File FEA/0000000509, Part D – Monetary Base Control

Original reference FEA\C\650\1440\02 D

PART 3

20/8/1981 – 22/10/1984

Pages 37-55

1 Mandatory monetary base control

Under mandatory monetary base control, the banks are obliged to observe a minimum reserve ratio against either all, or some subset, of their deposits. The authorities use open market operations to affect the reserve base of the system, and thereby hope to influence the total of deposits against which the reserve requirement is levied (1).

The following conclusions may be drawn from the debate as regards mandatory monetary base control. First a mandatory reserve requirement amounts in some degree to a tax on banking. This applies even if a market rate of interest is paid on required reserve holdings, since, as already noted, sub-market rates must be paid on excess reserve holdings. The requirement therefore offers an incentive to the banks to disintermediate their business. Whilst it is possible, as it was with the corset, for the authorities to prevent some forms of disintermediation, since the removal of exchange controls in October 1979 there has been no means by which the authorities can permanently prevent a shift of wholesale banking business from London to the euro-sterling centres.

The second conclusion is that, even if the problem of disintermediation could be ignored, it would be imprudent to use mandatory monetary base control with reserve requirements levied against a set of deposits as wide as the set included in sterling M3. The reason is that as already mentioned the effects of interest-rate changes on sterling M3 are slow and uncertain. This remark applies as well to aggregates broader than sterling M3. If monetary base control works by means of induced changes in interest rates, then it is likely that the applicatio of base control to sterling M3 or a broader aggregate would result in frequent upward or downward spirals in interest rates. The induced changes in the monetary aggregate or the demand for reserves would be weak because, as already mentioned, these aggregates are not very responsive to interest rate movements in the short run. If the second mechanism mentioned above - the effect of monetary base control on the behaviour of the banks - could be relied upon to ensure that the growth of the broad target aggregate was held in line with the pre-announced growth of the monetary base without interest-rate instability, then no problem need arise. However, this mechanism has not been tested and it would be dangerous to rely on it alone to

(1) The position is obviously more complicated in systems like those in operation in the USA and in Germany, in which different percentage reserve requirements are levied against deposits of different kinds.

secure the success of a new system of monetary control. In practice, the result of the attempt to use base control on a broad aggregate would almost certainly be greater volatility of interest rates probably combined with some cosmetic disintermediation of banking business.

Nevertheless these two points do not rule out mandatory monetary base control. They do indicate, though, that the technique should be used only on an aggregate which is interest-sensitive, and which represents deposits created by banking business which is unlikely to be disintermediated in a purely cosmetic fashion. As already explained, sterling M3 and broader aggregates are not suitable for mandatory monetary base control; and neither is M1, since a substantia proportion of M1 consists of wholesale interest-bearing sight deposits which could be cosmetically disintermediated without great difficulty. The idea of using non-interest-bearing M1 as an object for mandatory monetary base control was rejected because of the uncertainty and unpredictability of the speed with which the practice of paying interest on demand deposits will spread. Indeed, if mandatory base control related to non-interest-bearing M1 were introduced, the banks might choose to offer interest payments on sight deposits in order to avoid the tax implicit in the minimum reserve requirement.

Partly because neither M1 nor non-interest-bearing M1 provide a clear and satisfactory measure of transactions deposits, the authorities have asked the banks to start supplying statistics of "retail deposits which, when added to the public's currency holdings, will comprise a new aggregate to be known as M2 (1)(2). It is hoped that the figures will provide some idea of the size of retail transactions balances, and that there will prove to be a stable relationship between the M2 aggregate on the one hand, and nominal incomes and the level of interest rates on the other. The definition of retail deposits is to be as follows:

---

(1) This is not the same as the M2 series which was introduced in 1970 (see the article "The stock of money", in the Bank of England Quarterly Bulletin, September 1970, pp 320-326). Publication of this series ended in December 1971. A large percentage of buildi society shares and deposits are similar in nature to retail deposi held with banks, and it may well prove to be the case that a bette relationship with incomes and interest rates will be obtained by adding these building society liabilities to M2 rather than by looking at M2 alone.

(2) The new M2 series represents the first attempt in the UK to construct a monetary aggregate according to an economic rather tha an institutional concept.

