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THE STABILITY OF MONEY DEMAND FUNCTIONS: AN ALTERNATIVE APPROACH

by
Palle S. Andersen

BANK FOR INTERNATIONAL SETTLEMENTS
Monetary and Economic Department
BASLE

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THE STABILITY OF MONEY DEMAND FUNCTIONS: AN ALTERNATIVE APPROACH[1]

"No proposition in macroeconomics has received more attention than that there exists, at the level of the aggregate economy, a stable demand for money function."

Laidler, D. (1982), p. 39

Introduction

Few economists would disagree with this view, especially following the adoption by several central banks of aggregate targets for the control and implementation of monetary policy. However, despite intensive analytical and empirical efforts, there is no general consensus concerning the stability (or instability) of money demand functions.[2] This casts some doubt on one of the fundamental assumptions of monetary targeting, viz. the existence of a stable and

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[2] In a recent review of the literature, Judd and Scadding (1982b) concluded that the major shifts in US money demand could be related to financial innovations. However, when testing money demand functions for the seven major countries, OECD (1984) found that most shifts had been associated with the adoption of aggregate money supply targets.

predictable relationship between money supply and aggregate nominal income.[3]

Sometimes instability is illustrated by unexpected changes in the income velocity of money. More frequently, however, the stability problem is analysed in terms of the money demand function, i.e. the relationship between money stocks and a few key macroeconomic variables such as aggregate income and interest rates. In order to clarify conceptual differences and to provide a framework for the topics to be discussed in this paper, it may be useful to distinguish between three sources of instability:

(i) firstly, the income velocity of money will change in response to fluctuations in interest rates as well as to movements in other arguments of the money demand function which are not related to income. Moreover, velocity changes may be observed because of lags in the adjustment of money demand to income. Usually, however, such changes are both predictable and transitory and they can be interpreted as movements along an otherwise stable money demand function with constant lag structures;[4]

(ii) secondly, the money demand function itself may shift, reflecting either unstable parameters or new developments and involving unexpected velocity changes as well. For instance, the process of financial innovation and deregulation may at times accelerate, possibly affecting both the interest elasticity of different monetary aggregates and the balances held at each level of interest rates.[5] Another source of instability may be shifts in the

[3] On the other hand, before drawing firm conclusions, it is also important to recall Hendry's observation that "instability in an estimated *econometric* equation provides little evidence about the stability or otherwise of the sought-after *economic* relationship". See Hendry (1979), p. 217.

[4] It is more difficult to classify velocity changes caused by shifts in the composition of either aggregate demand (see Tatom (1983)) or monetary aggregates (see Wenninger (1984b)), as these are unpredictable, though usually only transitory.

[5] In other words, financial innovation may induce a shift as well as a change in the slope of the money demand function (for illustration see Johnston (1984)), though the size and even the direction of these changes are difficult to predict (see Simpson (1984) and Wenninger (1984a)).

precautionary demand for money, related to changes in confidence, and ongoing institutional changes can create "ratchet" effects so that both current and earlier peak levels of interest rates and aggregate income affect money demand;

(iii) thirdly, since changes in money stocks are induced by movements in money demand as well as by factors on the supply side, the money stocks observed at a given point in time might be "off" the money demand function, unless the speed of adjustment is very high. In other words, over shorter periods the money stocks actually held may not correspond to the money balances desired. Such discrepancies will, of course, induce large and unexpected changes in velocity and can also give the impression that the money demand function has become unstable.

This paper focuses on the analytical and empirical problems related to disequilibrium in money markets and deals only superficially with the many issues that could be discussed under (ii). A distinction is made between a conventional approach which estimates the behaviour of money stocks as if they were *demand-determined*, and an alternative – or disequilibrium – approach which regards short-term changes in money balances as being determined on the *supply* side.[6] This exogeneity may be explained either by direct actions on the part of monetary authorities or by disturbances in credit markets and in net foreign assets of the banking system.

It should be stressed from the outset that in focusing in this paper on the supply of money it is not intended to question the existence of a long-run money demand function as a basis for monetary policy. In fact, one of the purposes of the empirical section is to derive the

[6] In making this distinction we have relied on the definition proposed by Coats (1982), p. 225, that

> "for the purpose of estimating the demand for money, the nominal money stock is exogenous if its changes are dominated by factors other than its own demand".

As will be discussed in Part I, the so-called "buffer stock" or "shock absorber" notion occupies an intermediate position, as money stock changes are interpreted as arising on the supply side but are included among the determinants of money demand.

parameters of the long-run money demand function and to evaluate these in the light of a priori expectations and alternative empirical estimates. The paper does, however, question the notion of a short-run money demand function and proposes an alternative dynamic adjustment path in situations where money markets are not in equilibrium. A whole range of transmission channels could be considered in this respect[7] but only that of interest rate adjustments is being explored.[8] Nonetheless, for several countries this is sufficient to mitigate some shortcomings of the conventional approach, especially the long adjustment lags.

At the same time, since it is not possible to draw a sharp distinction between demand and supply-induced changes in money balances the approach adopted in this paper will also be subject to estimation biases and identification problems.[9] These issues were recognised at an early stage of empirical monetary economics and were usually analysed on the assumption that money markets clear.[10] More recently, empirical techniques have been devised to estimate behavioural parameters in non-clearing markets, using various methods for identifying periods of excess demand and supply respectively. Given the emphasis on analysing the effects of money-market disequilibrium, it would have been natural to apply some of these new techniques. However, like the earlier debate on the

[7] Some of these transmission channels would involve a *direct* impact of money stocks on real variables, similar to the Pigou effect. However, unlike the latter, the impact would be transitory rather than permanent (see Knoester (1984b)).

[8] Again a clarification is called for, as the paper should not be read as a new theory concerning the determination of interest rates. Indeed, as the empirical discussion will show, the interest rate equations obtained are not always satisfactory.

[9] It is also subject to the criticism that by treating the conventional equations only superficially, the conclusions are biased in favour of the alternative approach. In particular, the analysis of the monetary aggregates derived from Divisia indices has for several countries captured disturbances which in this paper are ascribed to the supply side.

[10] In this respect Poloz (1980) presents an interesting analysis of the sensitivity of biases to the policy targets pursued while Heri (1984) identifies changes in policy régimes using vector autoregression analysis.

identification of money demand and supply functions, the choice of a rigorous and satisfactory estimation procedure could only have been made within a complete model of the financial system, which would be beyond the scope of the present paper.[11]

It should also be noted from the outset that, even though powerful arguments can be found in favour of the notion of buffer stocks and monetary disequilibrium (especially in Laidler (1984), Knoester (1984a and b) and Jonson (1976a and b)), there are also strong doubts with respect to the theoretical and empirical relevance of this concept. Kaldor (1980) and White (1981) point out that since money is the most liquid and adjustable asset, a disequilibrium in money markets is unlikely. Moreover, given the easy access to credit facilities, most economic agents would react to real and financial shocks by adjusting their net rather than their gross financial assets.[12] Finally, even though some promising empirical results have been obtained in recent years, doubts also remain in this area, particularly with respect to the robustness and stability of the parameters obtained.

Part I below discusses the main features of traditional money demand equations and of the alternative approaches which pay more attention to supply-side developments. Part II first reviews other studies which have applied the disequilibrium approach either in a complete model or in single equations. It then presents comparable estimates of money demand and interest rate equations for the seven major countries. Part III summarises the empirical results obtained, derives policy implications and considers areas of future work.

[11] In addition, the empirical analysis of non-clearing markets is still in its infancy and, so far, the more recent techniques have mainly been applied to credit, labour and goods markets. Artus (1984) presents a rigorous analysis along these lines of credit demand and supply in France as well as a review of earlier results obtained for Canada, Japan and the United States.

[12] Goodhart (1984) points out that this may be particularly important in the company sector, although the evidence for the United Kingdom suggests that the offsets are less than complete.

Annex I is a more technical presentation of the specifications used for the estimations and Annex II discusses alternative lag structures. Annex III gives the data sources and definitions and Annex IV is a selective list of references.

I
Demand for money functions: conventional and alternative approaches

In their recent review of the literature on money demand functions, Judd and Scadding (op cit.) require such functions to contain relatively few arguments, which, moreover, should represent significant links to the real sector.

These criteria have also been adopted in this paper as money demand is specified as being mainly dependent on real income, interest rates and the rate of inflation. These arguments represent currently accepted theories of money demand and they are likely to appear in most long-run money demand functions. The crucial question is, however, the nature of the short-run relationship between money balances and the aforementioned arguments. In this respect two approaches are distinguished: a conventional approach where money stocks are adjusting to changes in the arguments and an alternative approach which inverts traditional money demand functions and lets the arguments adjust to changes in money supply.[13]

[13] This difference between a conventional approach and that pursued in this paper may also be illustrated by recalling Goodhart's law whereby the choice of a particular monetary aggregate as a target variable by the authorities causes the demand function for this aggregate to become unstable or to break down. According to the approach proposed here it would no longer be appropriate to analyse this aggregate as if it were demand-determined. Instead, deviations between money supply and demand are removed by adjustments in both the financial and the real sectors of the economy and it is by analysing these transmission channels that the parameters of the long-run money demand function can be found.

A. Conventional approach

This assumes that money stocks are demand-determined and that changes take place along the demand curve for money. It is recognised that because of adjustment costs money stocks do not immediately adjust to changes in the arguments of the money demand function and this is modelled by a partial adjustment scheme. Thereby, a distinction is introduced between the short and the long-run demand for money, but an essential feature is that money *supply* is assumed to accommodate all changes in the *demand* for money.

If, for the sake of simplicity, the rate of inflation is disregarded, the conventional approach may be presented as suggested in Goldfeld (1973):

(i) $m^*_t = a + by_t - ci_t$ where
y = real income (permanent or actual)
i = one or more representative interest rates (in nominal terms)
m^* = desired real stock of money

(ii) $m_t - m_{t-1} = d\,(m^*_t - m_{t-1})$ where
m = actual stock of money (in real terms)
d = partial adjustment coefficient[14]

Combining (i) and (ii) gives:

(iii) $m_t - m_{t-1} = da + dby_t - dci_t - dm_{t-1}$ or
$m_t = da + dby_t - dci_t + (1-d)m_{t-1}$

This is relatively easy to estimate (usually with the variables measured in logs) and for most countries it gives an acceptable overall fit. However, there are certain shortcomings which cast

[14] The partial adjustment coefficient indicates the share of the desired adjustment which is completed in one period and the average or mean lag can be measured by $(1-d)/d$. The median lag (i.e. the time it takes to complete 50 per cent. of the adjustment) is calculated as $\log 0.5/\log (1-d)$ and is considerably smaller than the mean when d is close to 0. The partial adjustment mechanism has been widely criticised and alternative adjustment schemes and lag structures are discussed in Annex II.

doubt on the appropriateness of using such functions in setting aggregate targets:

– when estimated money demand equations are used in forecasting, the prediction errors are very large for some periods;

– when conventional equations are estimated over different subperiods the parameters sometimes undergo very large changes, suggesting parameter instability or structural shifts;

– the estimated coefficient with respect to the lagged money stock is often close to unity, implying very long adjustment lags.

B. Alternative approaches

Because of these shortcomings a large number of alternative specifications and approaches have been tested. It would, however, go far beyond the scope of this paper to review all these studies and the validity of the empirical estimates. Instead, we shall focus on a subset of the alternatives which attaches an important rôle to supply-side developments and within this subset we shall – at the risk of introducing some confusion – distinguish between two approaches: the "buffer stock" or "shock absorber" function of money and the notion of "monetary disequilibrium".[15, 16]

[15] In the literature these terms have often been used interchangeably or the same term has illustrated different phenomena. The distinction suggested above is not intended to designate separate motives for holding money, nor to describe separate effects of money supply changes. It is merely used to characterise two different methods of modelling the effects of a discrepancy between money supply and demand. Moreover, these methods should be seen as complementing each other, as the buffer stock function focuses on the part of the discrepancy which is temporarily included as money demand, whereas the disequilibrium approach looks at the effects of the remaining part as it is being unloaded from money holdings.

[16] Despite some similarities, neither the buffer stock nor the disequilibrium notion should be identified with Barro's (1980) distinction between anticipated and unanticipated changes in money supply (see also Goodhart (1984)). In the first place, Barro's equation for anticipated money growth is very different from conventional

(a) Buffer stock or shock absorber function

In addition to the empirical problems mentioned above, the conventional approach has the disadvantage that it is unsuitable for analysing supply-induced changes in the money stock. Indeed, the basic assumption of a demand-determined money stock combined with the partial adjustment scheme implies short-run overshooting of income and interest rates in the face of money supply shocks.[17] Moreover, several arguments can be advanced for allowing both demand and supply-induced changes in money stocks:

(i) the notion of a demand-determined money stock is difficult to reconcile with aggregate targets. If the monetary authorities have the power to influence money supply and do not accommodate all changes in demand, then the assumed adjustment path involves money demand adjusting to money supply and not the other way around;[18]

long-run money demand functions. Secondly, unanticipated money growth in Barro's model mainly affects real output and employment, whereas anticipated money growth has only nominal effects. Thirdly, in line with the underlying rational expectations hypothesis, prices are always at their market clearing levels. Although Jonson and Clements (1979) have attempted to reconcile the notion of disequilibrium money with that of unanticipated changes in money supply and have also found a technical solution to the problem, the two approaches appear to be derived from fundamentally different underlying hypotheses. In the following, the notion of unanticipated money growth will, therefore, be largely ignored.

[17] Tucker (1966) is a useful reference in this respect, but the issue has also been discussed in numerous other studies. Essentially, the overshooting occurs when the money market is assumed to clear and money stocks are set exogenously. Technically this can be shown by rewriting equation (iii), setting either real income or the interest rate on the left-hand side. This same relationship can also be used to illustrate the risk of instrument stability (see Radecki (1982 and 1984)).

[18] For some countries the announced aggregate targets may serve mainly as a "signal" of the intentions of the monetary authorities while money stocks are regarded as demand-determined and interest rates are used as the main "cutting edge" of monetary policy. In this case, it would also seem most appropriate to have interest rates as the dependent variable and interpret the corresponding equation as a reaction function. However, as is discussed on pages 16 and 17, this raises certain estimation problems.

(ii) even in a relatively closed economy where the central bank is accommodating and dampens fluctuations in interest rates, short-run money stock changes may reflect developments in credits rather than changes in money demand.[19] This argument deserves special attention in periods of large and rising public-sector demands for credit;

(iii) the case against seeing money stock developments as mainly demand-determined is probably strongest for small and open economies. For such countries it would be more appropriate to view short-run money developments as a residual in the identity linking money supply to domestic credit expansion and changes in foreign reserves;

(iv) for Canada, the United Kingdom and the United States (and possibly other countries as well) signs of parameter instability in conventional money demand functions have been particularly pronounced in periods of major institutional changes, including financial innovations and deregulation. The bulk of these changes have probably originated on the demand side but supply-side developments may also have contributed to the observed instability.

