The importance of money

A research paper prepared in the Bank's Economic Section. The paper is largely the work of C. A. E. Goodhart, assisted, particularly in the preparation of the appendices, by A. D. Crockett.

Definition and function

The distinguishing characteristic of that set of assets which may be described as money is that they perform the function of a medium of exchange. This definition does not, however, allow for a clear-cut distinction in practice between those assets which should be regarded as money, and those which cannot be so treated. Cash and cheques drawn on banks are the means of payment for transactions which are generally acceptable in most developed economies, and this fact has led many to conclude that cash and demand deposits in banks are the only real monetary assets. There are, however, certain demand deposits, for example compensating balances held with banks in the United States, which cannot be freely used for transactions purposes. On the other hand possession of a balance on time deposit, or access to overdraft facilities, may allow a purchaser to draw a cheque on his bank account even when he has insufficient demand deposits to meet that cheque. A more fundamental point is that the set of assets which is acceptable as payment for transactions is not immutable over time; it has changed in the past and could do so again in the future. If people should find it economically advantageous to accept, and to proffer, other financial claims in payment for transactions, then the set of assets which is to be described as money will alter.

This difficulty in distinguishing exactly which set of assets most nearly accords with the definition of money, as set out above, has led some to emphasise other characteristics which monetary assets possess, for example 'liquidity' or 'money as a temporary abode of purchasing power'. Such alternative definitions have, in general, proved too indistinct for practical, and more particularly analytical, purposes. Others have argued, on *a priori* grounds, that one or another definition of money, though admittedly imperfect, is the best approximation to the underlying concept of money. Others again have argued that the matter can be determined empirically. If people should regard time deposits with deposit banks, but not time deposits with accepting houses, as close substitutes for demand deposits, then the former asset should be included in the definition of money and the latter asset excluded. To seek a definition in this way implies the expectation of finding a clear division whereby assets to be defined as money are close substitutes for each other, but markedly less close substitutes for all other—non-monetary—financial assets. Whether such a clear division is found in reality is considered later in this paper.

The function of money as a medium of exchange makes it a convenient asset to hold, because it enables the holder to avoid the time and effort which would otherwise have to be involved in synchronising market exchanges (*i.e.* by barter). Convenience, particularly where it involves time saving, is something of a luxury. For this reason one might expect the demand for money, to provide such services, to rise by more

than in proportion to the growth of real *per capita* incomes.[1] On the other hand, there are certain economies (of large scale) in cash management that can, in principle, be obtained as transactions get bigger and more frequent. This factor would result in the demand for money increasing by less than in proportion to the growth of real incomes.

The convenience to be enjoyed by holding money balances is only obtained at a cost – the cost, in effect, of not using the funds thereby tied up for purchases of more goods or alternative assets. As a broad principle, holders of money will adjust their holdings of money balances until the extra convenience from holding such balances just offsets the additional costs of having to make do with fewer other goods or assets. In order to bring about this adjustment, the money holder can, in principle, vary his purchases of anything else – financial assets, real capital goods, consumer goods – or of everything equally, in order to bring his money holdings into the desired balance with other possible uses of his funds.

In general, if the additional attraction (utility) of any good or asset does not match its cost, the main weight of the adjustment process falls, at least initially, upon changes in expenditures on close substitutes. If tomato soup seems to be getting rather expensive, the normal response is to buy less tomato soup and more oxtail soup, not less tomato soup and more company securities.

The transmission mechanism, whereby monetary influences affect decisions to spend generally, will be determined by the way in which people adjust their equilibrium portfolio of assets in response to a disturbance initiated, for example, by the intervention of the authorities in financial markets. These reactions, and therefore the transmission mechanism, will depend on which assets people view as particularly close substitutes for money balances.

The distinction between that theoretical approach to monetary analysis which may, perhaps unfairly, be termed 'Keynesian', and that approach which, equally unfairly, may be described as 'neo-quantity' or 'monetarist', turns mainly on divergent *a priori* expectations about the degree of substitution between money and other financial assets, and between financial assets and real assets. These differences are purposely exposed, and perhaps exaggerated, in the following sections, which provide a short résumé of the two approaches. As the points of contention between the two schools of thought can be reduced to issues that are, at least in principle, subject to empirical verification, it is not surprising that the results of the many statistical tests recently undertaken, mainly, however, using U.S. data, have brought many proponents of both views to modify their initial positions.

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1 Holding additional money balances, as compared with bonds or equities whose capital value is subject to variation, tends to reduce the risk of unforeseen variation in the capital value of a portfolio of assets taken as a whole. In so far as risk avoidance is also something of a luxury, proportionately more money might be held in portfolios for this reason as people became more affluent. On the other hand, the development of the financial system has led to the introduction of a number of alternative capital-certain assets, in addition to money, which can be encashed at short notice. Therefore one would not expect the demand for money to have been strongly affected, at least in recent years, by the desire to avoid risk, because this motive can be equally well satisfied by holding alternative capital-certain assets yielding a higher return.