(a) all non-interest bearing sight deposits;

(b) all other chequable accounts up to £100,000;

(c) all accounts up to £100,000 from which standing orders, direct debit mandates or other regular payments may be made;

(d) all accounts of up to £100,000 with a residual maturity of 14 days or less;

(e) accounts up to £100,000 that can be withdrawn in cash, or used automatically or on the holder's instruction to make frequent transfers of funds to an account covered by (a), (b), (c) or (d) above without significant penalty. Loss of interest for 14 days or less would not normally be considered significant. Accounts are included only if three or more withdrawals or transfer per month are permitted, legally or by common practice, but inclusion should not depend on the number of withdrawals or transfers actually made.

Apart from the considerable intrinsic interest of these statistics, collecting them will enable the authorities to learn something about the effectiveness of a possible mandatory monetary base control scheme aimed at control of M2, by investigating the stability of the demand function for M2, and estimating the size of the interest elasticity of demand for M2. If the interest-elasticity were to prove to be very small, then there would be a danger that monetary base control applied to retail deposits would cause violent fluctuations in interest rates, whilst a very large elasticity would imply that other assets were such close substitutes for M2 that control of M2 alone was pointless.

2 Non-mandatory monetary base control

In non-mandatory systems of monetary base control, such as that in use in Switzerland, the banks are left free to hold non-interest-bearing reserves in whatever amount they think appropriate. Again the authorities use open market operations to keep the reserve base of the system on or close to some desired path. They may regard control of the base as sufficient by itself to secure control of the rate of inflation (as in Switzerland); or, alternatively, they may regard control of the base as a means of controlling broader monetary aggregates, M1, M2 or M3, control of which is necessary and/or sufficie for adequate control of the rate of inflation. The difference between these two approaches is that in the latter case, but not the former, the target for the growth of the monetary base would presumably be altered if the broader aggregates were to grow at a rate significantly different from that which had previously been expected.

It is reasonable to suppose that, if the banks had a stable non-zero demand for reserves which depended on the size of some part of their balance sheets and on the level of interest rates (ie the marginal opportunity cost of holding reserves), then in a non-mandatory system control of the monetary base would achieve control of bank deposits and control of this broad aggregate would in turn be a necessary condition for control of the price level. The issue of non-mandatory monetary base control therefore hangs on the nature of the banks' demand for reserves.

In fact, there is no basis for knowledge of what reserves banks in the UK would want to hold if left free to choose (1). Under the previous arrangements, the London clearing banks were required to hold 1 1/2% of their eligible liabilities in the form of non-interest-bearing deposits at the Bank of England. However, this was an <u>average</u> requirement - shortfalls were permitted provided they were made up later. The behaviour of the banks under the previous arrangements gave no guide to how they might behave under non-mandatory monetary base control, under which shortfalls (ie borrowing on overdraft from the central bank) would be heavily penalised. Banks' behaviour under the arrangements recently instituted may give some clues as to how they would behave under non-mandatory monetary base control.

Of course the example of Switzerland, where non-mandatory monetary base control has been employed by the authorities, is available. However, there are reasons for suspecting that the differences in institutional structure between the financial systems of Switzerland and the UK may mean that banks in the UK would behave differently from Swiss banks under non-mandatory monetary base control, although of course in the absence of any direct experience it is not possible to be certain how banks in the UK would behave.

The reasons for this suspicion are as follows. Banks hold reserves as an insurance against illiquidity. In the UK, where the government banks with the Bank of England and accounts for by far the larger part of the Bank of England's business, it is broadly true to say that the commercial banks as a group lose cash on days when the government has

---

(1) They were free in the inter-war period, and on make-up days maintained a ratio between reserves (including till money) and deposits of about 10%. However, the large banks reported on different days of the week, and the figures were subject to heavy window-dressing. In any case, conditions have changed so much since then that it would be unreasonable to draw any conclusions for current policy from the inter-war period.

a surplus and gain cash on days when it has a deficit. These daily surpluses and deficits frequently exceed the amount of clearing bank balances held at the Bank of England. The object of official operatic in the money markets is to buy or sell bills or to lend money in amount sufficient to provide just that amount of reserves which enables the banks to achieve their target balances at the end of the day. If these operations could be conducted with perfect accuracy, the sum of bankers' balances at the end of each day would be on target.

