0.259)	0.344	0.01506

* See note to table 2.

based on P as endogenous are given by footnote below.[1] As the notation indicates the ratio terms L/P, D/M, G_p/M and $L/(D+NW_b)$ are expressed logarithmically. This enables us to linearise all of the terms except $L/(D+NW_b)$. The accounting identity is also non-linear with respect to the logarithms of M, G_p and L. These two non-linear aspects are then the reason why we resorted to a non-linear method of calculating the FIML estimates. But though this involved an enormous amount of time and trouble, only moderate importance can be attached to it in the end, since the FIML estimates based on a linear approximation to the model are very similar. The computer program used for the FIML estimates of the non-linear model is Clifford Wymer's ASIMUL.

The R^2s and ρs (coefficients of autocorrelation in the residuals) at the bottom of both tables are the basic ones in the analysis, not those at the right of each equation. The latter R^2s and ρs pertain to the individual equation alone, and were constructed on the basis of the FIML estimates of the parameters, but the observed, as opposed to the fitted, values of the explanatory variables (including the observed values of the denominators of the dependent variables on the left in equations (6), (7), (8) and (9)). The fundamental interest of these last R^2s and ρs then lies in the comparison they provide with the essential ones at the bottom of the table.

The parameter estimates in Tables 2 and 3 refer to cumulative influences. Where these estimates involve Almon lags with a second-order polynomial – or in the case of i, i_f, $\dot{P}_a$ and $\ln Y$ in equation (6) and i_g in equation (9) – we provide the time-distributions of the influences. Otherwise, the time profiles of the distributed lags are always the same: 0·40 of the total influence at time t, 0·30 at time $t+1$, 0·20 at $t+2$ and 0·10 at $t+3$ (see earlier discussion, last paragraph of section II). The numbers in parentheses below the coefficients are ratios of the estimates of the coefficients to the estimates of the asymptotic standard errors. They are not Student t's; let us call them 't values'.

The bill rate, i_R, evidently does not completely dominate the econometric analysis in equation (5), as we might have feared. Despite the great significance of i_R in this equation, $L/(D+NW_b)$ and CCC both enter significantly and with the right sign.

In equation (6), or the demand for bank loans, the positive effect of real income is only clear when loans from building societies and finance companies are included, or in the case of M_5. But in this case, the estimate of the income-elasticity of the demand for loans seems much too high. Also, $CEIL$ is important only in the case of M_4, that is, when the narrower measure of bank loans is

[1] They are:

$$(M_4)\ i = \underset{(4\cdot64)}{3\cdot78} + \underset{(3\cdot28)}{4\cdot71} \ln\frac{L}{D+NW_b} + \underset{(32\cdot1)}{1\cdot05 i_R} - \underset{(3\cdot16)}{0\cdot74 CCC}$$
$$R^2 = 0\cdot985 \quad \rho = 0\cdot17$$

$$(M_5)\ i = \underset{(4\cdot49)}{3\cdot21} + \underset{(3\cdot24)}{4\cdot92} \ln\frac{L}{D+NW_b} + \underset{(33\cdot7)}{1\cdot06 i_R} - \underset{(2\cdot66)}{0\cdot50 CCC}$$
$$R^2 = 0\cdot985 \quad \rho = 0\cdot19$$

It is important to see that from an econometric standpoint, the case where F is endogenous is indistinguishable from the one where $PBR+F$ is considered as such. PBR and F enter strictly in the accounting identity and in the same way. Thus, if any theoretical case can be made for treating $PBR+F$ as the adjustment factor instead of F, all of the results with F as endogenous can be applied to $PBR+F$.

involved. This would indicate that the past lending requests of the Bank of England largely shifted lending from the banks toward the building societies, as is plausible since the building societies (though not necessarily the finance companies) have been subject to less stringent lending requests than the commercial banks (Artis and Meadows, n.d.; Alford, 1972). The time-profile of the impact of i and i_f in equation (6) is also quite sensible. However, those of $\ln Y$, and in the case of M_5, $\dot{P}_a$ are not. In the latter instances, the influence continues rising for three years before stopping abruptly. Despite numerous experiments, we were unable to remedy the aforementioned defects of the estimates of this demand equation.