An essential feature of several studies modelling the buffer stock function is the use of a proxy for uncertainty as an additional argument in conventional money demand equations. The justification for this procedure rests on the assumption that money stocks not only serve as a buffer against real shocks (as recognised in the precautionary motive) but can also absorb discrepancies between desired and actual money balances. In the literature four measures have been used as proxies and in all cases the coefficients were found to be positive (i.e. a money supply shock had a positive effect on money demand) and to provide a considerable improvement on conventional estimates:

[19] See Brunner and Meltzer's (1976) distinction between credit-market and money-market hypotheses. In this context it may also be noted that some of the largest residuals in the money demand equations were found in periods of unusual changes in credits; for instance, the United States in 1980 and the United Kingdom in 1972–73 and again in 1980–81.

– unanticipated changes in money supply growth used by Carr and Darby (1981) to explain the US money demand;[20]

– the variance of unanticipated money supply growth, used by Mascaro and Meltzer (1983) to explain money demand as well as interest rates in the United States;[21]

– changes in bank lending, used by Judd and Scadding (1981) in a money demand function for the United States;[22]

– changes in domestic credits and in the external public debt plus the current balance of payments, used by Kanniainen and Tarkka (1984) to explain money demand in the United States, Germany, Australia, Sweden and Finland.

The notion of a buffer stock mechanism is an appealing one and there is little doubt that the introduction of proxies helps to reduce the risk of the residuals of conventional money demand functions containing supply-induced changes in the money stock. On the other hand, some of the measures used may lead to biases of a different sort. For instance, unanticipated changes in money supply are likely to be very closely correlated with the residuals of a conventional money demand function.[23] Moreover, bank loans, and even more so the proxy used by Kanniainen and Tarkka, are important credit counterparts to current money stocks so that the estimated coefficients are biased towards unity.[24]

[20] Anticipated changes in money supply are assumed to be fully reflected in the rate of inflation and are determined in an ARIMA model. The distinction between anticipated and unanticipated changes is similar to that proposed by Barro, but the empirical methods differ.

[21] Although Mascaro and Meltzer only introduce the variance as a measure of uncertainty and do not base their hypothesis on the buffer stock notion, it is natural to mention their study in this context.

[22] This equation is included in a larger model expressing banks' portfolio behaviour. For the United Kingdom, Moore and Threadgold (1980) also underline the importance of bank lending in the money creation process.

[23] Laidler (1980), MacKinnon and Milbourne (1984) and White (1981) also discuss this "error term tautology".

[24] This proxy only omits private external debts from the money stock counterparts and the estimated coefficients are in some cases (United States and Sweden) very close to unity.

(b) Disequilibrium adjustment approach

This approach recognises money as an asset held by economic agents in accordance with a conventional long-run money demand function. Like the buffer stock notion, it also argues that observed short-run changes in money stocks are mainly supply-induced and that money may act as a buffer stock or shock absorber. However, instead of introducing additional variables serving to reduce or remove a discrepancy between money demand and supply, it assumes that disequilibrium in money markets will lead to changes in the financial as well as the real sectors of the economy. Consequently, it does not attempt to estimate money demand functions directly,[25] but derives the parameters of the long-run money demand function implicitly from other macroeconomic relationships.

The basic difference between the disequilibrium approach and most other methods of estimating the money demand function thus lies in the assumed dynamic adjustment to a situation of monetary disequilibrium and in the transmission of changes in monetary policy.[26] As an illustration of the disequilibrium approach, it may be helpful to consider a situation of excess money supply and the various channels by which this may be removed (assuming that no further disturbances occur):[27]

(i) a fall in interest rates which will raise money demand relative to the existing supply and lead to a general re-allocation of portfolios;

[25] In the short run, the disequilibrium approach assumes the money supply to be determined through the counterparts identity. It therefore differs from the well-known procedure proposed by Brainard and Tobin (1968), which satisfies the identity by imposing an adding-up constraint on the parameter estimates. It also differs from the practice adopted in several macroeconomic models, where interest rates are determined indirectly from separate money demand and supply equations.

[26] Compared with the empirical estimates of the buffer stock function discussed above, this difference is more apparent than real, as the disequilibrium approach is mainly characterised by "skipping" the transitory buffer stock absorption and moving directly to the real and financial effects of reducing buffer stock holdings of money (see also Santomero and Seater (1981)).

[27] See also Artis and Lewis (1981), Ch. III.

(ii) a rise in real expenditure – reflecting the fall in interest rates as well as the excess supply of money – which will tend to increase the demand for money (transaction motive);

(iii) a reduction in the supply of money through losses of foreign reserves, partly in response to higher imports induced by the rise in real expenditure under (ii) and partly as a result of capital outflows;[28]

(iv) a rise in the rate of price and wage inflation, which may be induced by the increase in real expenditure but could also occur earlier if the exchange rate depreciates and/or inflationary expectations are adversely influenced by the excess supply of money.[29]

There are, however, several practical problems in designing an estimation procedure incorporating these channels of adjustment. In the first place, there is the question of which aggregate to choose, since reactions to a discrepancy between demand and supply are not confined to monetary assets. In practice this question has been solved pragmatically by testing the hypothesis on two or more aggregates and this is also the procedure followed in this paper.[30]

[28] Under a régime of flexible exchange rates, exchange rate movements would replace changes in foreign reserves. Laidler et al. (1983) use changes in both foreign reserves and exchange rates in a disequilibrium model estimated for Canada.

[29] This is, in fact, a dominating influence in the empirical evidence reported by Jonson for Australia; see further below.

[30] Narrow aggregates (such as M_1) would seem most suitable for satisfying the buffer stock function, but, on the other hand, several authors have pointed out that narrow aggregates are more likely to be demand-determined than broader aggregates. This is due to the much wider substitution possibilities, though this general conclusion would have to be modified when narrow aggregates are used as targets. Laidler et al., op. cit., advance the additional argument that the counterparts identity usually corresponds to a broad aggregate. However, in the present context this would only seem relevant when the identity is used by the authorities in implementing a target, as for instance in France and the United Kingdom and partly also in Italy. Moreover, even though the identity may serve to identify the source of supply shocks, it does not indicate which deposits will be most affected (see Goodhart (1984)).

Secondly, there is the problem of measuring the degree of disequilibrium and of deriving the parameters of the long-run money demand function. The two issues are interrelated, since a measure of disequilibrium (defined as the difference between money demand and supply at a given point in time) requires knowledge of the long-run demand function. However, the parameters of this function have to be derived implicitly from the most important transmission channel, which presupposes a measure of disequilibrium.

In practice, two procedures have been applied: (i) simultaneous models which recognise the close connection between the two issues indicated above and attempt to estimate the transmission channels as well as the degree of monetary disequilibrium in a simultaneous process; (ii) single equation estimates, which solve the two issues sequentially; first, the most likely and fastest transmission channel is used in determining the parameters of the long-run money demand function; and secondly, a measure of monetary disequilibrium is calculated and used as an argument in estimating other macroeconomic relations.

This paper presents results only for the first stage of the single equation approach, using interest rates as the principal channel of adjustment. However, before turning to the empirical results and the evidence available from other sources, attention should be drawn to certain problems concerning interpretation of the findings. In the first place the adjustment mechanism implicitly assumes that money stocks are exogenous and that interest rate movements are mainly influenced by market reactions.[31] Alternatively, however, the monetary authorities may either have specific targets with respect to interest rate movements or rely on a feedback rule approach and use interest rates as an instrument for correcting

[31] For instance, in a situation where actual money stocks exceed the desired levels, interest rates can be expected to fall. Conversely, in a period of excess demand for money, they can be expected to rise.

deviations between actual and target money supply growth.[32] In the first case, money stocks would be demand-determined and the disequilibrium approach obviously inappropriate, while in the second case, reactions by the authorities could either strengthen or moderate (possibly offset) the influence of market forces, thereby complicating the derivation of precise estimates:

– if the target is exceeded because of excess supply in money markets, the authorities would raise interest rates and this effect would be reinforced when anticipated by market participants;

– if, on the other hand, above-target money growth is associated with excess demand in money markets, the reaction of the authorities would strengthen the hypothesised market reaction.

The expected market response was obtained in most countries for the period 1960–83 but this was not the case when shorter periods were considered. Moreover, several of the estimated interest rate equations are suggestive of missing variables or show signs of parameter instability and this could result from an actual or anticipated reaction function on the part of the authorities.

Secondly, by deriving the long-run money demand parameters only from interest rate equations, the chosen procedure leaves open the question of what to do in case an alternative adjustment mechanism leads to a different set of parameters. Only a simultaneous model approach would solve this problem, but, as indicated below, this method is subject to problems of its own.

Thirdly, in selecting interest rates we have focused on market-determined rates and ignored changes in the own rate of monetary

[32] This case may be illustrated by an interest rate reaction function $i_t = a\,(M^*_t - M_t)$, with M^* = money supply target and $a < 0$ and proportional to the inverse of the interest elasticity of the money demand function. As pointed out in Freedman (1981), money supply plays no rôle in this case as the authorities use interest rates to move along the demand curve and money demand always equals money supply. Radecki (1984) uses a similar approach in discussing the risk of instrument instability (i.e. larger and larger adjustments of interest rates) when the reaction function is combined with lags in either money demand or real expenditure functions. See also Lane (1984).

aggregates. Given the sharp rise in the share of interest-bearing demand deposits observed in some countries, this procedure clearly entails a risk of biased estimates. On the other hand, calculating indicators of own rates is a major exercise in itself, and including such indicators among the arguments would have complicated the inversion of the money demand functions.

Fourthly, all equations have been estimated in terms of real money stocks even though the arguments on pages 11 and 12 refer to nominal stocks. This procedure was preferred, as it tends to reduce the problem of multicollinearity, Moreover, it actually biases the results in favour of accepting the conventional approach,[33] although in practice the parameters obtained differ only marginally.[34]

II
Empirical results

A. Review of available evidence

(a) Simultaneous model approach

There can be little doubt that the estimation procedures used by Jonson and his associates in their models for Australia and the United Kingdom are the most satisfactory ones but also the most difficult ones to apply.[35] In the case of Australia (Jonson et al.

[33] In fact, several authors have invoked this procedure to identify a demand equation and Mehra (1978) shows that prior to 1972 real M_1 in the United States is strictly demand-determined, whereas nominal M_1 is not.

[34] See, for instance, den Butter and Fase (1981). Gordon (1984) notes that the long lags observed for money demand functions estimated in real terms may be due to slow price adjustments. However, the fact that equations based on nominal money stocks yield equally long lags throws some doubt on this proposition.

[35] The simultaneous estimation programme (an FIML procedure) is not widely available and the parameters can be extremely sensitive to changes in specification and in the period of observation. The latter, however, also applies to single equation estimates.

(1977)), the strongest disequilibrium effects are found with respect to private consumption, demand for labour and the rate of price and wage inflation.[36] On the other hand, monetary disequilibrium has apparently only little or no influence on external capital flows and on investment in real and financial assets.

Disequilibrium effects also figure prominently in a medium-term model recently developed in the Bank of Canada (see Rose and Selody (1985)), not only in terms of strengthening (although only temporarily) the real effects of changes in monetary policy, but also as a key element in generating the adjustment path towards long-run equilibrium. Nominal money stocks (measured by the monetary base) can be determined by the authorities and serve as a short-run buffer with respect to both real and nominal stocks. In the longer run, a main feature of the model is that the level of prices is regarded as the principal channel of adjustment in reconciling actual and desired real balances[37] and the discrepancy between the actual and the equilibrium price level (taken as a proxy for monetary disequilibrium) is found to have a significant effect on private consumption as well as on the rate of inflation.

In a series of papers[38] Laidler et al. have estimated small models on data for the United States, the United Kingdom, Canada and Italy using the same technique as Jonson et al. The models contain only seven or eight equations and the principal responses to a

[36] The latter is justified by the hypothesis that the degree of monetary disequilibrium serves as a measure of inflationary expectations. Laidler (1984) also discusses this question but relates buffer stocks to the *stickiness* of price and wage adjustments on the assumption that such adjustments are costly and that the availability of buffer stocks makes it less urgent to adjust prices and wages in line with market trends.

[37] Walters (1965) first recognised that conventional money demand equations are mis-specified when nominal money stocks are set by the authorities. Consequently, he interprets real demand functions as price adjustment functions on the assumption that price changes have to reconcile actual and desired real balances.

[38] See Laidler, Bentley, Johnson and Johnson (1983), Laidler and O'Shea (1980), Laidler and Bentley (1983) and Spinelli (1979).

monetary disequilibrium are assumed to be real expenditure and the stock of foreign reserves (United Kingdom, Italy and Canada) or interest rates (United States). The expected transmission channels receive strong support in the case of the United States and Italy, whereas for the United Kingdom and Canada the results are rather mixed; for Canada the model only produces acceptable estimates when periods of fixed and flexible exchange rates are separated, and even then it tends to break down after 1975; for the United Kingdom monetary disequilibrium only appears to influence changes in foreign reserves (which are generally badly explained in the model) and the model does not work after 1970.

Davidson (1984) estimates a full model for the United Kingdom, characterised by a very detailed explanation of the components of the counterparts identity and by providing separate estimates for fixed and flexible exchange rate régimes. Strong disequilibrium effects are found for the demand for bank credit, the rate of inflation and the exchange rate. On the other hand, bond prices and transactions as well as the rate of output growth are only weakly affected and the current balance-of-payments influence is of the wrong sign.

Knoester (1979) also adopts a full model approach, but uses ordinary least squares.[39] Monetary disequilibrium is regarded as the major link between the financial and the real sectors and significant disequilibrium effects are found with respect to private consumption, business fixed investment, residential construction and inventory formation. Because the disequilibrium measure relies on the adjusted monetary base, strong effects are also identified

[39] Disequilibrium is measured as the difference between the growth rates of nominal expenditure and the adjusted monetary base, defined as open-market operations by the central bank plus net changes in foreign reserves of the banking system. This definition makes it possible to use ordinary least squares and implies very strong balance-of-payments effects on money supply and the domestic economy. However, it imposes rather rigorous constraints on the parameters of the long-run money demand function.

within the financial sector, as non-borrowed reserves as well as the demand for broader monetary aggregates are found to be positively influenced by a rise in the monetary base relative to nominal spending. On the other hand, a positive coefficient in the foreign asset equation is more likely to reflect a reverse causality, as excess supply of money would normally generate a net capital outflow.

Finally, Sassanpour and Sheen (1984) have estimated simultaneous models for France and Germany, paying particular attention to the determination of credit demand and supply and to the influence of balance-of-payments developments on domestic financial markets. Discrepancies between money demand and supply were for both countries found to influence the rate of inflation (assuming an expectation effect as in the model by Jonson), real expenditure and changes in foreign reserves, with the coefficients being larger and better determined for France than for Germany. However, the sample period does not include any observations after 1973, so the results are difficult to compare with those to be discussed below.

(b) Single equation estimates

Among those who rely on single equation estimates, Artis and Lewis (1976) get promising results for the United Kingdom when testing the hypothesis that the major channel of adjustment to a monetary disequilibrium is through interest rates. In their estimating equation, current interest rates are assumed to adjust towards a market clearing rate and from the estimated parameters of this equation they are able to derive long-run demand functions for both M_1 and M_3.[40] In a more recent but still preliminary study applied to the UK company sector Wren-Lewis (1984) finds a very significant influence of disequilibrium in firms' short-term financial position on employment, inventory and output decisions. Furthermore, but less

[40] They also try an alternative formulation where the adjustment is assumed to take place through changes in nominal spending and income, but this specification yields less satisfactory results.

surprisingly, such disequilibria can be traced to fluctuations in company profits.