Of course this is not the same thing as ensuring that each bank individually is able to achieve its target balance. It might be expected that, if non-mandatory monetary base control were introduced, banks would want to hold reserves against the risk of illiquidity even in conditions where they knew that enough reserves would be available for the system as a whole. In other words, bank A would hold reserves not as insurance against a "system drain" of cash affecting bank A along with other banks, but as insurance against a drain of cash from bank A matched by an inflow of cash to the other banks.

However, it is impossible to be sure that banks in the UK would behave in this way under non-mandatory monetary base control. The tradition of large-scale inter-bank borrowing and lending is well established in London - there is a very active inter-bank deposit market - and it is entirely possible that instead of holding non-interest-bearing reserves as insurance against illiquidity, clearing banks would instead rely on their ability to borrow when they had a deficit in the clearing from the other clearing banks which had the corresponding surplus, secure in the knowledge that a "system drain" would be prevented by official operations. Alternatively, the clearing banks might settle debts among themselves in, eg, Treasury bills. In other words, the banks might not hold reserves in significant or stably-determined amounts under non-mandatory monetary base control, and official control of the monetary base might, consequently, not imply control of any aggregate of bank deposits.

In practice it is not possible for the authorities precisely to offset government surpluses and deficits through their open market operations, because uncertainty about the balance between the government's disbursements over the whole day and its revenues over the whole day persists right up to the end of each day. Nevertheless if the banks were willing to rely on settlement of debts among themselves by some

means not involving their balances at the Bank of England, the amount of those balances that they choose to hold would be determined by the likely size of "system drains" - ie by the likely size of official errors in forecasting government surpluses and deficits. It is clear that the likely size of these errors need bear no necessary relationship either to broader monetary aggregates or to nominal incomes; they are more likely to be related to the unpredictable variability of the government's daily surplus or deficit. This would be true even if the authorities abandoned altogether their objective of preventing "system drains".

The preceding few paragraphs have highlighted one area of uncertainty about the demand for monetary base under a non-mandatory system of monetary base control. The other principal uncertainty relates to the interest elasticity of demand for monetary base. As already mentioned, the price signal that a squeeze on the monetary base induces is a rise in interest rate. If the demand for base were interest inelastic, then there would be danger that monetary base control would entail large fluctuations in interest rates.

IV The changes in the monetary system

Folling the debate on monetary base control, the authorities concluded for the reasons indicated in the previous section that they did not know enough about the monetary system to be able to make a judgment about what the costs and benefits of monetary base control would be. Accordingly, the changes that have been made in the monetary system have been designed in such a way that the operation of the system after the changes have been made will provide more information about how monetary base control might work. The changes do not amount to the adoption of monetary base control, nor do they imply that monetary base control will be adopted. However, they are consistent with the future adoption of monetary base control; and quite apart from the question of monetary base control, they are considered desirable in their own right.

One change has already been mentioned - that the banks are being asked to provide figures of retail deposits, in order to establish whether retail deposits would be a suitable denominator for a system of mandatory monetary base control. The nature of the cash-holding requirement placed on banks has been altered. In the past the requirement was on the London clearing banks alone, to maintain an

average level of 1 1/2% of their eligible liabilities in the form of bankers' balances at the Bank of England. The requirement has now been extended to all banks, and it is that banks should hold 1/2% of their eligible liabilities in the form of a non-operational, frozen, non-interest-bearing balance at the Bank of England. In addition to that the banks may hold in separate accounts whatever operational non-interest-bearing balances they wish. The purpose of the non-operational balances is purely to provide an income for the Bank of England (which does not profit from the note issue); it has no monetary control function. The behaviour of the operational balances should provide information about the banks' voluntary demand for reserves, which will be of obvious use in assessing the merits of non-mandatory monetary base control.