The estimates of equation (7), the desired deposits-to-money ratio, are quite good in the case of M_4, but less so in the case of M_5, where i, *CEIL* and *CCC* are insignificant. We generally find the influences of these last three variables to be smaller in the case of M_5, or when building societies and finance companies are included as banks. It should be observed that the coefficients of autocorrelation in the residuals of the estimates of D are too high.

In the demand-for-money equation (8), the impact of anticipated inflation in Great Britain clearly comes to light, perhaps for the first time. We are generally successful in obtaining significant and opposite-sign coefficients of i_f, $\dot{P}_a$ and i in the demand for money and the demand for loans. Similarly *CEIL* properly discourages both bank borrowing and money-holding, whereas *CCC* encourages both of them.[1] The only basic failure of the econometric analysis in regard to equation (8) is our aforementioned inability to display the negative influence of the interest rate on government securities, i_g.

We encountered special difficulty with the portfolio-demand for government securities. This is evident in our abandonment of all interest rate terms except the own-rate, i_g. The failure to find a negative coefficient of i is particularly regrettable since the variable performs very well in equations (6) and (8), and also in the case of M_4, equation (7). In addition, the time-profile of the estimated influence of i_g in equation (9) is unsatisfactory. This influence steadily rises until the end. The fault may lie in the use of the accounting rather than the market value of G_p. To explain, a rise in i_g reduces the market, not the accounting value, of a government security. Hence, following such a rise, the accounting value of G_p is too high relative to the appropriate value, and this excess in value fades with time as the market price of the security converges toward maturity value. The result is to produce unduly low coefficients at first. This may then largely explain the rising time-profile in our estimates. (The same use of the accounting value of G_p could underlie some of our other difficulties with interest rate variables in this equation.)[2]

[1] On the issue of *CEIL*, note the interesting work on credit rationing of P. D. Spencer (1975) at the British Treasury (of which we have seen only memos thus far). Our estimates of the effect of *CCC* on the demand for money corroborates the general view in Great Britain of a 'shift' in the demand for money in 1971. Our interpretation of the role of *CCC* in explaining this 'shift' also agrees particularly well with the views of the research staff of the Bank of England. See Hacche (1974). In addition, our results are compatible with the view of Michael Artis and M. K. Lewis (1976) that an important element in this 'shift' may be simultaneous-equation bias in single-equation estimates of the demand for money.

[2] Mervyn King has pointed out to us that the failure to take into account the taxation of interest income may be another reason for these difficulties with the interest rate variables.

Equation (10) conforms to our hypotheses about government behaviour.

It may be noted, quite generally, that if P is endogenous instead of F, the R^2 for G_p is notably higher and the R^2s for L, D and M are somewhat lower. With either P or F as endogenous, the model with M_4 also involves substantially less autocorrelation in the residuals than the one with M_5.

Tables 4 and 5 concern the respective reduced forms with F and P as endogenous. In both cases, the tables provide the *cumulative* impacts of changes in the exogenous variables.[1] In Table 4, where F is endogenous, the first numerical column confirms the earlier theoretical possibility that a rise in i_R, while lowering L, would raise M. The estimates of this rise in M might even seem exaggerated by our omission of the restraining, negative effect of i_g on the demand for money. However, this is debatable since the coefficient of i in the demand for money should reflect the combined influence of i and i_g, since multi-collinearity between the two rates is the reason why we removed i_g from the equation in the first place. Accordingly, we would argue that the coefficient of i in the demand for money is already mitigated by the negative effect of i_g. Similarly, we would argue that the restraining effect of the missing variable i in the portfolio-demand for government securities is implicit in the coefficient of the collinear variable i_g. The impact of a rise in i_R in this column in jointly raising M, G_p and implicitly G_b (as the banks reduce their loans in favour of government securities), is made possible by the inflow of official reserves.

The next two columns show the impact of respective percentage-point rises in i_f and $\dot{P}_a$. The results conform generally to expectations: deposits, money and official reserves fall, but the private sector borrows more from the British banks. Of course, both of these columns are strongly conditioned by the assumption that the authorities keep i_R the same. This last assumption is especially important in explaining the moderation of the rise in i and i_g.