For the United States, the interest rate adjustment equation does not seem to work, and especially not in equations using M_1 as the aggregate (see Laidler (1980)). On the other hand, Coats (1982) finds a significant disequilibrium effect on the rate of inflation, and some of the results reported by Laidler (1980) indicate that adjustments are also taking place through real spending. In both cases, however, the shortcomings of relying on a single equation approach are evident, as the estimated parameters are difficult to interpret. Moreover, considering that most model simulations unambiguously show that an expansion of money supply growth affects real spending almost immediately but inflation only with a certain lag, the results by Coats, as well as those reported by Jonson and Davidson, are slightly surprising.[41]

Finally, Kanniainen and Tarkka (1983) have tested a model which shows promising results for small and open economies with fixed or pegged exchange rates and excess demand for credit. By combining a conventional money demand function with the counterparts identity, they first estimate an equation with private capital flows as the dependent variable. From the coefficients of this equation they then derive the parameters of the long-run money demand function as well as a measure of the offset (through capital flows) to a domestic expansion of money supply.[42]

[41] Coats' statistical test is also questionable, as it is based on a comparison of standard errors from equations with different dependent variables. However, Judd and Scadding (1982a) have tested the various alternatives (including the conventional approach) and obtain the best estimates for the price adjustment equation as proposed by Coats. They use a so-called canonical form which respecifies all cases to have changes in real money supply as the dependent variable, while the arguments appearing on the right-hand side reflect the various hypotheses tested.

[42] This model is similar to an earlier one proposed by Kouri and Porter (1974) except that changes in capital flows are assumed to act as a shock absorber and not to depend on portfolio substitution.

B. Recent and comparative estimates

The empirical estimates to be discussed below are based on quarterly observations for the seven major countries. The sample period is in most cases 1960/I – 1983/IV and the purpose is to compare the statistical and economic properties of conventional money demand functions with those of equations based on the disequilibrium approach, assuming that interest adjustments act as the principal transmission channel. The specifications and methods used in deriving the long-run elasticities are based on those proposed in Artis and Lewis (1976) and are discussed in Annex I. The estimates obtained from the two sets of equations are presented in seven tables, with each table showing short-run parameter estimates, various statistical measures and the implied long-run money demand elasticities together with the average adjustment lags.[43] The stability of the equations is evaluated by Chow tests (Table 8), and in a set of graphs which for each country show the parameters obtained for overlapping ten-year periods.

The estimation strategy and the criteria used in selecting equations to be presented in the tables may be summarised in the following three steps:

– firstly, the same specification and observation period was used

[43] The reduction in average lags when moving from the conventional to the alternative approach will receive a relatively large weight in the following evaluations, even though this criterion is not without problems. First of all, the coefficient on the lagged dependent variable tends to be very sensitive to structural changes and to other causes of parameter instability and may, therefore, give an inappropriate measure of the lags. Secondly, with the adopted specification, it is not possible to distinguish between expectation lags and adjustment lags. Thirdly, it is questionable whether lags of alternative dynamic adjustment paths are at all comparable. Fourthly, both the mean and the median lag could be used as representative measures and, as noted on page 9, they can differ substantially. Finally, the lags obtained for the interest rate equations may seem rather long, given the normally assumed efficiency of financial markets. In this context, however, it should be recalled that part of the discrepancy is initially absorbed in money demand through the buffer stock function. See also White (1981).

for all countries and the best results are shown as equations 1 to 4 or 5 of the tables, with deviations from the standard specification introduced only when the coefficients were of the wrong sign;

– secondly, parameter stability and specification errors were analysed using the graphs, the stability tests and the pattern of residuals for equations estimated over the whole sample period;

– thirdly, for the interest rate equations various modifications (changing the time period and introducing dummy variables, international interest rates and time trends) were made on the basis of step 2 and the most satisfactory results are shown with one or two asterisks attached to the modified equation.

United States. The two money demand equations yield acceptable results in terms of overall fit[44] and size of coefficients. However, for M_1 the average adjustment lag is estimated at more than four years and from Graph 1a it appears that a lengthening of the lag structure occurred around 1974–75 when aggregate targets were first announced and the demand for M_1 is generally recognised to have shifted. For M_3 the adjustment lag is much shorter, but autocorrelation is high (suggesting mis-specification) and Table 8 (see page 51) clearly implies a problem of parameter instability, which (see Graph 1b) is mainly due to a trend decline in the coefficients with respect to the interest rate and the rate of inflation.[45] The coefficients on income and the lagged dependent

[44] For both equations the largest residual occurs in 1980/II, when actual money stocks were overestimated by more than 3 per cent., probably reflecting the introduction of credit controls, i.e. a supply-side disturbance.

[45] As noted in Annex I, it is empirically difficult to separate the impact of inflation from that of nominal interest rates. Graphs 1a and b show a large change in the estimated parameters, with that of interest rates falling (in absolute terms) while the measured impact of inflation has either increased (M_1) or fallen less than that of nominal interest rates (M_3). This may suggest a certain change in economic agents' perception of the opportunity costs of holding money, with a larger weight being attached to the inflation component and a correspondingly smaller weight to the interest rate component. An additional and more recent source of parameter shifts is the introduction of interest-bearing demand deposits.

Table 1

United States: Money demand and interest rate equations.

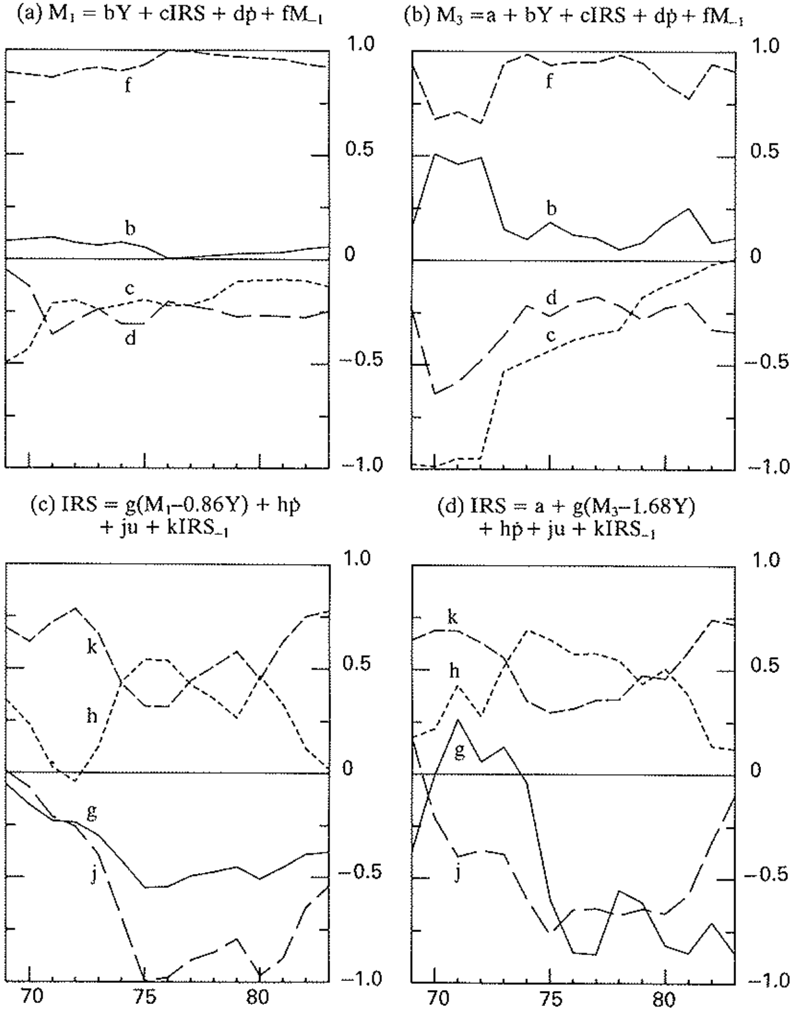
Dependent variable	Independent variables										Statistics			Long-run money demand elasticities			Average lag
	C	m	y	IRS	$\dot{p}$	u	Lagged dep.	Additional variables Dxm	Dxy	D74/IV	SE	h	δ	y	IR[1]	$\dot{p}$[1,2]	(quarters)
(1) M_1	–	–	0.05 (7.3)	−0.12 (3.0)	−0.30 (6.4)	–	0.94 (116.4)				0.7	0.1	–	0.83	−0.24	−0.34	16.2
(2) IRS	–	−4.88 (2.9)	4.21 (3.0)	–	0.07 (0.9)	−0.28 (3.0)	0.75 (11.3)				1.0	1.0	0.1	0.86	−0.64	−0.29	2.9
(3) M_3	−0.49 (4.0)	–	0.17 (3.0)	−0.11 (2.1)	−0.41 (5.0)	–	0.90 (20.1)				0.7	0.7	0.6	1.68	−0.15	−0.33	8.8
(4) IRS	−30.9 (2.0)	−6.42 (1.1)	10.78 (1.4)	–	0.07 (0.8)	−0.13 (1.2)	0.76 (11.7)				1.1	1.0	0.1	1.68	−0.45	−0.19	3.2
(5) IRL	−11.8 (2.7)	−3.67 (2.6)	5.21 (2.7)	–	0.05 (1.7)	–	0.93 (33.8)				0.4	1.1	–	1.43	−0.26	−0.07	12.8
(2*) IRS	–	−2.00 (1.1)	2.28 (1.5)	–	0.48 (4.7)	−0.53 (5.2)	0.24 (2.3)	−10.63 (0.8)	8.48 (0.8)		0.9	n.a.	0.2	0.85	−0.73	−0.15	0.3
(2**) IRS	2.78 (2.4)	−4.10[3] (1.9)		–	0.50 (4.8)	−0.47 (3.7)	0.24 (2.6)	−5.28[3] (6.1)		−0.68 (1.1)	0.9	1.7	0.2	0.85[4]	−0.99	−0.20	0.3

Notation:
C = Constant term
m = Real money stock
y = Real GNP/GDP
IRS = Short-term interest rate
IRL = Long-term interest rate
$\dot{p}$ = Rate of change in GNP deflator over four quarters
u = Rate of unemployment
SE = Standard error of estimates (percentages)
h = Durbin's h-statistic
δ = First-order autocorrelation coefficient.
Additional variables explained in text.

[1] Elasticities calculated at 1980–83 average rates. IR and $\dot{p}$ measured as fractions in the money demand functions and as percentages in the interest rate equations.
[2] Calculated on the assumption that in the long run nominal interest rates fully reflect changes in the rate of inflation (see Annex I).
[3] Coefficient with respect to (m–by).
[4] Imposed.

Graph 1

United States: Parameter estimates 1960–69 to 1974–83



Note: In this and the following six graphs the estimated parameters are shown relative to the final year of the overlapping sample periods.

variable shifted about two years prior to those of M_1, but have since moved back towards earlier levels.

The short-term interest rate equations corresponding to M_1 and M_3 yield well-determined parameters (except for the inflation rate) and the implied long-run money demand coefficients are plausible. Moreover, the speed of adjustment is much faster, and while there is some autocorrelation, it is not a serious problem.[46] Finally, the short-term interest rate seems to be a more appropriate channel of adjustment as the long-term rate is subject to very long lags (see equation 5).

However, equations 2 and 4 are subject to some problems of their own. In the first place, very large residuals occur in the period after 1979/IV, when the Federal Reserve Board introduced a reserve-based money control policy. The residuals do not follow a systematic pattern, suggesting a general rise in interest volatility rather than the effect of new variables. Secondly, even though parameter instability is not significant in a statistical sense (see Table 8), Graphs 1c and d clearly indicate that the parameters have been far from stable over time. The estimated impact of the composite variable (m – by), which may be regarded as a proxy for the degree of monetary disequilibrium,[47] has increased, and in both cases this shift coincides with the introduction of aggregate targets. The coefficients with respect to the inflation rate and the lagged dependent variable are also subject to changes which for some periods seem to be related to fluctuations in the rate of inflation. Thus the deceleration from 1980 onwards has obviously not been reflected in nominal interest rates and the same applies – with the sign reversed – to the early 1970s when inflation was accelerating. In both cases the change was also reflected in a lengthening of the lag

[46] All interest rate equations were tested for autocorrelation of first to fourth order. For the United States both short-term interest rate equations were found to have negative autocorrelation of second order, which may be related to the problem of volatility (see below).

[47] It is obviously an approximation, as the impact of other arguments in the money demand functions (interest rates and inflation) is ignored.

structure, which may suggest that the adjustment of *expected* inflation to actual inflation was very slow. For the intermediate years, the impact of inflation is found to be much higher and the lags correspondingly shorter, possibly indicating that agents had become accustomed to the higher rate of inflation.[48]

The last two equations show the best results, obtained after various modifications were introduced. However, neither version is entirely satisfactory, especially as regards autocorrelation and interest rate volatility after 1979. In equation 2* the coefficients on m and y are allowed to change after 1979/IV (Dxy and DXm, with D = 1 after 1979/IV), resulting in a marked rise in the influence of monetary disequilibrium on interest rates and a reduction in the average adjustment lag to only one month. This re-specification also yields a higher and more significant impact of the rate of inflation,[49] but the coefficients with respect to m and y (both before and after 1979/IV) are subject to large standard errors. Consequently, in equation 2** the long-run income elasticity of money demand was constrained to 0.85 and this further strengthens the effects of monetary disequilibrium after 1979/IV, though the coefficient with respect to m–by prior to the introduction of a reserve-based control policy remains significant and of the right sign. The adoption of aggregate targets in the early 1970s was modelled by an intercept shift in 1974/IV,[50] which is found to be negative, suggesting that the effects of the simultaneous downward shift of the money demand function exceeded those induced by the policy change. The implied long-run interest elasticity of money demand is rather high in

[48] When interpreting the graphs and the overlapping regressions in this way, we have paid most attention to the inflation rates in the terminal years of the regression.

[49] Equation 2 was also re-estimated allowing shifts in the inflation rate coefficient, and the results implied a marked rise after 1979/IV, suggesting that the introduction of a reserve-based money control policy may have strengthened the direct impact of monetary developments on the rate of inflation.

[50] In alternative versions of equation 2** various dates for the intercept shift were tested and the coefficient with respect to m-by was also allowed to change in 1974–75. In all cases, however, the results were less satisfactory than those shown in Table 1.

equation 2** and, as in 2*, the problems of autocorrelation and interest volatility remain.

To sum up, both conventional equations present problems: for M_1 an implausibly long adjustment lag and for M_3 parameter instability and autocorrelation. The interest rate equations look promising as alternatives and it is especially encouraging that it is possible to derive plausible long-run parameters when the interest rate equation is based on M_1, as narrow aggregates are usually assumed to be less exogenous than broader aggregates. Nonetheless, there is clearly scope for further improvement. In the first place, while the parameter shift observed in 1979/IV looks plausible, the coefficients are not very robust and alternative transmission channels of the policy change should be further explored. Secondly, the rise in interest rate volatility after 1979 has not been explained and autocorrelation is relatively high, even in the modified equations.