Important changes have been made in the Bank's technique of operating in the money markets. The object of the changes has been to secure a greater market influence on the determination of interest rates other than at the very short end, and to a more limited extent on the level of very short-term rates. The nature of the changes is as follows. The Bank's dealings in the money market now overwhelmingly take the form of open-market operations, that is purchases and sales of bills (Treasury bills, eligible commercial bills, and local authority bills), rather than direct lending to the discount houses. Moreover, rather than, as in the past, declaring rates at which it was prepared to buy bills, the Bank has adopted the practice of inviting offers of bills, and of basing the decision as to which offers to accept partly at least on the estimated shortage of cash in the system. Thirdly, the authorities' objective of deliberately creating a shortage of funds in the money market every week, in order to be able to have a greater influence on interest rates, has been abandoned. These changes mean that the interest rates at which the Bank supplies cash to the market, or withdraws cash from the market, are no longer directly administered by the Bank.

It is a necessary concomitant of these changes that the Bank should abandon the practice of continuously posting a discount rate. The Bank's Minimum Lending Rate (MLR) has therefore been suspended - although the Bank has retained the option, for use in exceptional circumstances, to announce a minimum lending rate to be maintained for

a finite unspecified period. However, official interest rate objectives have not been abandoned. The authorities now aim to ensure that very short-term interest rates are kept within a band of finite range, the position and width of which is unpublished. There is no objective for longer-term rates, however. The balance between official and market influence on the level of interest rates is capable of being varied under the new system; the aim at the outset has been to maintain a significant official influence, but there is scope for evolution towards a greater element of market determination of interest rates. It is hoped that changes in the band, being unannounced, will not normally be important political events in the same way as changes in MLR, and this should do something to reduce the "bias for delay" in interest rate changes. Moreover, there should be some induced effects on bank behaviour. Banks will no longer be able to use MLR as a guideline for their own interest rates. This may lead to more flexible pricing of overdrafts, which might help to eliminate round-tripping; and, more important, it may mean that the effects of official operations in the money markets are more quickly communicated to the economy at large. Finally, it is possible, although not certain, that heightened uncertainty about official lending rates will make the banks more cautious in their own lending operations.

Another change is the aboliton of the required reserve asset ratio. As already noted, any squeeze, whether deliberately engineered by the authorities or not, on the reserve asset base resulted in liability management by the banks and the opening up of opportunities for round-tripping.

The Bank is, as has already been described, to concentrate its open-market operations in the bill market rather than on direct lending to the discount houses. An alternative and at first sight more natural medium for official operations might be the inter-bank deposit market. The Bank could simply place or take deposits in whatever amounts were considered appropriate. This option was considered but was rejected, for reasons connected with the structure of the UK banking system. There is a small number of large clearing banks which have extensive branch networks and which account for a very large percentage of retail deposits. These few banks generally have surplus funds to lend in the inter-bank market, whilst the very many other banks are normally obliged to borrow in the inter-bank

market to fund their lending. The authorities are concerned that if they were to conduct their open-market operations in the inter-bank market in these conditions, the process of interest rate determination would not be that of a free market, but that it would be subject to undue influence from the small number of clearing banks which normally constitute the lending side of the market.

For this reason, the Bank is anxious to continue operating in the bill market through the discount houses. The problem is to ensure that the bill market remains large enough to accommodate official operations. The membership of the group of banks whose acceptances are eligible for rediscount at the Bank has been widened, and those banks which are members of the group have undertaken to hold on average a certain percentage of their eligible liabilities in the form of deposits with the discount houses,(1) subject to a fixed minimum percentage, in order to enable the houses to continue to make a market in bills. This requirement is a kind of insurance policy designed to ensure that the bill market survives. If in the light of experience it becomes clear that the bill market can survive without the requirement or with a lighter requirement, then this aspect of the new arrangements will be modified.

V What next?

Recent discussions of monetary control in the UK have been remarkable for the number of unanswered questions they have thrown up. Some of the unanswered questions about monetary base control may be answered by experience of operating the monetary system following the changes described in Section IV. However, there is a fundamental question relating to money supply control which is largely unrelated to the new arrangements for official operations in the money markets. This relates to the choice of target aggregate.

Section I of this paper described the considerations involved in choosing a suitable target aggregate; and events since monetary targetting was adopted five years ago in the UK have not demonstrated convincingly that a narrow aggregate would have been better as a target aggregate than a broad one.