It is not surprising to find in the next column that a 1 % rise in real income has much greater impact on M and L in the case of M_5 than M_4, as the coefficients of $\ln Y$ in the demand for loans and the demand for money are much larger in the case of M_5 than M_4. What is surprising, however, is the negative impact of $\ln Y$ on official reserves. The literature on the monetary approach has conditioned us to expect the opposite, positive sign. But it must be remembered that in this particular application of the monetary approach, the authorities follow an interest-rate objective. Therefore the positive influence of Y_p on the demand for loans bears repercussions on the domestic source component of the supply of money (or $PBR+L-G_p-NW_b$). As this demand for loans rises, the banks expand their loans at the expense of government securities. The private sector similarly tries to sell government securities ($\ln Y$ reducing G_p/M enough to offset the rise in G_p which is associated with the increase in the demand for money). The excess supply of government securities thus resulting is necessarily purchased by the authorities in order to prevent i_R and i_g from rising, which

[1] In order to construct these tables, we first calculated by hand the cumulative-impact (or steady state) coefficients of the reduced form as algebraic functions of the parameters, doing so by linearising the system. Wymer's computer program then did the rest, furnishing the numerical values of the coefficients and the t values. (The program supplies t values for any functions of the parameters.)

Table 4

The cumulative-impact coefficients of the two reduced forms with F endogenous

	Change of one percentage-point						Change of 1 %							
Exogenous	i_R		i_f		$\dot{P}_a$		Y		P		CCC		$CEIL$	
Endogenous	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5
i	0·75	0·83	0·11	0·10	0·14	0·16	0·09	0·43	—	—	−0·48	−0·46	0·01	0·04
	(9·0)	(10·5)	(4·4)	(3·7)	(3·6)	(3·4)	(0·5)	(2·4)			(3·5)	(3·0)	(0·4)	(1·6)
L	−4·1 %	−3·4 %	0·59 %	0·68 %	1·9 %	1·9 %	3·2 %	11·5 %	1 %	1 %	21·2 %	9·3 %	−1·9 %	−0·40 %
	(4·0)	(4·1)	(1·6)	(2·2)	(2·6)	(3·1)	(0·8)	(3·3)			(9·7)	(5·1)	(3·9)	(0·9)
D	2·5 %	1·3 %	−1·8 %	−1·4 %	−1·1 %	−1·4 %	1·27 %	2·6 %	1 %	1 %	16·0 %	8·6 %	−2·1 %	−1·2 %
	(7·7)	(4·8)	(10·6)	(10·2)	(3·8)	(6·1)	(2·2)	(8·5)			(9·3)	(4·8)	(3·9)	(1·9)
M	2·2 %	1·4 %	−1·9 %	−1·4 %	−1·1 %	−1·4 %	0·4 %	1·6 %	1 %	1 %	11·1 %	8·4 %	−0·7 %	−0·60 %
	(8·2)	(7·0)	(11·3)	(10·2)	(4·1)	(6·2)	(0·8)	(5·3)			(8·9)	(7·2)	(2·4)	(1·8)
i_g	0·60	0·60	0·14	0·14	0·20	0·20	—	—	—	—	—	—	—	—
	(8·6)	(8·6)	(3·7)	(3·7)	(7·6)	(7·6)								
G_p	5·2 %	4·2 %	−1·1 %	−0·73 %	−0·13 %	−0·48 %	−0·8 %	−0·58 %	1 %	1 %	−0·6 %	−0·5 %	2·1 %	2·3 %
	(8·9)	(7·1)	(4·1)	(3·0)	(0·4)	(1·5)	(1·6)	(1·8)			(0·3)	(0·3)	(3·3)	(3·4)
F*	2·1	1·93	−0·81	−0·79	−0·60	−1·02	−0·44	−1·92	0·345	0·345	0·35	1·15	0·41	0·23
	(9·4)	(8·8)	(9·0)	(8·5)	(4·5)	(6·6)	(1·3)	(3·0)			(0·6)	(2·0)	(2·5)	(1·7)

* The numbers in this row are in billions of pounds.