Japan. The M_1 equation is rather unsatisfactory, with a low and badly determined income coefficient, a poor overall fit, a high degree of autocorrelation and an average adjustment lag of more than three years. The equation for M_2 + CDs is better and the implied adjustment lag is not implausible. The interest rate equations produce a significant increase in the speed of adjustment, but are subject to other problems, especially the equation corresponding to M_2 + CDs; here, the implied income elasticity falls to 0.75 while the interest elasticity rises to -3, which seems rather high.[51]

Turning to the stability measures (see Table 8), the conventional money demand equations show significant parameter instability[52] and in both cases (see Graphs 2a and b) this is due to a badly determined income elasticity which for some periods is negative. The interest elasticity for M_1 is also unstable, whereas for M_2 + CDs

[51] Only the short-term interest rate was considered as an argument of the money demand functions and as a channel of adjustment.

[52] This confirms the observation made in Suzuki (1984) that structural changes for both M_1 and M_2 + CDs occurred around 1973–74.

Table 2

Japan: Money demand and interest rate equations.

Dependent variable	Independent variables						Additional variables		Statistics			Long-run money demand elasticities			Average lag
	C	m	y	IRS	$\dot{p}$	Lagged dep.	DI	DIxIRUS	SE	h	δ	y	IR[1]	$\dot{p}$[1,2]	(quarters)
(1) M_1	0.14 (1.1)	–	0.06 (1.4)	−0.47 (4.6)	–	0.92 (25.5)			1.7	0.5	0.3	0.79	−0.50	–	12.3
(2) IRS	−6.23 (0.8)	−4.56 (2.0)	4.73 (1.8)	–	0.14 (3.8)	0.68 (10.2)			1.0	1.5	0.2	1.04	−0.55	−0.08	2.2
(3) M_2	−0.11 (1.0)	–	0.12 (3.2)	−0.19 (2.7)	−0.21 (5.5)	0.89 (29.3)			1.0	−0.1	0.4	1.09	−0.16	−0.05	7.9
(4) IRS	3.68 (2.1)	−0.86[4] (1.4)		–	0.10 (3.2)	0.74 (11.7)			1.0	1.4	0.2	0.75[3]	−2.4	−0.36	2.8
(4*) IRS	–	−6.79 (4.9)	6.75 (5.0)	–	0.19 (5.9)	0.60 (9.7)	2.32 (5.0)		0.9	1.1	0.2	0.99	−0.47	−0.06	1.5
(4**) IRS	–	−5.44 (3.9)	5.44 (4.0)	–	0.17 (4.9)	0.63 (9.7)		0.14 (3.8)	0.9	1.3	0.2	1.00	−0.54	−0.07	1.7

Notation: C = Constant term
m = Real money stock
y = Real GNP/GDP
IRS = Short-term interest rate
$\dot{p}$ = Rate of change in GNP deflator over four quarters
SE = Standard error of estimates (percentages)
h = Durbin's h-statistic
δ = First-order autocorrelation coefficient.
Additional variables explained in text.

[1] Elasticities calculated at 1980–83 average rates. IR and $\dot{p}$ measured as fractions in the money demand functions and as percentages in the interest rate equations.
[2] Calculated on the assumption that in the long run nominal interest rates fully reflect changes in the rate of inflation (see Annex I).
[3] Derived by iterative process.
[4] Coefficient with respect to (m–by).

Graph 2

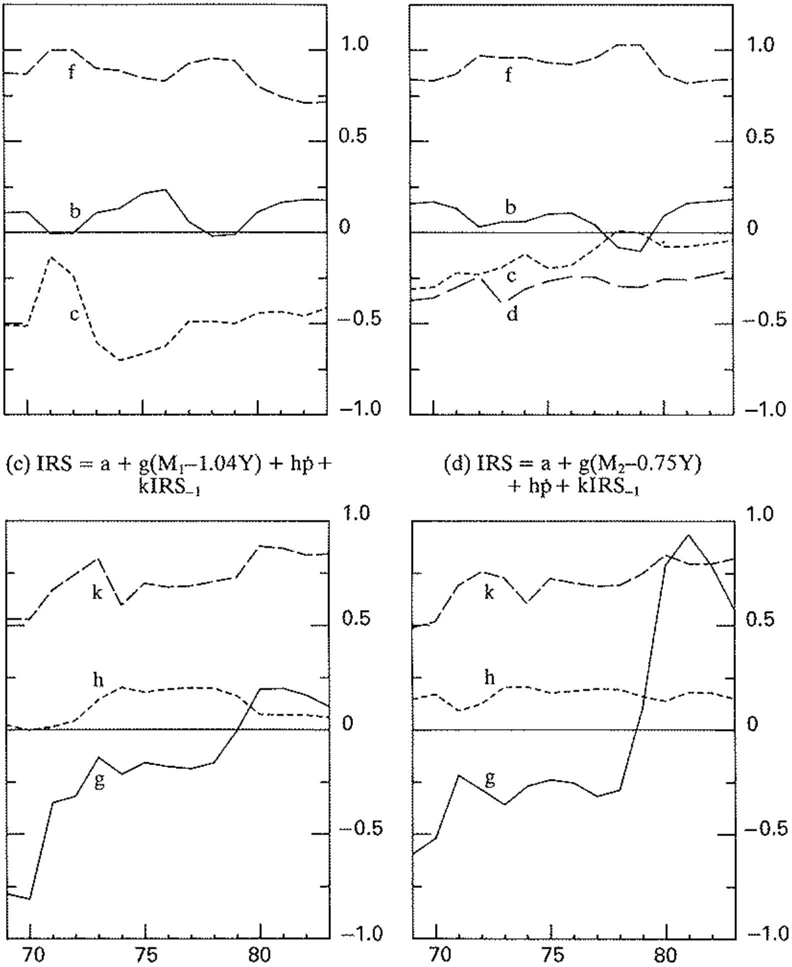
Japan: Parameter estimates 1960–69 to 1974–83

(a) $M_1 = a + bY + cIRS + fM_{-1}$

(b) $M_2 = a + bY + cIRS + d\dot{p} + fM_{-1}$

(c) $IRS = a + g(M_1 - 1.04Y) + h\dot{p} + kIRS_{-1}$

(d) $IRS = a + g(M_2 - 0.75Y) + h\dot{p} + kIRS_{-1}$



the impact of both inflation and nominal interest rates shows a trend decline similar to that observed for the United States. Graphs 2c and d also reveal parameter instability, even though this is not statistically significant according to Table 8. The coefficients on the proxy for monetary disequilibrium are subject to especially wide fluctuations and in both equations they take on the wrong sign during 1979, when real interest rates rose to historically high levels and the equations estimated for the total period started to show very large residuals.

Against this preliminary evidence, the usefulness of the disequilibrium approach is not apparent in the case of Japan, especially as regards the aggregate forecast by the authorities. However, interest rates have been subject to a large measure of control for most of the sample period and, once this is allowed for, a noticeable improvement is obtained. In equation 4*, which introduces an intercept shift in 1979/III all coefficients are well determined and plausible and the impact of monetary disequilibrium can be explained without constraining the income elasticity. It is also interesting to note that the US interest rate only affects developments after 1979/II,[53] (see equation 4**) but it is not possible to say whether the shifts are due to domestic or external factors, as equations 4* and 4** give equally satisfactory results.

Apart from this ambiguity and the rather crude modifications, the interest rate approach looks promising also for Japan and it seems appropriate to both aggregates.[54]

Germany. The conventional approach to estimating the demand for M_1 yields very satisfactory results and little is gained by adopting an alternative approach. The M_3 equation is also acceptable but in this case the average adjustment lag is more than halved when using the interest rate approach. Equation 4, however, is subject to a

[53] Kuroda and Okubo (1982) obtain a similar result, using monthly data for long-term interest rates (secondary government bond market).

[54] When the modifications were tested on equation 2, the results obtained confirm the shifts shown in 4* but there were only marginal changes to the coefficients shown in 2.

disturbingly high degree of autocorrelation and the implied long-run income elasticity of the demand for M_3 is rather high. Equation 5 for the long-term rate also suffers from autocorrelation, but the elasticities for the long-run money demand function are plausible, suggesting that adjustments to a monetary disequilibrium may take place through changes in both short and long-term interest rates.

The stability tests confirm the superiority of the conventional M_1 equation, even though the corresponding interest rate equation passes the Chow test. Graphs 3b and d, on the other hand, reveal certain problems with respect to the stability of the conventional M_3 equation[55] and its corresponding short-term interest function. In both cases "breaks" occur around 1972–73 and again during 1979–80. The first shift seems partly to reflect a very slow adjustment of nominal interest rates to the accelerating rate of inflation (as in the United States), but there are also signs of a stronger influence of market forces, which may be related to the adoption of a more flexible exchange rate policy and the subsequent introduction of aggregate targets. As in Japan, the instability observed for 1979–80 coincides with a sharp rise in real interest rates and with the appearance of very large residuals in the equation obtained for the full sample period. The shift is mainly reflected in a sharp drop in the income elasticity of the demand for money (and a corresponding rise in the average lag) and in a marked rise in the effect of monetary disequilibrium on interest rates.

Equations 4* and 4** attempt to meet these shortcomings by introducing the US short-term interest rate as an argument and by allowing parameter shifts. In equation 4** the coefficients on m and y were constrained to zero prior to 1973/III and in equation 4* this shift is imposed on the inflation rate coefficient.[56] The US rate has a powerful influence in both versions, but unlike in Japan it is

[55] See Buscher (1984), who also finds some fluctuations in the parameters of M_3 demand equations but concludes (on the basis of more rigorous tests than those used in this paper) that these are merely random.

[56] When the same modifications were applied to equation 5, the results were slightly less satisfactory.

Table 3
Germany: Money demand and interest rate equations.

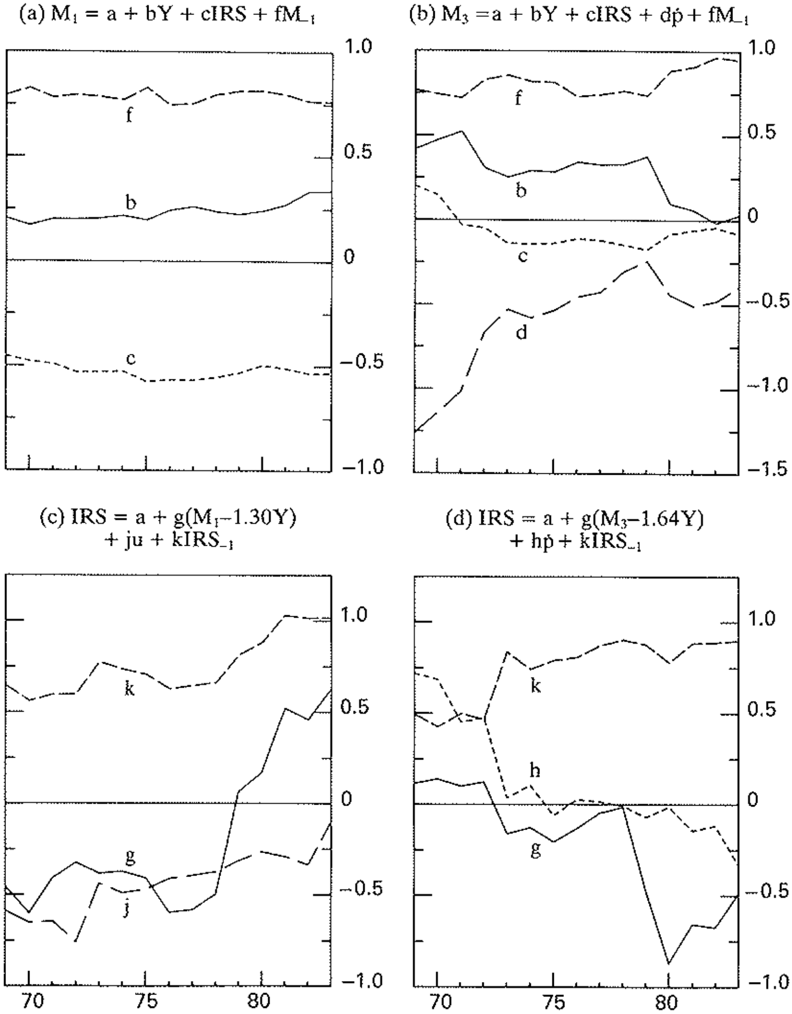
Dependent variable	Independent variables							Additional variables		Statistics			Long-run money demand elasticities			Average lag
	C	m	y	IRS	$\dot{p}$	u	Lagged dep.	D1x$\dot{p}$	IRUS	SE	h	δ	y	IR[1]	$\dot{p}$[1,2]	(quarters)
(1) M_1	−0.11	–	0.15	−0.47	–	–	0.87			1.0	−0.4	–	1.13	−0.35	–	6.7
	(3.7)		(5.5)	(10.1)			(34.3)									
(2) IRS	−13.4	−7.28[3]		–	–	−0.12	0.71			1.1	1.3	0.3	1.3[4]	−0.35	–	2.5
	(2.6)	(2.8)				(1.8)	(9.5)									
(3) M_3	−0.15	–	0.15	−0.11	−0.27	–	0.89			0.9	0.5	–	1.40	−0.10	−0.10	8.3
	(1.9)		(2.8)	(2.6)	(3.3)		(25.2)									
(4) IRS	−15.5	−5.78	9.40	–	0.02	–	0.78			1.2	1.1	0.3	1.64	−0.35	−0.14	3.6
	(1.2)	(1.0)	(1.1)		(0.1)		(10.6)									
(5) IRL	−10.3	−4.54	7.11	–	−0.03	–	0.83			0.5	1.3	0.4	1.57	−0.33	−0.18	5.1
	(2.0)	(1.9)	(2.1)		(0.7)		(13.1)									
(4*) IRS	–	−6.09	6.55	–	0.22	–	0.59	−0.14	0.38	1.0	0.4	0.3	1.07	−0.61	−0.22	1.4
		(1.9)	(1.9)		(2.2)		(7.6)	(1.7)	(5.3)							
(4**) IRS	–	−9.53[5]	10.33[5]	–	0.17	–	0.56	–	0.38	1.0	0.5	0.3	1.08	−0.42	−0.12	1.3
		(1.8)	(1.8)		(2.1)		(7.2)		(5.8)							

Notation: C = Constant term
m = Real money stock
y = Real GNP/GDP
IRS = Short-term interest rate
IRL = Long-term interest rate
$\dot{p}$ = Rate of change in GNP deflator over four quarters
u = Rate of unemployment
SE = Standard error of estimates (percentages)
h = Durbin's h-static
δ = First-order autocorrelation coefficient.
Additional variables explained in text.

[1] Elasticities calculated at 1980–83 average rates. IR and $\dot{p}$ measured as fractions in the money demand functions and as percentages in the interest rate equations.
[2] Calculated on the assumption that in the long run nominal interest rates fully reflect changes in the rate of inflation (see Annex I).
[3] Coefficient with respect to (m–by).
[4] Derived by iterative process.
[5] Only after 1973/II.