---

(1) And money brokers and gilt-edged jobbers.

However, the difficulties of controlling an aggregate as broad as sterling M3, by whatever means, are formidable. There is strong evidence that the banks in the UK are efficient and competitive in relation to other financial institutions and that they are anxious and able to increase their share of the market in the provision of financial services, and indeed to increase the size of that market. In the field of lending to the personal sector, banks have gained share at the expense of other financial intermediaries over the last few years; and banks have had a near monopoly of corporate lending during the current recession (though it is true that the monopoly may be coming to an end). Moreover, the address by the Chairman of Barclays to the 1981 Annual General Meeting contains the following revealing passage:

> "What then does the future hold in store for the clearing bankers? I believe we must be prepared to think of ourselves as universal providers of finance, at least in this country. With an extensive and expensive network of branches, we must make sure that we are able to offer every form of finance for all our citizens and this will certainly include a mortgage. Even more important than the provision of finance, is the ability to compete effectively for savings and we must make sure that we find means of marketing new schemes as they arise."

This extension of the scope of the activities of the banks is bound to involve a larger increase in sterling M3 than would otherwise have occurred. In this light, it is difficult to know what should be the attitude of the authorities to the aggression, enterprise, and competitiveness of the banks. Two alternative, and diametrically opposed attitudes are possible, as follows.

1 The accumulation of financial liabilities by banks is not inherently more inflationary than the accumulation of similar liabilities by non-bank financial institutions. The enterprise of the banks is a national asset and it would be entirely wrong to try to stifle it in the name of monetary control. Monetary control should not be synonymous with containing the size of the banking system; it should consist either (a) of controlling a narrow aggregate, or (b) of controlling a price (eg, exchange rate or real interest rates, or else (c) of controlling an aggregate encompassing the liabilities not only of the banks, but of other institutions as well. The last of these options might, however, still cramp the banks' style somewhat, and is therefore the least desirable.

2 Research has shown that sterling M3 is as good an indicator of future inflation as any other monetary aggregate. The over-riding priority for economic policy is to reduce the rate of inflation, and this entails limiting the deposit-creating activities of the banks. It may be true that this involved stifling enterprise, but that is just too bad.

The choice is an unpleasant and difficult one, but it is one that will have to be made before a durable system of monetary control can be established.

APPENDIX 1 DEMAND FOR M1 EQUATIONS by J M Trundle

This appendix describes first the method of choosing an equation for forecasting M1 used in this paper, and the theory which lies behind it. Secondly, it reports the estimated equations used to derive the forecasts in table 2 of this paper. The results quoted here are part of unfinished research currently being undertaken in the Bank of England.

A Method

The method involves first estimating a general form of the equation which represents the maintained hypothesis. Plausible restrictions are then placed upon this equation and tested against the maintained hypothesis. Imposing successive acceptable restrictions leads to an equation involving fewer explanatory variables and thus leaving more degrees of freedom for estimation without losing any significant information from the excluded independent variables(1).

In the case of estimating a demand function for M1, the general form includes current and lagged values of real output (or expenditure), prices and interest rates. The regressor is nominal M1.

The theory underlying this specification is that holdings of notes and coin and of sight deposits (ie of M1(2)) are demand-determined. Banks do not refuse sight deposits nor do they alter the cost of their money transmission services in response to changes in the volume of deposits at all quickly. The banks respond to changes in the level of deposits placed with them by varying interest rates in the wholesale money markets (eg in the CD market). The banks' liabilities

---

(1) This procedure is discussed in great detail for the consumption function in a paper by Davidson, Hendry, Srba and Yeo (Economic Journal, December 1978). See also Hendry and Mizon (Economic Journal, September 1978), who specifically consider demand for money functions.

(2) Until recently an overwhelming proportion of M1 was non-interest-bearing (nib). More recently, however, interest-bearing sight deposits have been growing fast and they are included in the M1 aggregate. They accounted for 16% of the total at mid-July 1981. It is difficult to estimate a demand for nib M1 equation over a long data period because statistics for nib M1 are available only from May 1975. [Not only does the interest-bearing component introduce the simultaneous equation bias problem into the model but it may also conflict with the theory. M1 is intended to be a measure of transaction balances but interest-bearing balances are probably also held for speculative purposes.]

in these markets are not included in M1 and so this avoids a simultaneity problem. Furthermore, the authorities have not tried to control the economy through a target for M1 (officially nor unofficially). All these considerations suggest that the stock of nominal M1 is determined by the non-banks' demand for it. This demand is assumed to depend on the level of real output (as a proxy for transactions), prices and interest rates (which represent the opportunity cost of holding money).