Table 5

The cumulative-impact coefficients of the two reduced forms with P endogenous

Exogenous	Change of one percentage-point						Change of 1 %							
	i_R		i_f		$\dot{P}_a$		Y		$PBR+F$		CCC		$CEIL$	
Endogenous	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5	M_4	M_5
i	0·75 (9·0)	0·83 (10·5)	0·11 (4·4)	0·10 (3·7)	0·14 (3·6)	0·16 (3·4)	0·09 (0·5)	0·43 (2·4)	—	—	−0·48 (3·5)	−0·46 (3·0)	0·01 (0·4)	0·04 (1·6)
L	−10·19 % (6·6)	−9·0 % (6·7)	2·94 % (5·7)	2·97 % (6·0)	3·64 % (4·0)	4·86 % (5·3)	4·48 % (0·8)	17·07 % (3·1)	1 %	1 %	20·18 % (6·6)	5·96 % (1·9)	−3·09 % (4·2)	−1·07 % (1·8)
D	−3·59 % (6·8)	−4·3 % (7·3)	0·55 % (3·3)	0·89 % (4·4)	0·64 % (2·4)	1·56 % (4·3)	2·55 % (1·7)	8·17 % (3·9)	1 %	1 %	14·98 % (7·9)	5·26 % (2·5)	−3·29 % (4·6)	−1·87 % (2·6)
M	−3·89 % (7·7)	−4·2 % (7·5)	0·45 % (3·1)	0·89 % (4·5)	0·64 % (2·3)	1·56 % (4·4)	1·68 % (1·2)	7·17 % (3·4)	1 %	1 %	10·08 % (8·1)	5·06 % (3·4)	−1·89 % (4·7)	−1·27 % (3·0)
i_g	0·60 (8·6)	0·60 (8·6)	0·14 (3·7)	0·14 (3·7)	0·20 (7·6)	0·20 (7·6)	—	—	—	—	—	—	—	—
G_p	0·89 % (2·0)	1·4 % (7·5)	1·25 % (7·3)	1·56 % (7·5)	1·61 % (6·3)	2·38 % (6·9)	0·48 % (0·3)	4·99 % (2·4)	1 %	1 %	−1·62 % (1·7)	−3·84 % (2·7)	0·91 % (3·3)	1·63 % (3·5)
P	−6·09 % (9·4)	−5·6 % (8·8)	2·35 % (9·0)	2·29 % (8·5)	1·74 % (4·5)	2·96 % (6·6)	1·28 % (1·3)	5·57 % (3·0)	1 %	1 %	−1·02 % (0·6)	−3·34 % (2·0)	−1·19 % (2·5)	−0·67 % (1·7)

in turn leads to an increase in the domestic source component of the money supply (of the exact value of the rise in $L-G_p$). The outcome is a fall in F, since the increase in this last source component is even larger than the rise in the demand for money. It may be seen that ultimately the fall in F can be traced mainly to the much higher coefficient of $\ln Y$ in the demand for loans than the demand for money. Since the estimate of the income-elasticity of the demand for loans may be considered excessive, there is therefore a doubt about the negative impact of Y on F. Also no weight at all should be attached to the sizeably higher estimate of the fall in F in the case of M_5 than M_4. Whereas exogenous disturbances can have different quantitative effects on L, D, M and G_p depending on the measure of money, since different measures of these variables are involved, the effects on i, i_g, F and P theoretically must be independent of the money measure.

The P column derives from the neutrality conditions. The next column, relating to *CCC*, confirms the general impression that this once-and-for-all reform had colossal effects, both on the domestic source component of the supply of M_4 and on the demand for M_4. Similarly, the reform had much smaller but nevertheless substantial effects on both the domestic source component of supply and the demand for M_5. These effects on supply and demand are nearly matching in both cases, and therefore the influence on official reserves is ambiguous, though tending to be positive. If anything, then, the reform was deflationary. The numbers in the *CEIL* column may seem quite arbitrary at first, but are really fairly meaningful, since the passage from zero to unity on the Artis–Meadows scale is equivalent to the use of a dummy variable to describe an event. The main arbitrary element in the scale is probably the assumption that the credit restraint involved in passing from zero to one is equivalent to the one involved in passing from one to two. Thus we may reasonably conclude from this column that credit controls are a much weaker instrument than bill rate. In so far as such controls play a role (that is, particularly in the case of M_4), they have the advantage over the bill rate of limiting loans and raising official reserves without *encouraging money* in the case of a fixed exchange system (when F is endogenous).