Graph 3

Germany: Parameter estimates 1960–69 to 1974–83



significant for the whole period.[57] In addition, there is a marked reduction in the average lag, a much better determination of the inflation rate coefficient and a fall in the implied income elasticity of money demand. The two versions mainly differ with respect to the implied interest and price elasticities of money demand, with equation 4** providing the most plausible results. However, the introduction of additional variables has only a marginal influence on the degree of autocorrelation.

In the case of Germany, therefore, there is no need to replace the conventional M_1 equation, whereas for M_3 the alternative interest rate equation offers certain advantages, especially after the introduction of US interest rates and of parameter shifts in the early 1970s. Probably reflecting a larger influence of market forces than in most other countries, it also appears that the long-term rate plays a rôle in the transmission process, but for both short and long-term rates the sources of structural changes are poorly identified and the estimates are subject to autocorrelation.

France. The conventional M_1 equation has satisfactory statistical properties, with significant coefficients on both income and the short-term interest rate and a plausible lag structure. With the alternative approach (see equation 2) the implied demand elasticities for M_1 all increase (in absolute terms) and the adjustment lag falls to only two quarters. However, there is a high degree of autocorrelation and the long-run income elasticity can only be determined with a wide margin of uncertainty.

The conventional equation for M_2 (see equation 3) is unsatisfactory, as the average lag is very long and the parameters are both implausible and unstable. However, the alternative approach (see equations 4 and 5) does not yield any obvious gains, except that the average lag is drastically reduced when the short-term interest rate is used as the dependent variable.

[57] The rise in the US rate after 1979 has, of course, led to a larger overall influence on the development in German rates.

Table 4
France: Money demand and interest rate equations.

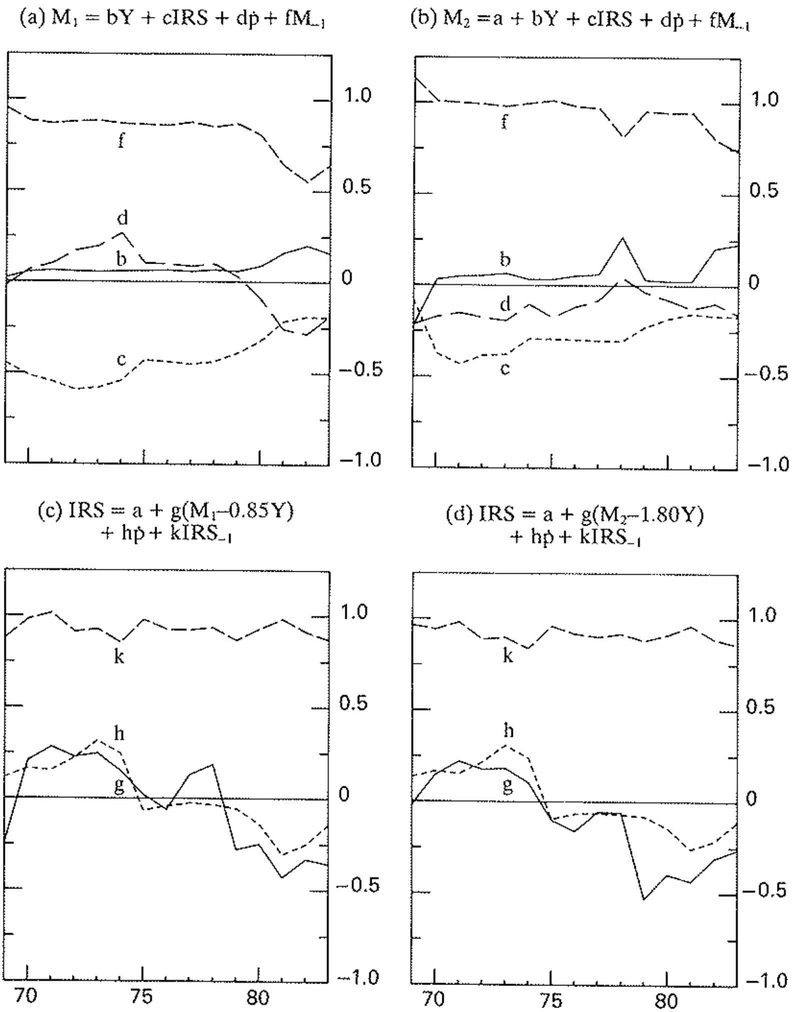
Dependent variable	Independent variables						Additional variables			Statistics			Long-run money demand elasticities			Average lag
	C	m	y	IRS	$\dot{p}$	Lagged dep.	IRUS	IRDE	DxIRDE	SE	h	δ	y	IR[1]	$\dot{p}$ [1,2]	(quarters)
(1) M_1	−0.13	–	0.08	−0.24	−0.05	0.84				1.2	1.1	–	0.53	−0.20	−0.04	5.2
	(0.9)		(3.2)	(3.7)	(0.6)	(16.5)										
(2) IRS	−32.4	−7.23[3]		–	0.02	0.68				1.1	1.0	0.4	0.85[4]	−0.60	−0.48	2.1
	(1.9)	(1.9)			(0.2)	(7.6)										
(3) M_2	−0.45	–	0.05	−0.21	−0.10	0.96				1.2	−0.4	–	1.68	−0.87	−0.35	28.9
	(1.0)		(1.0)	(3.3)	(1.2)	(22.4)										
(4) IRS	−81.2	−5.18[3]		–	0.05	0.69				1.1	0.9	0.4	1.8[4]	−0.80	−0.58	2.2
	(1.9)	(1.9)			(0.5)	(7.9)										
(5) IRL	−24.8	−1.59[3]		–	–	0.92				0.4	0.1	0.4	1.8[4]	−0.76	−0.57	11.5
	(1.3)	(1.3)				(18.6)										
(4*) IRS	–	1.14	−0.49	–	–	0.63	0.32	–	–	0.9	0.5	0.3	–	–	–	1.7
		(1.1)	(1.0)			(9.7)	(5.0)									
(4**) IRS	–	2.53	−1.09	–	–	0.60	–	0.24	0.14	0.9	0.6	0.3	–	–	–	1.5
		(2.4)	(2.2)			(8.7)		(3.7)	(2.5)							
(5**) IRL	–	1.85	−0.78	–	–	0.75	–	0.10	0.12	0.3	−0.2	0.2	–	–	–	3.0
		(4.8)	(4.6)			(21.5)		(2.9)	(6.4)							

Notation: C = Constant term
m = Real money stock
y = Real GNP/GDP
IRS = Short-term interest rate
IRL = Long-term interest rate
$\dot{p}$ = Rate of change in GNP deflator over four quarters
SE = Standard error of estimates (percentages)
h = Durbin's h-statistic
δ = First-order autocorrelation coefficient.
Additional variables explained in text.

[1] Elasticities calculated at 1980–83 average rates. IR and $\dot{p}$ measured as fractions in the money demand functions and as percentages in the interest rate equations.
[2] Calculated on the assumption that in the long run nominal interest rates fully reflect changes in the rate of inflation (see Annex I).
[3] Coefficient with respect to (m–by).
[4] Derived by iterative process.

Graph 4

France: Parameter estimates 1960–69 to 1974–83



Graph 4a and the accompanying Table 8 point to some parameter instability in the conventional M_1 equation, as there are signs of a rise in the income elasticity around 1979–80 while the lags get shorter. The conventional equation for M_2 also fails the Chow test and, as can be seen from Graph 4b, the elasticities with respect to income (in some periods negative) and the interest rate show a particularly high degree of instability. The corresponding interest rate equations both pass the Chow test, although there are clear signs of unstable parameters, especially around 1973–74.

The results discussed above do not give very strong support to the disequilibrium approach in the case of France, and this finding was confirmed when the interest rate equations corresponding to M_2 were modified to include the effect of foreign interest rates. Thus, introducing the US short-term rate in place of the domestic inflation rate (see equation 4*) led to a better overall fit and a further reduction in the average lag. However, the sign with respect to the impact of a monetary disequilibrium is reversed compared with equation 4, suggesting that interest rate movements have been determined by a reaction function rather than by market forces. This impression is further strengthened in equations 4** and 5*, which include German interest rates, with a parameter shift following the introduction of the EMS (DxIRDE, with D equal to 1 for 1979/IV–1983/IV). The coefficients with respect to y and m are now statistically significant and can be separately determined. Moreover, there appears to have been a significant rise in the influence of German interest rates after the introduction of the EMS, and the average lag falls to less than a year even for the long-term rate. Finally, the degree of autocorrelation has been reduced compared with the original equations 4 and 5, although there is still some indication of missing variables.

In conclusion, it appears that, as in Germany, there is little need to replace the conventional M_1 equation, whereas for the aggregate targeted by the authorities (M_2) an alternative approach is required. However, from the various results obtained, interest rates do not appear to be the principal transmission mechanism, since there are rather clear signs of reactions to exchange-market pressures rather than domestic market forces dominating both short and long-term interest rates. Consequently, in the case of France the alternative approach cannot be used in assessing the parameters of the long-run money demand function.

United Kingdom. Although the standard error of estimate is high, the conventional approach is satisfactory when applied to M_1, and only a marginal gain is obtained by shifting to the corresponding interest rate equation. In fact, the latter is mis-specified and all the coefficients have large errors. The conventional M_3 equation, on the other hand, is subject to several shortcomings. The unexplained residuals are very large, particularly for the period 1972/I–1974/I, when credit controls were abolished, and 1980/II–1981/IV, when low profits and large sectoral imbalances led to a renewed strong expansion of bank credit.[58] There is also a high degree of autocorrelation and the average lag comes to more than four years, compared with only four quarters in the disequilibrium approach. The latter, however, implies a long-run income elasticity for sterling M_3 of 3.5, and the other elasticities also seem to be on the high side. In addition, the problem of autocorrelation has not been removed by adopting the alternative approach. The equation for the long-term rate produces more plausible long-run money demand elasticities and does not suffer from autocorrelation, but the average lag is again very long.

Graphs 5a and c and the accompanying Table 8 confirm the superiority of the conventional M_1 equation relative to the interest rate alternative, whereas the conventional equation for sterling M_3 (see Graph 5b) is clearly unstable. As regards the short-term interest rate (see Graph 5d), the inflation impact has been close to zero in most periods and there are relatively large and interrelated fluctuations in the parameters measuring the influence of

[58] See Allen (1983). Goodhart (1984) further notes that instability of money demand functions has frequently coincided with instability of bank credit equations.

Table 5

United Kingdom: Money demand and interest rate equations.

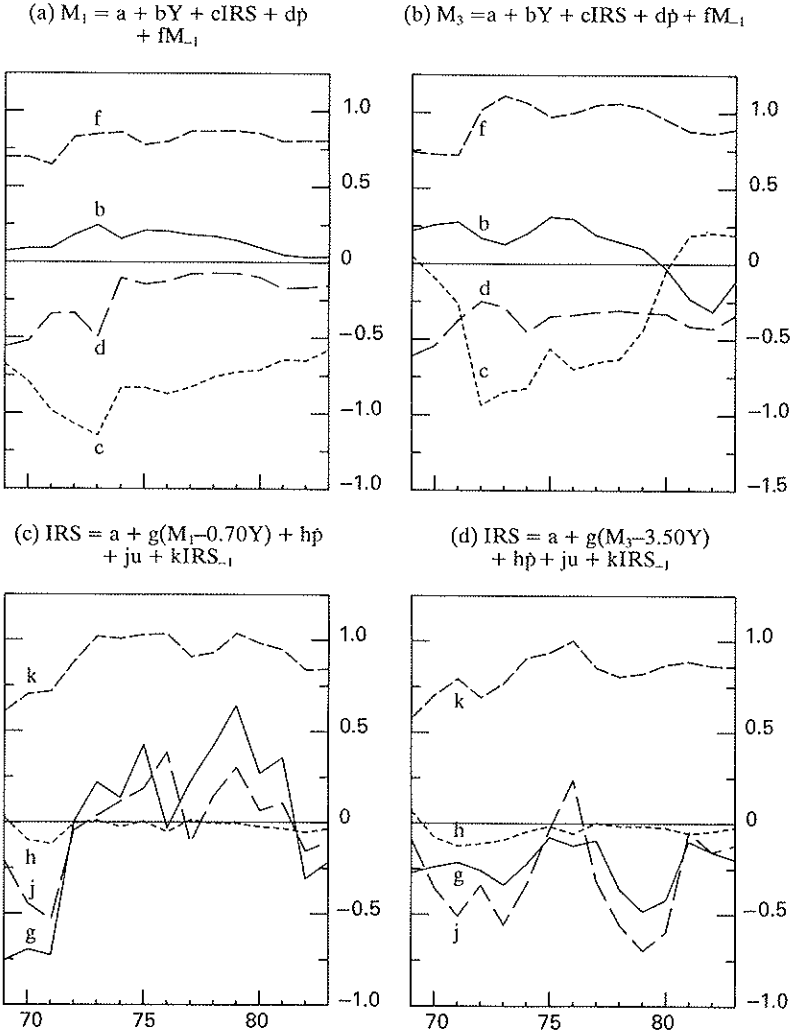
Dependent variable	Independent variables									Statistics			Long-run money demand elasticities			Average lag
	C	m	y	IRS	$\dot{p}$	u	Lagged dep.	Additional variables Dxy	Dxm	IRUS	SE	h	δ	y	IR[1]	$\dot{p}$ [1,2]	(quarters)
(1) M_1	0.61	–	0.12	−0.66	−0.12	–	0.82				1.7	−1.5	–	0.68	−0.45	−0.07	4.6
	(1.3)		(5.3)	(7.1)	(3.1)		(23.6)										
(2) IRS	29.7	9.08[3]		–	−0.02	−0.11	0.65				1.1	1.9	0.3	0.7[4]	−0.48	−0.47	1.8
	(2.2)	(2.1)			(0.5)	(1.1)	(6.6)										
(3) M_3	−0.59	–	0.12	−0.05	−0.26	–	0.94				2.1	0.2	0.3	2.02	−0.11	−0.50	16.2
	(1.4)		(2.7)	(0.4)	(4.3)		(26.5)										
(4) IRS	−49.2	−1.92[3]		–	−0.01	−0.10	0.81				1.1	1.0	0.2	3.5[4]	−1.21	−1.17	4.2
	(2.3)	(2.3)			(0.4)	(1.3)	(11.0)										
(5) IRL	−19.3	−0.76[3]		–	−0.01	−0.08	0.95				0.7	0.3	–	3.5[4]	−0.86	−0.85	19.0
	(1.5)	(1.5)			(0.3)	(2.0)	(14.4)										
(4*) IRS	−47.2	−7.40	12.25	–	–	–	0.61	−12.95	12.67		1.1	1.9	0.3	1.65	−0.65	−0.60	1.6
	(2.2)	(2.5)	(3.7)				(7.7)	(3.4)	(3.4)								
(4**) IRS	–	−5.28	5.57	–	–	–	0.58	−8.23	8.11	0.23	1.0	1.7	0.3	1.05	−0.97	−0.87	1.4
		(1.7)	(1.8)				(8.0)	(2.1)	(2.1)	(3.3)							

Notation: C = Constant term
m = Real money stock
y = Real GNP/GDP
IRS = Short-term interest rate
IRL = Long-term interest rate
$\dot{p}$ = Rate of change in GNP deflator over four quarters
u = Rate of unemployment
SE = Standard error of estimates (percentages)
h = Durbin's h-statistic
δ = First-order autocorrelation coefficient.
Additional variables explained in text.