Including the price terms on the right-hand side of the equation rather than estimating the equation in real terms is justified as follows. As argued above, nominal M1 is thought to be endogenous in the UK - it is not targeted either by the authorities or by the banks. While long-run price homogeneity is a highly plausible property of the demand function, there is no reason to assume that individuals alter their nominal M1 balances instantaneously in response to a change in prices in order to achieve a real balances target. A change in prices may well have a lagged effect on nominal money holdings. It is, of course, possible to impose the feature of long-run price homogeneity without imposing instantaneous adjustment. The imposition of long-run homogeneity, however, is itself a restriction - albeit a plausible one. These two restrictions may be tested in turn [see Section (C) below].

Economic theory suggests that long-run price homogeneity should apply and therefore it can be argued that other possibilities should not be allowed. This restriction has been tested in the work undertaken in the Bank of England, however, because it is felt that errors in the choice of the price index[1] may make the restriction inappropriate. While a theoretical model should include this property, a particular equation estimated over a particular dataset and subsequently used for forecasting should not necessarily have homogeneity imposed. In fact, the equations used to make the forecasts in table 2 of the main text do have price homogeneity but not instantaneous adjustment. This restriction is appropriate here but has not always been so, when different datasets have been used.

---

(1) Or possibly multicollinearity between changes in transactions costs and in the price level. The demand for M1 (considered as a proxy for transactions balances) is normally estimated under the assumption that transaction costs are constant.

The Bank's last published article on demand for money was in 1978[1]. In that article it was argued that there was some evidence that a stable demand for M1 could be identified using appropriate techniques. The preferred equations in the article were subjected to some stability testing and appeared to perform better than previous equations. These preferred equations were unusual in not having the homogeneity assumption imposed[2] and in their use of flexible rational lags [3] rather than of imposed lag structures.

Since publication of that article, however, the equations have not forecast well, although it is not clear why. Work has continued on the subject using more recent data but without identifying a stable function[4]. This failure to identify a stable demand function for transaction balances could have been caused by one or more of three problems. First, it may have been caused by identification problems (ie 'supply side' influences in the demand function) such as the implicit payment of interest on non-interest-bearing balances in the form of reduced bank charges or the explicit payment of interest on some M1 balances.[5] Secondly, M1 may not be the appropriate measure of transaction balances; other liquid assets such as building society deposits may also fill this role. Thirdly, the demand for transaction balances may not be stable. This may reflect changes in the institutional structure such as the increased use of credit cards.

---

(1) R T Coghlan "A transactions demand for money" (Bank of England Quarterly Bulletin, March 1978).

(2) Not only was the restriction tested, but it was rejected over that particular dataset.

(3) An earlier attempt to use different lags on the independent variables was made by L D D Price (BEQB, March 1972) but he was unable to obtain satisfactory results for M1 with the limited data then available.

(4) Even Coghlan's equations displayed coefficient instability when estimated over several data periods - especially when the constant was included. Inclusion of the constant also worsened the forecasting performance of his equations.

(5) This would only cause problems in identifying the demand function if the response of the independent variable to changes in the dependent variable (M1) occurred within the period of observation (a quarter). If, however, the independent variable (in this case interest rates) effectively is predetermined for each observation then this identification problem would not occur.

A further complication is that some of the Bank's research is done using seasonally adjusted (sa) data and some using unadjusted. Earlier work by the Bank using sa data has been criticised on the grounds that adjusted series will have certain frequencies attenuated or enhanced relative to the original series with the effect depending on the values of the parameters in the seasonal filter(1).