The coefficients in Table 5 are derivable from those in the previous table. The effects on i and i_g in both tables are necessarily almost identical because of the near-neutrality conditions. The key to the other coefficients in Table 5 lies in the last value in the P column of Table 4. This value says that an exogenous rise in $PBR+F$ of 0·345 billion pounds would lead all nominal values to rise by 1 %. If so, at a given level of commodity prices and official reserves, any excess demand for real money balances that can be resolved by raising F by one billion pounds can equally be resolved by lowering P by (1000/345) % or 2·9 %. Multiplying the coefficients of the F row of Table 4 by $-2{\cdot}9$ then yields the corresponding coefficients of the P row of Table 5. Once we know this P row, the L, D, M and G_p rows follow because L/P, D/P, M/P and G_p/P in both tables are the same. The only genuinely new information in Table 5 therefore concerns the t values.

Note the occasional differences in signs regarding the same nominal variables

Table 6

Predictions 1975.1–1976.4

		74·4	75·1	75·2	75·3	75·4	76·1	76·2	76·3	76·4	APE*
i	M_4–F		12·12	11·52	12·41	12·78	10·60	12·50	13·38	16·11	8·78
	M_4–P		12·13	11·50	12·37	12·71	10·58	12·45	13·33	16·03	8·42
	M_5–F		12·04	11·67	12·84	13·43	11·21	13·24	14·07	16·85	13·10
	M_5–P		12·05	11·68	12·84	13·42	11·24	13·26	14·08	16·84	13·20
	Observed	12·96	12·417	10·75	11·125	11·75	9·958	11·50	11·792	14·417	
L	M_4–F		29·99	30·11	29·17	28·81	29·20	30·94	33·22	35·62	3·31
	M_4–P		30·51	29·05	27·30	26·31	28·67	29·22	30·85	31·88	3·28
	Observed	28·94	29·21	29·36	28·62	28·49	29·01	30·38	31·25	32·57	
	M_5–F		47·98	50·55	51·06	52·56	53·95	58·27	61·50	65·37	10·74
	M_5–P		49·16	51·21	52·09	53·68	59·98	63·50	65·83	68·03	16·48
	Observed	45·30	46·10	46·88	46·91	47·62	48·97	51·36	53·78	55·45	
D	M_4–F		34·16	35·30	35·84	37·41	36·38	39·02	41·18	43·95	6·06
	M_4–P		34·74	34·09	33·55	34·16	35·70	36·82	38·21	39·25	2·42
	Observed	33·90	32·96	34·13	35·07	35·52	35·40	36·25	37·68	38·42	
	M_5–F		54·27	55·87	55·76	57·63	57·46	61·19	64·07	67·63	2·10
	M_5–P		55·59	56·71	57·17	59·15	64·33	67·22	69·20	71·02	6·41
	Observed	52·02	52·41	54·63	56·44	57·86	59·30	61·11	63·29	64·42	
M	M_4–F		50·30	52·62	54·06	56·43	54·65	58·56	61·50	63·63	6·47
	M_4–P		51·16	50·81	50·55	51·52	53·62	55·26	57·05	58·62	1·98
	Observed	50·21	49·39	50·83	51·87	52·84	52·69	54·06	56·20	57·60	
	M_5–F		70·60	73·41	74·29	76·94	76·02	81·05	84·78	89·39	2·91
	M_5–P		72·31	74·52	76·17	79·04	85·20	89·12	91·56	93·88	8·42
	Observed	68·33	68·84	71·33	73·23	75·17	76·59	78·93	81·81	83·61	
i_g	M_4–F		11·78	11·83	12·72	13·27	11·71	12·93	13·55	15·52	8·13
	M_4–P		11·78	11·83	12·72	13·27	11·71	12·93	13·55	15·52	8·13
	M_5–F		11·76	11·81	12·70	13·25	11·68	12·91	13·57	15·51	7·96
	M_5–P		11·76	11·81	12·70	13·25	11·68	12·91	13·57	15·51	7·96
	Observed	12·88	11·08	11·37	12·00	12·13	10·44	11·47	12·35	14·87	
G_p	M_4–F		26·55	29·25	31·22	33·45	32·95	36·53	38·75	42·31	4·15
	M_4–P		27·00	28·22	29·22	30·57	32·36	34·47	35·98	37·79	2·95
	Observed	24·98	27·48	28·49	29·27	31·43	33·64	36·83	37·25	39·51	
	M_5–F		23·22	25·31	26·84	28·47	27·99	30·88	32·72	35·62	3·29
	M_5–P		23·78	25·71	27·55	29·31	31·41	34·02	35·41	37·49	6·58
	Observed	21·99	24·19	24·56	25·30	27·17	28·99	32·06	32·58	35·16	
F	M_4–F		−2·10	−0·004	1·52	2·88	−2·039	−1·415	−1·052	−1·73	
	M_5–F		−2·45	−2·74	−3·58	−4·28	−9·59	−10·98	−15·03	−9·70	
	Observed	−0·96	−1·28	−1·85	−2·07	−2·42	−3·10	−5·05	−5·92	−6·05	
P	M_4–P		1·818	1·850	1·895	1·929	2·088	2·079	2·115	2·083	5·90
	M_5–P		1·831	1·946	2·073	2·166	2·380	2·421	2·457	2·447	5·50
	Observed	1·654	1·788	1·912	2·023	2·109	2·125	2·202	2·277	2·330	