[1] Elasticities calculated at 1980–83 average rates. IR and $\dot{p}$ measured as fractions in the money demand functions and as percentages in the interest rate equations.
[2] Calculated on the assumption that in the long run nominal interest rates fully reflect changes in the rate of inflation (see Annex I).
[3] Coefficient with respect to (m–by).
[4] Derived by iterative process.

Graph 5

United Kingdom: Parameter estimates 1960–69 to 1974–83



unemployment and monetary disequilibrium.[59] Finally, even though the residuals of the interest rate equation for the overall period do not grow particularly large in the course of 1979, as for instance in Japan and Germany, there are some signs of parameter shifts around this period.

Equations 4* and 4** show the results of two modifications made on the basis of the evidence presented above:

(i) the introduction of a temporary parameter change on m and y for the period 1973/III–1978/IV (Dxy and Dxm, with D taking the value of unity for the period 1973/III–1978/IV and zero elsewhere), while, at the same time, dropping $\dot{p}$ and u from the arguments as they are no longer significant. The coefficients on m and y during 1973/III–1978/IV are indicative of a reaction function, whereas the influence of market forces is observed for the rest of the period and the implied income elasticity of money demand can be estimated at 1.65 without imposing constraints as in equation 4. Moreover, the elasticities on $\dot{p}$ and i decline in absolute terms and the average lag falls to only 1.6 quarters;

(ii) the introduction of the US short-term interest rate (see equation 4**)[60] as an additional argument. This produces a further shortening of the average lag and a slightly better overall fit. However, the implied money demand elasticities may be less plausible.

The conclusions for the United Kingdom are very similar to those for Germany: there is little need to find alternatives for the conventional M_1-equation, and it is preferable to look at interest rate movements when analysing adjustments to changes in sterling M_3. The estimated interest rate equations are, however, not entirely satisfactory in their present form, as autocorrelation is relatively high even after several modifications were made.

[59] This is especially the case between 1973 and 1979, when both coefficients (measured in absolute terms) first fell quite sharply and subsequently rose again.

[60] An intercept shift in 1979 was also tested, but yielded slightly less satisfactory results than the equation including the US rate. As for Germany, the latter was found to be significant for the whole sample period, with no parameter change in 1979.

Italy. At first sight the disequilibrium approach appears to offer clear advantages: both conventional money demand equations have very large standard errors and long lags, with the M_3 equation actually being unstable. By contrast, the lags obtained for the short-term interest rate equations are much shorter and the implied long-run demand elasticities are reduced. However, both equations suffer from autocorrelation and the long-term rate may serve as an additional or alternative channel of adjustment, even if the average lag exceeds two years.

The conventional equations also have unstable parameters (Graphs 6a and b), with M_1 showing a very large drop in the estimated interest rate coefficient. For M_3 the interest rate is also the major source of instability, although the equation is not rejected by the Chow test (see Table 8). A main feature of Graphs 6c and d is the trend rise (in absolute terms) in the coefficient with respect to the proxy for monetary disequilibrium and the corresponding trend decline in the average lags. This points to a gradual rise in the influence of market forces over the period considered, possibly reflecting the change in policy controls from one of interest rate smoothing (or control) to aggregate credit targets. At the same time, Graphs 6c and d do not reveal any abrupt structural shifts.

These gradual parameter changes were modelled in two alternative ways in the modified equations reported in the last two lines of Table 6: by introducing a linear trend as a separate argument (equation 4*) and by pre-multiplying m and y by a trend (4**). As for the other countries considered, the short-term US rate was also included and the result of these modifications is a reduction (in absolute terms) of the elasticities of the long-run money demand function. Moreover, the US rate has a significant influence in both versions and the average lag is reduced to 0.7 and 1.2 quarters respectively. Apart from the estimated lags there are no major differences between the two versions of the trend correction, but neither the US rate nor the trend has solved the problem of autocorrelation.[61]

[61] The various modifications were also tried on M_1 with very similar results.

Table 6
Italy: Money demand and interest rate equations.

Dependent variable	Independent variables						Additional variables		Statistics			Long-run money demand elasticities			Average lag
	C	m	y	IRS	$\dot{p}$	Lagged dep.	Tr	IRUS	SE	h	δ	y	IR[1]	$\dot{p}$[1,2]	(quarters)
(1) M_1	−0.67 (2.7)	–	0.11 (2.1)	−0.27 (2.3)	−0.18 (2.5)	0.96 (35.1)			1.8	0.7	–	3.2	−1.46	−0.95	27.6
(2) IRS	−95.1 (4.9)	−8.55 (3.9)	19.08 (4.6)	–	0.21 (3.8)	0.49 (6.2)			1.1	2.8	0.4	2.2	−1.10	−0.63	1.0
(3) M_3	−0.18 (0.6)	–	0.01 (0.1)	−0.16 (1.9)	−0.09 (1.5)	1.00 (16.6)			1.6	0.4	–	–	–	–	–
(4) IRS	−99.1 (4.5)	−14.60 (3.6)	26.77 (4.1)	–	0.14 (2.8)	0.65 (9.9)			1.1	1.6	0.4	1.8	−0.44	−0.25	1.8
(5) IRL	−23.0 (2.2)	−3.74 (2.0)	6.64 (2.1)	–	0.05 (2.7)	0.89 (28.9)			0.5	0.4	0.3	1.8	−0.52	−0.28	8.2
(4*) IRS	–	−15.15 (3.6)	16.54 (3.6)	–	0.21 (3.9)	0.40 (4.8)	0.12 (4.0)	0.19 (2.4)	1.1	1.2	0.4	1.1	−0.73	0.46	0.7
(4**) IRS	−1.53 (2.7)	−0.14[3] (1.9)	0.16[3] (2.0)	–	0.19 (3.5)	0.54 (6.9)	–	0.22 (2.8)	1.1	1.3	0.4	1.2	−0.73[4]	−0.40[4]	1.2

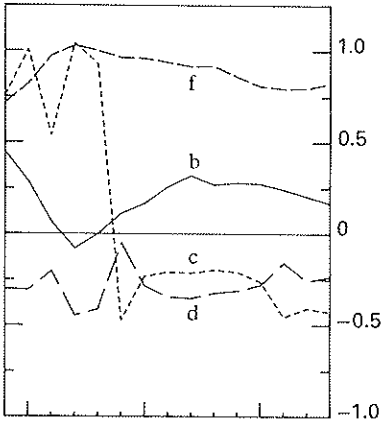
Notation: C = Constant term
m = Real money stock
y = Real GNP/GDP
IRS = Short-term interest rate
IRL = Long-term interest rate
$\dot{p}$ = Rate of change in GNP deflator over four quarters
SE = Standard error of estimates (percentages)
h = Durbin's h-statistic
δ = First-order autocorrelation coefficient.
Additional variables explained in text.

[1] Elasticities calculated at 1980–83 average rates. IR and $\dot{p}$ measured as fractions in the money demand functions and as percentages in the interest rate equations.
[2] Calculated on the assumption that in the long run nominal interest rates fully reflect changes in the rate of inflation (see Annex I).
[3] Coefficient with respect to the products of trend and y and m respectively.
[4] Calculated at average trend-value for 1980–83.

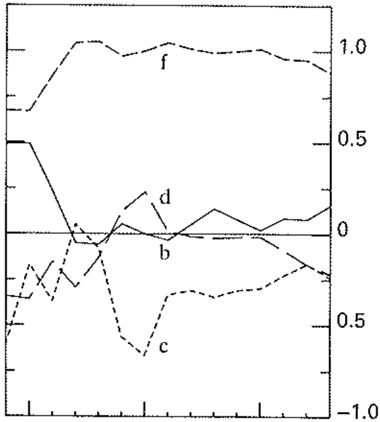
Graph 6

Italy: Parameter estimates 1960–69 to 1974–83

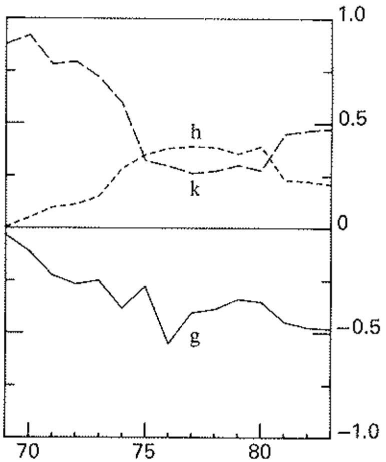
(a) $M_1 = a + bY + cIRS + d\dot{p} + fM_{-1}$



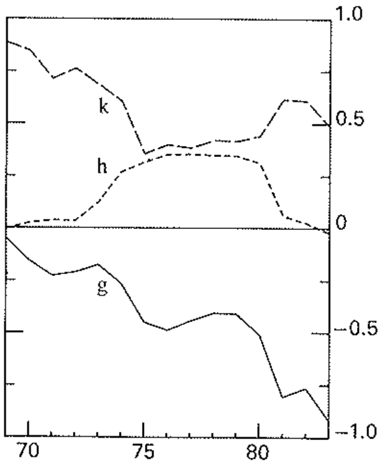
(b) $M_3 = a + bY + cIRS + d\dot{p} + fM_{-1}$



(c) $IRS = a + g(M_1 - 2.20Y) + h\dot{p} + kIRS_{-1}$



(d) $IRS = a + g(M_3 - 1.70Y) + h\dot{p} + kIRS_{-1}$



As in Japan, the alternative approach appears to be equally preferable for both narrow and broad aggregates, and in the case of Italy there may be several reasons for this: (i) the authorities have adopted a credit rather than a monetary aggregate target; (ii) deviations from the targets can, to a large extent, be explained by the growing credit demand of the public sector and by movements in foreign reserves. Consequently, short-run money stock movements can best be seen as determined residually through the counterparts identity and as exogenous relative to the arguments of the money demand function; (iii) since all deposits carry interest rates, a certain similarity in the behaviour of narrow and broader aggregates is to be expected. The alternative interest rate equations are largely satisfactory, except that the various modifications have not solved the problem of autocorrelation.

Canada. Canada turned out to be the most difficult case for testing the alternative approaches to the demand for money and the results shown in Table 7 are very tentative and preliminary. Both conventional equations show long lags and the standard errors are high, compared, for instance, with those found for the United States. However, it was not possible to derive a satisfactory interest rate equation corresponding to M_3 and when short-term rates were used as an alternative to the conventional M_1 function it was necessary to introduce various modifications to allow for periods of fixed and flexible exchange rates.[62] For the period 1962/II–1970/III, when the Canadian dollar was fixed relative to the US dollar, the US short-term interest rate replaced the rate of domestic inflation as an argument on the assumption that rate differentials had to be contained in order to prevent exchange rate pressures through capital flows. For the period 1975/II–1983/IV, on the other hand, both the US short-term rate and the domestic inflation rate were entered as arguments, as the inflation rate can be expected to play a larger rôle in a flexible exchange rate régime, while, at the same time, the policy of the authorities can be interpreted as gradually

[62] See also Laidler et al. (1983).

Table 7

Canada: Money demand and interest rate equations.

Dependent variable	Independent variables							Statistics			Long-run money demand elasticities			Average lag
	C	m	y	IRS	IRL	$\dot{p}$	Lagged dep.	SE	h	δ	y	IR[1]	$\dot{p}$ [1,2]	(quarters)
(1) M_1	−0.13 (0.9)	–	0.07 (5.0)	−0.54 (6.6)	–	−0.06 (0.7)	0.93 (36.0)	1.4	−1.1	–	1.05	−1.05	−0.08	13.5
(2) M_1	−0.33 (1.9)	–	0.08 (3.2)	–	−0.56 (3.3)	−0.22 (2.7)	0.93 (24.6)	1.6	0.3	–	1.35	−1.30	−0.33	14.7
(3) IRS	–	−1.03[3] (5.2)		0.37[5] (4.6)	0.38[6] (8.4)	0.24[7] (4.2)	0.30 (4.2)	0.9	1.4	0.4	1.00[4]	−9.1	−4.2	0.4
(4) IRL	−5.46 (0.8)	−1.79 (1.1)	2.05 (1.6)	–	–	0.05 (1.7)	0.80 (10.7)	0.6	0.5	0.2	1.14	−1.56	−0.74	4.2
(5) M_3	−0.42 (2.6)	–	0.11 (3.0)	–	−0.06 (0.4)	–	0.92 (29.1)	1.3	0.4	0.3	1.39	−0.12	–	11.3
(3) IRS	7.54 (2.4)	2.75[3] (1.7)		0.38[5] (5.0)	0.43[6] (8.4)	0.27[7] (5.0)	0.39 (5.2)	0.8	1.1	0.3	–	–	–	0.6

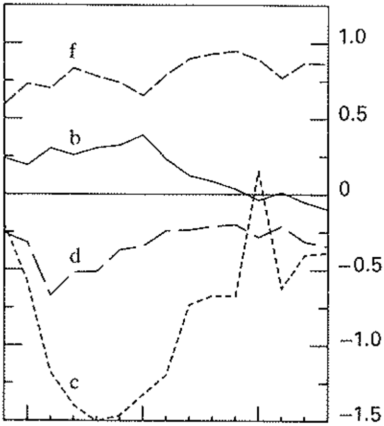
Notation: C = Constant term
m = Real money stock
y = Real GNP/GDP
IRS = Short-term interest rate
IRL = Long-term interest rate
$\dot{p}$ = Rate of change in GNP deflator over four quarters
SE = Standard error of estimates (percentages)
h = Durbin's h-statistic
δ = First-order autocorrelation coefficient.

[1] Elasticities calculated at 1980–83 average rates. IR and $\dot{p}$ measured as fractions in the money demand functions and as percentages in the interest rate equations.
[2] Calculated on the assumption that in the long run nominal interest rates fully reflect changes in the rate of inflation (see Annex I).
[3] Coefficient with respect to (m–by).
[4] Derived by iterative process.
[5] US short-term rate 1962/II–1970/II.
[6] US short-term rate 1975/II–1983/IV.
[7] Excluding 1962/II–1970/II.

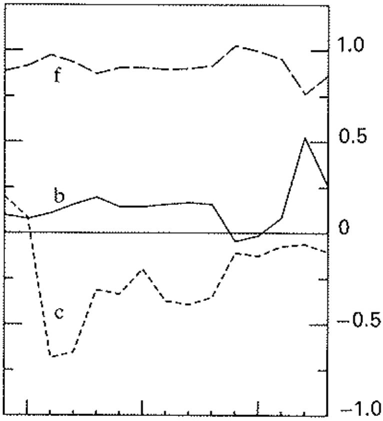
Graph 7

Canada: Parameter estimates 1960–69 to 1974–83

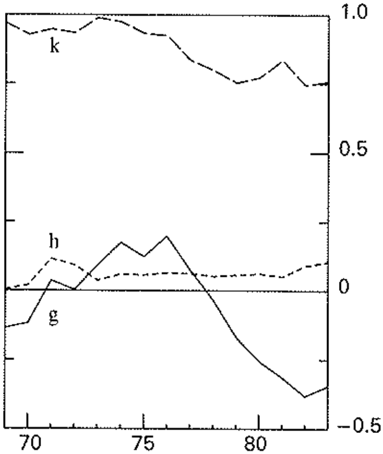
(a) $M_1 = a + bY + cIRL + d\dot{p} + fM_{-1}$



(b) $M_2 = a + bY + cIRL + fM_{-1}$



(c) $IRL = a + g(M_1 - 1.14Y) + h\dot{p} + kIRL_{-1}$



moving towards stabilisation of the exchange rate through maintenance of a certain differential against the US rate.