Official seasonal adjustment procedures, however, do more than just filter out fixed seasonal patterns. They take account of other known factors such as changes in the timing of tax payments and public holidays and allow the seasonal pattern to vary. In addition, when the equations are used to make (ex ante) forecasts only sa values of the independent variables are usually available. This is because forecasts of independent variables usually come from models which are wholly in seasonally adjusted terms. Thus some estimation and all forecasting in the Bank is still done in sa terms(2).

It is also suggested sometimes that demand for money equations should be estimated in per capita terms. This has not been recent practice in the Bank. It is thought that less than two-thirds of M1 is held by persons (as opposed to businesses) and so deflating total money balances by population or the number of households seems somewhat arbitrary. In addition, UK population growth is slow especially compared with the growth of other variables in the equation.

Another possibility - of disaggregating the equations by type of holder - is limited by lack of data. Data giving the split of sight deposits between sectors (eg between companies and persons) are only available since 1975. The division of notes and coin holdings between sectors is not known.

The particular equations reported in this Appendix have been estimated in log-linear form with the exception that interest rates are measured

---

(1) Hendry and Mizon (op cit) pointed out that using different seasonal filters can create serial correlation and dynamic specification problems which lead to inconsistent and inefficient estimates. Some attempt to test for such problems has been made by regressing money on leads as well as lags of the independent variables but this did not produce any significant coefficients on the lead variables.

(2) In fact the choice of equation has not been markedly different whichever type of data have been used.

linearly. Thus an x percentage point change in interest rates leads to a γ x per cent change in M1 where γ, which is assumed to be constant, is the long-run "semi-elasticity"(1) of money with respect to interest rates.

B Results

An appropriate specification of the M1 equation was obtained from the general form using the method outlined in Section A with quarterly(2) data from 1963 to 1980 inclusive. Table 1 below shows the general form of the equation and various stages in the removal of insignificant variables.

The chosen equation(3) is of the form:-

$$(10)\quad m_t = \alpha_1 x_{t-1} + \alpha_3 x_{t-3} + \beta_1 p_{t-1} + \beta_2 p_{t-2} + \gamma_0 R_t + \delta_1 m_{t-1} + \delta_2 m_{t-2}$$

---

(1) This may be written as a model of the form $M = kX^{\alpha}P^{\beta}e^{\gamma R}$, which corresponds to $m = C + \alpha x + \beta p + \gamma R$ where capital letters represent levels and lower case letters represent natural logarithms. [Each variable also has a (different) lag structure.] The "semi-elasticity" is calculated as the sum of coefficients on the interest rate terms divided by one minus the sum of the coefficient of the lagged dependent variables. The true elasticity varies with the level of interest rates and may be calculated by multiplying the semi-elasticity by the level of interest rates at which the true elasticity is to be measured.

(2) Demand for M1 equations have been estimated using both quarterly and monthly data. Only results using both quarterly data are reported in this paper.

(3) The precise definition of the variables is as follows:-

M = M1 smoothed for breaks in series caused by changes in reporting arrangements
X = TFE (Total final expenditure) at constant market prices
P = TFE deflator (1975=1)
R = Local authorities three-month deposit rate

Lower case letters signify natural logarithms.

In fact equation 10 is used with the long-run price homogeneity restriction imposed ie. $\beta_1 + \beta_2 = 1-\delta_1-\delta_2$. The test for this restriction is shown in section C below.[2] The restriction makes very little difference to the estimates of the coefficients.

where m = ln (M1)
x = ln (real expenditure)
p = ln (prices)
R = short-run interest rates

This is referred to as the "best equation" and it is assumed that it is our best estimate of the underlying structural equation - despite the fact that its properties are not fully satisfactory [see below].

It is then assumed that the subset of explanatory variables comprising this best equation was known in each of the forecast periods and the equation is estimated up to the start of each period. Thus the coefficients of equation 10 change but the specification does not. The coefficients used to make each forecast are shown in Table 2 below.

The forecasts are all out of sample dynamic forecasts. They are dynamic in the sense that lags of the estimated value of the dependent variable rather than of the actual value are used on the right-hand side. As these forecasts are made ex-post it is possible to use actual values of the independent variables on the right-hand side - rather than expected values. Thus this exercise tests the forecasting ability of the M1 equation itself rather than the Bank's ability to forecast M1 which would also depend upon its ability to predict the independent variables.