in Tables 4 and 5, as for example with respect to the influence of i_R, i_f and $\dot{P}_a$ on D and M. These opposite signs, of course, highlight the importance of the exchange rate regime, Table 4 relating to fixed rates and Table 5 to flexible rates. The estimates therefore show, in accordance with theory, that the two basic monetary instruments, i_R and *CEIL*, have a much stronger quantitative impact on deposits and money under flexible rates, and that i_f and $\dot{P}_a$ have a much stronger effect on deposits and money under fixed rates. A change in real income alters nominal variables much more under flexible than under fixed rates.

Table 6 bears on the predictive accuracy of the model in 1975–6, or during the eight quarters immediately following the sample period.[1] It provides us our single most important means of choosing between the model with F or P as endogenous. Post-sample simulations were performed with M_4 and M_5 and either one of these two as endogenous.[2] We find that the model always overshoots i and i_g. In fact, in the case of M_5 with P as endogenous, the model overshoots every endogenous variable. On the other hand, with M_5 and F as endogenous, or M_4 and either F or P as endogenous, the predictive accuracy of the model is reasonable. Indeed, the average percentage errors in predicting D, M and G_p are within 2 to 3·3 % in the case of the combinations M_4–P and M_5–F. Thus the predictive tests do not permit a clear choice between P or F as endogenous. These tests do, however, reinforce the previous conclusion (largely based on the coefficients of autocorrelation in the residuals in Tables 2 and 3) that the model performs better with M_4 than M_5. The M_4 model clearly predicts L and i better than the M_5 one, most likely because of the excessive income-elasticity of the demand for loans (13·38) in the case of M_5 (3·74 in the case of M_4).

Finally, with the use of either M_4 or M_5 and P or F as endogenous – or in all cases – the model is not particularly effective in predicting F or P, the two variables to which we pay least attention in the theoretical analysis. As a matter of practical judgment, in looking for improvements we would be prone to analyse official reserves and the price level simultaneously. We would be similarly prone to refine the reaction function of the authorities. These two modifications go hand in hand.

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[1] Because non-linear estimation is involved, Wymer's computer program does not supply confidence intervals for the predictions, nor the ingredients that would permit us to calculate them ourselves.

[2] The predictive tests required us to extend the Artis–Meadow index of *CEIL* to 1975 and 1976. We set the values of the index for the eight quarters in these two years as 1–0–0–0 0–0–0–1, basing ourselves on the abolition of supplementary special deposits from end-February 1975 to mid-November 1976.

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