These modifications are admittedly ad hoc, but, even so, the resulting equation is far from satisfactory. The implied interest rate elasticity of the long-run demand for M_1 is much too high and the short lag probably reflects a very narrow band around the US rate rather than a quick adjustment to a disequilibrium in the domestic money markets.[63] Against this background the long-term rate seems to offer a more promising channel of adjustment, as the average lag is only four quarters, the implied money demand elasticities look plausible, and the interest rate equation itself does not point to errors of specifications.[64]

The various stability tests also show that the estimates for Canada are still at a preliminary stage. M_1 is unstable (see Table 8)[65] and it appears (see Graph 7a) that the interest rate coefficient is the main cause of the instability. For M_3, large but statistically insignificant fluctuations are observed for the coefficients on both income and the rate of interest and for the long-term interest rate equation the parameter for the disequilibrium proxy is clearly unstable (see Graph 7c). In fact, it obtains the wrong sign throughout the period 1971–78.

For the various reasons given above it is difficult to draw even tentative conclusions in the case of Canada, except that interest rates are probably not the most appropriate transmission channel given

[63] Given the use of short-term interest rates as the principal instrument in bringing M_1 growth into line with that of nominal income, attempts at modelling short-term interest rate movements may be capturing a reaction function rather than the influence of market forces. In fact, when equation 3 was estimated including an intercept term the result was that shown in equation 3′ in the last line of Table 7. This is slightly more satisfactory than what was obtained before, but, as in the case of the modified equations for France, the sign on the money-market pressure variable (m–by) has now been reversed.

[64] However, when the US rate is included as an additional argument it totally dominates the equation.

[65] See also Rausser and Laumas (1976).

Table 8
Stability test.

Countries	Equation No.[1]	Dependent variable	SSQR ratio[2]
United States	(1)	M_1	1.6
	(2)	IRS	0.6
	(3)	M_3	7.5
	(4)	IRS	1.8
Japan	(1)	M_1	3.6
	(2)	IRS	0.6
	(3)	M_2	4.6
	(4)	IRS	2.1
Germany	(1)	M_1	1.9
	(2)	IRS	1.4
	(3)	M_3	2.7
	(4)	IRS	3.0
France	(1)	M_1	4.7
	(2)	IRS	3.9
	(3)	M_2	3.9
	(4)	IRS	1.6
United Kingdom	(1)	M_1	1.6
	(2)	IRS	0.4
	(3)	M_3	5.5
	(4)	IRS	0.2
Italy	(1)	M_1	4.7
	(2)	IRS	0.5
	(3)	M_3	1.2
	(4)	IRS	9.1
Canada	(2)	M_1	5.1
	(4)	IRL	0.6
	(5)	M_3	0.3

[1] See Tables 1–7

[2] Calculated as $\dfrac{(SSQR_{63-83}-SSQR_{63-73}-SSQR_{73-83})/k}{(SSQR_{63-73}+SSQR_{73-83})/(n-2k)}$

where n= number of observations, k=number of explanatory variables and the SSQR terms refer to the sum of squared residuals for the periods incicated by the subscripts. The critical values of the F test are for equations with five explanatory variables 2.3–3.2 (significance at the 5 per cent. and 1 per cent. levels respectively) and 2.5–3.6 for equations with only four variables.

the close link to US rates. Instead, adjustments to a monetary disequilibrium may be sought in exchange rate movements and/or in capital flows.

III
Summary, conclusions and future work

From the empirical evidence presented in Part II it can be concluded that in four of the seven countries, viz. the United States, Japan, the United Kingdom and Italy, the alternative procedure proposed in this paper is clearly better than the conventional approach to estimating money demand functions. For Germany some marginal improvements are also found, whereas for France and Canada the alternative procedure does not work when interest rates are used as the adjustment channel.

A second conclusion is that in two countries (the United States and the United Kingdom) the gains were most pronounced for those aggregates which are targeted by the authorities. Germany could also be added, as slightly better results were obtained for M_3 (which is very closely related to the central-bank money stock targeted by the authorities), while in Japan and Italy, more satisfactory estimates were obtained for both narrow and broad aggregates.

Thirdly, in the United States, Japan and the United Kingdom the short-term interest rate appears to be the principal transmission channel. In Germany and Italy, on the other hand, the removal of a monetary disequilibrium seems to occur through variations in both short and long-term rates.

Given the technical nature of this paper, relatively few policy implications can be drawn and they do not apply equally strongly to all of the seven countries. It is, however, worth re-emphasising that the alternative approach offered promising results for both narrow and more broadly defined aggregates. This suggests that the authorities may have had an independent influence on the development of money balances and have not just accommodated changes in money demand as some would claim and as the conventional approach assumes.

Secondly, the fact that the disequilibrium approach generated a more satisfactory dynamic adjustment process in money markets as well as plausible elasticities for the long-run money demand function might indicate that these functions are not as unstable as has been claimed. Short-term and transitory aberrations may, of course, call for a less rigorous pursuit of the targets (M_1 in the United States) or for a temporary suspension (M_1 in Canada). Moreover, the tests presented do not, by any means, preclude the fact that permanent shifts have occurred from time to time. Nevertheless, the underlying money demand functions derived in this paper could for some countries serve as a preliminary basis for the setting of medium-term policy targets.

Thirdly, even if the results obtained are not considered sufficiently robust in their present form, the mere recognition of an alternative approach would imply that conclusions with respect to the stability of money demand functions should not be drawn until the various adjustment channels have been explored. Tests and analyses confined to conventional money demand functions are insufficient (and frequently unnecessary) and could lead to a premature change in the control of monetary aggregates and in the choice of policy targets.[66]

It is, however, on this last point that the present paper is most incomplete and needs to be supplemented by further work:

– in the first place, only the transmission mechanism via interest rate movements has been tested and in most cases the results obtained need further examination. Particularly for small and open economies, changes in foreign reserves and/or in exchange rates may be more likely candidates as primary channels of adjustment;

– secondly, the paper has only tested the first stage of the two-

[66] For instance, an observed shift in money balances might call for a change in control procedures if it originated on the demand side, whereas a supply-induced shift would have different policy implications. See Judd and Scadding (1981).

stage procedure outlined on page 16. However, the second stage should also be developed in order to derive more precise measures of buffer stock holdings of money. Once such measures are obtained, additional (and possibly quite powerful) transmission effects of monetary policy changes through real expenditure and the rate of inflation could be explored;

– thirdly, the assumption that short-run money supply is determined residually via the counterparts identity needs to be relaxed. In the first place, to the extent that this assumption is invalid, the coefficients reported in this paper will be biased. Secondly, the buffer stock function of money may be satisfied by variations in bank credit as well as by changes in money holdings. Thirdly, endogenising the credit demand of the non-financial sectors and the portfolio behaviour of the financial sector is likely to throw additional light on the causes and consequences of money-market disequilibrium.[67]

[67] See Judd and Scadding (1981) and Davidson (1984).

Annex I
Specification of estimated equations

For each of the seven countries two sets of equations were estimated on seasonally adjusted quarterly data: demand equations for narrow and broad monetary aggregates and interest rate equations for long and short-term interest rates. The money demand equations were specified along traditional lines using real money stocks as the dependent variable and real income, interest rates and the lagged dependent variable as the principal arguments. The specification, which initially was the same for all countries but was subsequently adjusted in the light of the results obtained, also included the rate of inflation, measured as the percentage change in the GDP deflator over four quarters.[68] However, the coefficient on this variable is difficult to interpret as it may reflect the effect of several different factors:

– in earlier studies the rate of inflation has frequently been left out on the assumption that inflationary expectations were already included in nominal interest rates. However, because of lags, tax regulations and institutional factors, nominal interest rates may only partly reflect inflationary expectations (and thereby the opportunity cost of holding money), especially in periods of rapid acceleration or deceleration in the rate of price increases;

– as discussed in Annex II, it is not certain whether the partial adjustment scheme should be applied to nominal or real money stocks. The estimates shown in Tables 1 to 7 are based on a specification in real terms, whereby log $(M/P)_{t-1}$ enters as an argument in the money demand function with a coefficient of (1–d) (see page 9). Assuming that the adjustments apply to nominal balances leads to the term (1–d) log (M_{t-1}/P_t), i.e. the lagged nominal money stock deflated by the current price level. This is equivalent to a specification in real terms and a separate term in the current rate of inflation, implying that the coefficients reported in Tables 1 to 7 reflect the impact of inflationary expectations as well as the effect of the real adjustment scheme;

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[68] Initially the rate of unemployment was also included as a proxy for uncertainty in an attempt to capture the precautionary motive. However, the coefficients obtained were in most cases insignificant or of the wrong sign, suggesting that the precautionary motive is already captured by other arguments or that the rate of unemployment is a poor proxy. For the European countries this finding is contrary to the results obtained by den Butter and Fase (1981), whereas for the United States Goldfeld (1976) observes that conventional money demand functions tend to overpredict M_1 in recessions. Furthermore, in a study of the demand for transactions balances, the Bank of England (1982) finds a negative impact of the rate of unemployment and ascribes this to a decline in weekly salary payments, when employment falls.

– all the equations reported in the text assume that the demand for nominal balances is homogenous of degree one with respect to prices. Alternative studies indicate that this assumption is valid for most countries, but if it does not hold, the coefficient on the rate of inflation contains a specification error. For instance, when the elasticity of nominal balances with respect to prices is higher than unity, the coefficient has a positive bias, and conversely for elasticities significantly below unity;

– finally, the rate of inflation may serve as a proxy for uncertainty and the associated precautionary motive for holding money.[69] On this assumption, the coefficient is positive, as agents would tend to demand more money in periods of accelerating inflation.

Although the various arguments given above have conflicting implications for the sign of the inflation rate in a money demand equation stated in real terms, it would seem reasonable to assume a negative net effect.[70] However, in cases where the precautionary motive is strong and/or the price elasticity is well above unity, the coefficient obtained may not differ significantly from zero.

With the addition of the rate of inflation the money demand functions tested can be written as:

$m_t = a + by_t + ci_t + d\dot{p}_t + fm_{t-1}$

and the expected signs of the parameters are: $a \gtrless 0$, $b > 0$, $c < 0$, $d \leq 0$ and $0 < f < 1$.[71]

From the estimated money demand functions there are three candidates[72] for the transmission process: income, interest rates and the rate of inflation. Interest rates were considered the most likely variable of adjustment mainly for two reasons:

– the response lag is likely to be shorter than for real income and, especially, for the rate of inflation;

[69] The variability of the rate of inflation has also been tested as a measure of uncertainty, but the results are rather mixed; see Klein (1975) and Buscher (1984).

[70] This implies that a fall in the actual or expected rate of inflation will reduce the income velocity of money, as happened in 1982–83. Keran (1984) obtains a similar result by considering equilibrium points in an IS–LM framework, where the IS curve is a function of real rates, the LM curve a function of nominal rates and real and nominal rates are linked by the Fisher equation.

[71] i and $\dot{p}$ have been measured in percentages, implying that the coefficients indicate the percentage change in the demand for money for each percentage point change in these variables. However, elasticity measures can easily be obtained by multiplying the coefficients by the current or average rates of $\dot{p}$ and i and these are shown in Tables 1 to 7 for the long-run money demand functions.

[72] As noted elsewhere, movements in exchange rates and foreign reserves may also serve to eliminate a discrepancy between money demand and supply, but they are usually not found as arguments in the money demand function.

– reduced-form interest rate equations were considered to be less complicated than the corresponding ones for real income and inflation.[73]

The equations actually applied in testing the usefulness of the disequilibrium approach were based on two simplifying assumptions:

(i) the equilibrium interest rate which clears the money market is influenced by two additional factors: the expected rate of inflation and cyclical conditions as measured by the rate of unemployment. An expression for the equilibrium rate can therefore be obtained by rewriting the money demand equation given above so that the rate of interest appears on the left-hand side and then adding the two additional terms:

$$i_t^* = (1/c)(m_t - by_t - d\dot{p}_t - a) + g\dot{p}_t + hu_t + k$$

k is an intercept term and has been added since $\dot{p}$ and u in the estimation equation given below should be measured as deviations from past averages;

(ii) the actual interest rate in period t adjusts to the equilibrium rate according to a partial scheme:[74]

$$i_t - i_{t-1} = j\,(i_t^* - i_{t-1}), \text{ where } 0 < j < 1$$

or, substituting for i_t^*:

$$i_t = (j/c)(m_t - by_t - d\dot{p}_t - a) + jg\,\dot{p}_t + jh\,u_t + jk + (1-j)\,i_{t-1}$$

If it can be assumed that in the long run inflation is fully reflected in nominal interest rates, g may be set equal to 1 and the estimation equation can be written as:[75]

$$i_t = a' + b'y_t + c'm_t + d'\dot{p}_t + e'u_t + j'i_{t-1} \text{ with}$$

$$a' = jk - aj/c \lesseqgtr 0$$

$$b' = -bj/c > 0$$

$$c' = j/c < 0$$

$$d' = -dj/c + j \lesseqgtr 0$$

$$e' = jh < 0$$

$$j' = (1-j) \text{ with } 0 < (1-j) < 1.$$

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[73] This is not to say that the derivation of interest rate equations is without complications. In fact, several of the estimates presented in Tables 1 to 7 show signs of mis-specification.

[74] Assuming that the hypothesis with respect to interest rate adjustments is correct and accepting the notion of transitory buffer stocks, the average lag $(1-j)/j$ would correspond to the speed with which buffer stocks are being "unloaded" onto the money market. This lag serves to reduce the risk of interest rates overshooting in conditions of a monetary disequilibrium; see White (1981).

[75] If g is less than unity, the long-run price coefficients given in Tables 1 to 7 would be smaller in absolute terms. On the other hand, assuming that $d < 0$ and that interest rate changes serve to clear money markets the finding that $d'/1-j)<1$ cannot be taken as proof that the so-called Fisher effect is below unity. A more vigorous and extensive discussion of this issue can be found in Patterson and Ryding (1984).

From these expressions, the coefficients of the underlying money demand equation can be derived through the following steps:

– from j′ calculate j and the average speed of adjustment j′/(1–j′)
– from c′ calculate c as j/c′
– from b′ and c′ calculate b as – b′/c′
– from d′ calculate d as – (d′ – j)/c′.