The coefficients show some instability, but are similar to those reported in Coghlan's article (op cit, Table B). The instability is most marked in the long-run semi-elasticity of interest rates when the constant is excluded. If the constant is included it is insignificant but leads to the long-run output elasticity being rather high (at about 1.5). These elasticities are particularly sensitive to changes in the coefficients on the lagged dependent variables since the sum of these coefficients is not very much less than unity. This has three main effects. First, the long-run properties of the equation become quite variable. Secondly, the major part of the effect of a change in an independent variable takes a long time to work through to the dependent variable[1]. Thirdly, as a result forecasts of M1 over a few quarters are not very sensitive to different

(1) Coghlan's preferred equation only contained the first lag of the dependent variable. Using the approach adopted here, however, higher lags cannot be excluded.

assumptions about the paths of the independent variables. The system tends to be 'driven' by the lagged dependent variables making this approach akin to time series modelling.

The stages in choosing the form of the equations which were used to make the forecasts in table 2 of the main text are shown in table 1. The first eight equations are estimated using unadjusted data. The long-run elasticity on real output (X) is very high in the first seven equations as shown in table 1(b). When the constant is removed however, the elasticity falls to the more plausible level of unity. Very similar results are obtained when seasonally adjusted data are used - see equations 9 and 10. This result may occur because of collinearity between the output terms and the constant. Suppressing the (insignificant) constant certainly improves the long-run properties of the equation.(1)

Equation 10 does not have price homogeneity imposed. When this restriction is added, however, the equation becomes equation 10a and is referred to in the text as the 'best equation'. Equation 10a is used to produce the forecasts reproduced in the text. The coefficients and properties of equation 10a estimated over each of several data periods are shown in table 2(a). The forecasts reported in the main text are made on the assumption that the residual in the last period of estimation is likely to persist for the forthcoming year. That is, the forecast rate of growth using fitted values of M1 in the best equation is taken rather than taking the forecast level of M1 and calculating the implied rate of growth over the actual level. This method produces a lower standard deviation for forecasts of M1 over the sample period 1976-1981. Forecasts using both assumptions about the residuals and the preferred equation with (ie equation 10a) and without (ie equation 10) the price homogeneity assumption, are shown in table 2(b). All four sets of results are quite similar, but the price homogeneity restriction improves forecasting performance somewhat. Including a constant worsens the performance.

---

(1) Excluding a constant from a log-linear equation constrains the scale variable to unity. It seems, however, to make little difference to the forecasting performance.

The table below shows how long it takes for half[1] and three-quarters of the total effect of a change in an independent variable to come through to M1 (using equation 10a).

Number of quarters for part effect on M1

	half-effect (median lag)	75% effect	long-run elasticity
X (real output)	1 1/2	8	1.02
P (prices)	1	9	1.00 (imposed)
R (short interest rate)	7	15	-6.6 (semi-elasticit

The effect of interest rates is particularly slow. A one point change in interest rates will lead to a 3.3% change in M1 after 7 quarters and to a little less than 5 % after 15 quarters. (The reported semi-elasticity represents a point elasticity of -0.66 when interest rates are at 10%.)

The effect of interest rates on M1 is much more marked than on notes and coin (see Appendix 2). This important difference in the demand equations suggests that sight deposits display most of the interest-sensitivity. It may then be inappropriate to aggregate notes and coin and sight deposits into M1 for estimation purposes.

Work has been undertaken to estimate demand for sight deposit equations but as yet without producing helpful results. Errors in the notes and coin equation tend to be inversely correlated with those in sight deposit equations which gives some justification for aggregation. There are pronounced fluctuations in the notes and coin series representing day of week, day of month, holiday effects and so on and these are reflected in the sight deposit series. Work is continuing in this area using data which have been "prior-adjusted"[2] for these known seasonal influences on the series.

---

(1) This is the median lag. Although there are changes of sign in the coefficients, the cumulative response does not cross the half or three-quarters line more than once. The size and timing of these effects are particularly sensitive to the estimates of the coefficients on the lagged dependent variables.

(2) For a fuller explanation of the basis of these series see "season adjustment of monthly money statistics" (BEQB, June 1978). Similar procedures are applied to quarterly data.