It is therefore possible to derive all the parameters of the long-run money demand function, and the coefficients reported in Tables 1 to 7 are in most cases plausible. Nonetheless, two problems encountered in the empirical work should be mentioned:

(i) since m_t and y_t are highly correlated,[76] it proved difficult, in some cases, to estimate separate coefficients and even when this was possible the parameters were very unstable and highly dependent on the specific time period chosen.[77] On the other hand, given the restrictions on the parameters b′ and c′, a constrained procedure is likely to give more efficient estimates. This was implemented in a rather crude way as in those cases where y and m were too highly correlated they were replaced by the variable $(m–by)_t$ with b determined in an iterative process;[78]

(ii) for several countries the interest rate equations were subject to autocorrelation, suggesting that certain variables are missing from the specification chosen. In the results reported in equations 1 to 5 of Tables 1 to 7, this problem has been "solved" by using the Cochrane-Orcutt correction procedure,[79] but it would,

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[76] Assuming that money is exogenous, this high correlation may be indicative of a direct effect of real money stocks on the level of activity.

[77] The unusually stong dependence on the time periods chosen also helps to explain why earlier studies have often led to conflicting conclusions with respect to the robustness of the interest rate adjustment channel. For this reason the parameters shown in the graphs were obtained by using the income coefficient (b) for the total-period equation and estimating only the coefficient with respect to (m–by) for the sub-periods.

[78] In practice, the first b-value chosen was close to that obtained from the conventional approach and the search continued until the coefficient of determination appeared to reach a maximum. In several cases, however, the likelihood function was rather flat, so that the reported b-values are not very well determined.

[79] In this context it should be recalled that in the presence of autocorrelation the coefficient on the lagged dependent variable will be biased towards unity. Consequently, the "true" lags in the interest rate equations are likely to be even shorter than those shown in Tables 1 to 7. On the other hand, since autocorrelation was absent from most of the conventional money demand estimates, the very long adjustment lags found in these equations cannot be ascribed to estimation biases of this sort.

obviously, have been more satisfactory to search for the missing variables. Consequently, additional tests of two kinds were carried out. In the first place, international rates, proxied by the short-term US rate (or the German rate, in the case of France), were entered except for the United States. Secondly, dummy variables, specified as intercept shifts or as changes in one or more of the coefficients, were introduced as proxies for the structural shifts observed in the stability graphs and in the pattern of residuals of the interest rate equations. In some cases these additions helped to explain the shifts observed in the graphs and to yield more satisfactory parameters. However, the problem of autocorrelation remained.[80]

All the equations were estimated using ordinary least squares, and the parameters obtained are presented in Tables 1 to 7 with t-statistics shown in brackets. The tables further report standard errors of estimates (which can be interpreted as percentage errors for the money demand equations and as percentage point errors for the interest rate equations), h-statistics (which are the appropriate measures of autocorrelation when the lagged dependent variable is included among the arguments) and the first-order autocorrelation coefficients, when corrections were made (δ).[81] The R^2s are not shown, as in all cases they were 0.95 or higher and therefore of little comparative interest.

The last four columns of the tables indicate the average adjustment lags together with the implied elasticities of the long-run money functions, which, in the cases of the interest and inflation rate elasticities, were calculated using the average rates for 1980–83.

Finally, the stability of the parameters was evaluated by a visual inspection of parameter values obtained for different sub-periods[82, 83] and by the Chow test. The

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[80] The autocorrelation problem should not be taken lightly. As pointed out by Coats (1982), the derivation of money supply changes from the counterparts identity implicitly assumes that credit markets clear. If, however, interest rates are determined in credit markets (see Laidler (1984)) or disequilibria are more likely to occur in credit markets than in money markets (see Kaldor (1980) and White (1981)), the interest rate equations used in the present paper are badly mis-specified.

[81] All interest rate equations were tested for autocorrelation of first to fourth order, but only the equations for the United States showed evidence of significant autocorrelation of order higher than 1.

[82] A whole battery of statistical tests are available for evaluating the stability of estimated equations (see, for instance, Boughton (1980) and OECD (1984)). Very often these tests yield conflicting results, owing partly to the specific nature of the test statistics and partly to differences in the type of instability they are designed to measure. We have not applied these tests, except for the Chow test, but it is natural to mention a recent test developed by Cooley and Prescot (1976) which is designed to distinguish between permanent and transitory changes in the regression coefficients

latter is designed as a measure of stability (using the F-distribution to determine levels of significance), which is derived by first estimating a given equation over a longer period (constrained estimates) and then re-estimating it on two pre-chosen sub-periods where the coefficients are allowed to take separate values for each of the sub-periods (unconstrained estimates). If the unconstrained estimates produce a marked reduction in the sum of squared residuals compared with the constrained estimates, the test will reject the null hypothesis of unchanged parameters. It is generally recognised that the Chow test is a relatively weak test, which accepts the null hypothesis when other indicators suggest instability, and this may in part explain the differences between the graphs and the figures shown in Table 8.[84] However, two additional sources of discrepancy should be mentioned: firstly, in order to make the two sub-periods consistent with the overall period, the Chow test was confined to the last twenty years of the sample period (i.e. the period 1960–63 was left out); secondly, when the equation tested is poorly determined, the Chow test is likely to be passed. This last point is particularly relevant, as all the parameters displayed in the graphs were derived from preliminary equations.

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and which could have served as a useful adjunct to the graphs. However, this test requires rather strong prior assumptions and some recent results (for instance, acceptance of a stable M_1 function for the United States and a stable sterling M_3 function for the United Kingdom (see Ram (1981)) made us a little doubtful of its usefulness.

[83] In the graphs, the parameter values are shown relative to the *final* years of the overlapping regressions.

[84] For instance, when the unexplained residuals are concentrated in one of the sub-periods the Chow test does not reveal any parameter shifts, even though such a distribution of the residuals strongly suggests a structural change. This is particularly the case for the interest rate equations shown for France but was also found for other countries.

Annex II
Alternative lag structure and adjustment patterns

The partial adjustment scheme applied throughout this paper is frequently used in estimating money demand functions. At the same time, this scheme has been widely criticised, a particular problem being that it imposes the same lag structure on all the arguments of the money demand function. It may, therefore, be useful briefly to discuss alternative adjustment schemes and to illustrate the restrictions and limitations of the partial scheme within a more general framework. An additional and related issue is whether the adjustment mechanism – in whatever form – should be applied to real or nominal money stocks (see Annex I).

One feature of the partial adjustment scheme is that it adopts a specific lag pattern without testing more general forms. By contrast, if one starts with the most general structure consistent with the data, it is possible to test the validity of various restrictions suggested by economic theory and in this way arrive at a final form which is consistent with both the data and a specific economic hypothesis.[85]

As an illustration (and using the same notation as in Annex I), consider a general first-order lag form, where, in order to simplify the presentation, the inflation rate is not included among the arguments:[86]

$$m_t = a_0 + a_1y_t + a_2y_{t-1} + a_3i_t + a_4i_{t-1} + a_5m_{t-1}$$

Specific hypotheses may now be presented and illustrated by introducing various restrictions on the coefficients.

(i) $a_2 = a_4 = 0$ and $0 < a_5 < 1$

which yields the equation:

$$m_t = a_0 + a_1y_t + a_3i_t + a_5m_{t-1}$$

Except for the inflation rate term, this is easily seen to be identical to the partial adjustment scheme used in this paper.

(ii) $a_0 = 0$, $a_2 = -a_1$, $a_4 = -a_3$ and $a_5 = 1$

which implies that the money demand equation can be written in first-difference form:

$$dm_t = a_1dy_t + a_3di_t$$

This has been used in several studies for the United States and the United Kingdom

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[85] This procedure is often referred to as a "general to particular" search strategy and was first proposed by D.F. Hendry. It has been applied to UK money demand functions by Hendry as well as in other studies (see bibliography) and has also found wide application outside the area of monetary economics.

[86] As noted in Hendry et al. (1982), at least nine specific forms may be derived from this general form. Even so, the choice of a first-order form in itself implies a severe restriction and for quarterly data one would normally start with fourth or fifth-order lags.

and is often found to yield better predictions than the conventional equations in level form. However, it has the disadvantage that there is no longer-run relationship between the levels of income and money.

(iii) $a_4 = -a_3$

which implies a money demand function of the form:

$$dm_t = a_0 + a_1 dy_t + a_3 di_t + (a_5 - 1)(m/y)_{t-1} + (a_1 + a_2 + a_5 - 1)y_{t-1}$$

This differs from (ii) by introducing the "error correction term" $(m/y)_{t-1}$, which not only imposes a certain long-run relationship between m and y but also lets past deviations between m and y influence the current rate of change in money demand. The last term may be interpreted as a measure of the precise long-term relationship between m and y, with a coefficient significantly different from zero implying that the income elasticity of money demand differs from unity. Given the emphasis on possible disequilibrium effects, this estimation procedure offers several advantages in the context of the present paper and it has been used to improve estimates for the United Kingdom. However, when Gordon (1984) tested it on US data he found little support, and the same applies to OECD (1984), which tested a more condensed version on data for the seven major countries.

(iv) $a_2 = 0$, $a_4 = -a_3a_5$, and $0 \leq a_5 \leq 1$.

These restrictions may be derived from a money demand equation where actual income is replaced by expected income and the latter is determined by an adaptive expectations-generating function:

$$y_t^e = y_{t-1}^e + k\,(y_t - y_{t-1}^e) = ky_t + (1 - k)\,y_{t-1}^e$$

By continued substitution this yields:

$$y_t^e = k(y_t + (1 - k)y_{t-1}\,(1 - k)^2 y_{t-2} + \ldots (1 - k)^n y_{t-n} \ldots) = k \sum_{i=0}^{\infty} (1 - k)^i y_{t-i}$$

so that the original demand function:

$$m_t = a + b\,y_t^e + c\,i_t$$

can be rewritten as:

$$m_t = a + bk \sum_{i=0}^{\infty} (1 - k)^i y_{t-i} + c\,i_t$$

Using a Koyck-transformation, this equation may finally be expressed as:

$$m_t = a - (1 - k)a + bk\,y_t + c\,i_r - c(1 - k)\,i_{t-i} + (1 - k)\,m_{t-1} \text{ or}$$

$$m_t = a_0 + a_1 y_t + a_3 i_t + a_4 i_{t-1} + a_5 m_{t-1} \text{ with } a_4 = -a_3 a_5$$

Except for the term in i_{t-1} this is similar to the partial adjustment scheme and the statistical significance of a_4 could, therefore, be taken as an indication of whether the lags have been generated by a partial adjustment scheme or by adaptive expectations with respect to income.[87] Moreover, if lags of order higher than one were introduced, this test could be extended to include expectation effects for arguments other than income, just as the existence of expectation effects as well as adjustment lags could be tested.[88]

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[87] The pattern of residuals may also be considered in this respect.

[88] See den Butter and Fase (1981) and the pioneering article by Feige (1968).

Consequently, even a very simple but general lag structure leads to numerous alternative options, and if some of these had been further explored an improvement of the empirical estimates might in some cases have been obtained. However, to facilitate comparisons between alternative dynamic adjustment paths and between countries, only the partial adjustment scheme was tried. An additional consideration was that the improvements obtained by more general and sophisticated methods are frequently only marginal.

Another issue with respect to the partial adjustment scheme is whether it should be applied to nominal or real balances.[89] The equations reported in the text are all based on adjustments in real terms which implicitly assume that nominal balances respond to price changes without lags. Alternatively, the adjustment scheme could be applied to nominal balances and this has implications for the lag structure as well as for the estimated coefficient on the inflation rate (see Annex I). As an illustration, assume as in the text that

$$m_t^* = \log(M^*/P) = a + b\,y_t + c\,i_t.$$

Next, however, specify the adjustment function as:

$$\log(M_t/M_{t-1}) = d\,\log(M^*/M_{t-1})$$

Substituting for M^* then gives:

$$\log M_t = d\,(a + b\,y_t + c\,i_t) + d\,\log P_t + (1 - d)\,\log M_{t-1} \text{ or}$$

$$m_t = da + db\,y_t + dc\,i_t + (1 - d)\,\log(M_{t-1}/P_t) \text{ or}^{[90]}$$

$$m_t = da + db\,y_t + dc\,i_t + (d - 1)\,\log(P_t/P_{t-1}) + (1 - d)\,m_{t-1}$$

where $\log(P_t/P_{t-1})$ is virtually identical to the percentage change in prices. As an illustration, consider the following equation for M_1 in the United States, estimated with nominal adjustments:

$$\log(M/P)_t = \underset{(6.6)}{0.045\,y_t} - \underset{(2.7)}{0.110\,i_t} - \underset{(1.6)}{0.078\,\dot{p}_t} + \underset{(110.9)}{0.945\,\log(M_{t-1}/P_t)}$$

Comparing this with equation 1 of Table 1 and recalling that $\dot{p}$ is measured as the rate of change over four quarters, it can be seen that the specific inflation effect may be estimated at $4\times(-0.300) - 0.943 = -0.257$, which is quite close to $4\times(-0.078) = -0.312$.[91]

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[89] Goldfeld (1976) and Hafer and Hein (1980) find some support for the adjustment based on nominal money stocks and the same applies to Gordon (1984). Carr and Darby (1981), on the other hand, present strong arguments for the real adjustment.

[90] Coats (1982) offers yet another adjustment scheme where the last term is $\log(M/P_{t-1})$ and the same is used by Laidler (1982) to illustrate the case where price changes serve as the main channel of adjustment.

[91] For further discussion of this issue and of the influence of inflation on the steady state demand for money, see Cuthbertson (1984) and Milbourne (1983).

Annex III
Definitions and data sources

M_1	all countries, narrow money stock, national definitions,[92] quarterly averages of monthly figures, s.a.
$M_{2/3}$	broad money stock, national definitions, quarterly averages of monthly figures, s.a. United States: M_3 Japan: M_2 + CDs Germany: M_3 France: M_2 United Kingdom: sterling M_3 Italy: M_3 (1960–63 – taken from OECD Main Economic Indicators) Canada: currency + total Canadian dollar privately held chartered bank deposits
y	total income in constant market prices, quarterly figures, s.a. United States: GNP at 1972 prices Japan: GNP at 1975 prices Germany: GNP (expenditure) at 1976 prices France: GDP at 1970 prices United Kingdom: GDP (income) at 1980 prices Italy: GDP at 1970 prices Canada: GNP at 1971 prices
$\dot{p}$	all countries, GNP/GDP deflator, percentage change over four quarters, s.a.
u	all countries, number of unemployed as a percentage of civilian labour force, quarterly averages, s.a.
IRS	short-term interest rate, n.s.a., quarterly averages of daily or monthly figures United States: 90-day bankers' acceptances Japan: call money (unconditional) Germany: 3-month loans (from Frankfurt banks) France: day-to-day loans (data prior to 1976 from OECD Main Economic Indicators) United Kingdom: 91-day Treasury bills Italy: interbank demand deposits of more than 10^9 lire Canada: 3-month finance company paper
IRL	long-term interest rate, n.s.a., quarterly averages of daily or monthly figures

[92] Italy 1960–62 taken from OECD Main Economic Indicators.

United States: AAA (Moody's) corporate bonds
Japan: industrial bonds
Germany: fully taxed fixed-interest bearer bond yields
France: public and semi-public-sector bonds
United Kingdom: 20-year government stocks
Italy: 15-year bonds of specialised industrial credit institutions
Canada: all weighted long-term corporate bonds.

Annex IV
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