The transmission mechanism

'Keynesian' analysis

It is the conviction of Keynesian theorists that financial assets, particularly of a short-term liquid nature, are close substitutes for money, whereas goods and real assets are viewed as not being such close substitutes. In support of this position, Keynesians emphasise (a) the difficulty of defining which set of assets actually comprises the stock of money (which implies that such assets are similar in many respects), (b) the ease and simplicity with which a cash position can be adjusted at any given time by arranging the portfolio of financial assets to this end, and (c) the similarity of the character of financial assets adjoining each other in the liquidity spectrum ranging from cash at one end to, say, equities at the other.

If the authorities should bring about an increase in the money stock[1] by open-market operations,[2] for example, the extra convenience which such augmented money balances would provide would, other things being equal, not match the opportunity cost represented by the return available on other assets. Under such circumstances the adjustment back to a position of portfolio equilibrium would, according to Keynesian theory, take place mainly, if not necessarily entirely, by way of purchases of money substitutes, *i.e.* alternative liquid financial assets, rather than directly through purchases of goods and physical assets. This would raise the price and lower the yield on such financial assets, and would cause in turn further purchases of somewhat less liquid assets, further along the liquidity spectrum. The effect of a change in the money supply is seen to be like a ripple passing along the range of financial assets, diminishing in amplitude and in predictability as it proceeds farther away from the initial disturbance. This 'ripple' eventually reaches to the long end of the financial market, causing a change in yields, which will bring about a divergence between the cost of capital and the return on capital.

The effect of changes in the money supply upon expenditure decisions is regarded, by Keynesians, as taking place almost entirely by way of the changes in interest rates on financial assets caused by the monetary disturbance. This analysis, if true, has an immediate and obvious implication for monetary policy. It implies that monetary policy could be undertaken with greater certainty by acting directly to influence and to control interest rates than by seeking to control the money stock.[3]

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1 As the authorities can, in theory, control the level of the money stock, it is customary in text books to treat the money stock as determined exogenously, that is to say, independently of the rest of the economic system, by the authorities. At a later stage in this paper, this method of treating the authorities' policy actions will be questioned.

2 Open-market operations are undertaken in financial markets. Actions by the authorities to alter the money stock do not, therefore, affect everyone in the economy equally, but have their initial impact upon people and institutions active in such markets. It is quite possible that those active in such markets could have a higher interest-elasticity of demand for money than the average for the economy as a whole. The possible distributional effects of the particular nature of the authorities' monetary actions have received surprisingly little attention in the literature.

3 It is, however, the level of real interest rates that influences expenditure decisions, while the authorities can directly observe only nominal interest rates. In orderto estimate the real cost of borrowing, the nominal rate of interest has to be adjusted by taking into consideration expectations of the prospective rate of inflation, the possible impact of tax arrangements and expectations of future levels of nominal interest rates themselves.

In addition to the familiar cost-of-capital effect, the impact of changes in interest rates upon expenditures should be understood to include 'availability' effects and 'wealth' effects. Availability effects, in general, result from the presence of rigidities in certain interest rates and the consequent divergence of these rates from the more freely determined market rates (a good example of 'sticky' rates is provided by the Building Societies Association's recommended rates). In such cases a divergence of free market rates from the pegged rate may cause such large changes in the channels through which funds may flow that certain forms of credit may be rationed or entirely cut off. In those markets, such as housing, where credit subject to such effects is of great importance, the impact of availability effects can be considerable. The wealth effect occurs, in the main, because changes in interest rates alter the present value of existing physical assets. For example, if interest rates fall, the present value of physical assets will rise.[1] The ultimate owners of such real assets, very largely the holders of the company securities, will feel better off, and no-one will feel worse off.

Notwithstanding the theoretical argument, it for long seemed doubtful whether changes in interest rates had much effect on expenditure decisions, which appeared in general to be unresponsive to changes in interest rates. This implied, for Keynesians, that monetary policy could have little effect in influencing the level of expenditures; and this appreciation of the situation has been influential in conditioning the conduct of monetary policy in recent decades. In part this finding, of the lack of response to interest rate changes, may have been owing to the coincidence of movements of interest rates and of expectations about the future rate of price inflation, so that variations of real interest rates – even if usually in the same direction, perhaps, as nominal yields – have been much dampened. Indeed in those cases when the main cause of variations in the public's demand for marketable financial assets was changes in expectations of future price inflation, a policy of 'leaning into the wind'[2] by the authorities in, for example, the gilt-edged market would cause divergent but unobservable movements in real and nominal interest rates. If people became fearful of a faster rate of inflation and so began to sell gilts, support for the market by the authorities, who can in practice only observe nominal interest rates, would tend to prevent these rates rising sufficiently to reflect the more pessimistic view being taken of prospective inflation.

In recent years, however, more detailed empirical investigation has suggested the existence of some noticeable interest rate effects – though most of the work has used U.S. data, and the most significant effects have been found on State and local government expenditure, public utilities,

1 In some cases there may also be a wealth effect following a fall in interest rates even when the financial asset held is not backed by real capital assets, as for example in the case of dead-weight national debt. In this instance a rise in the present value of these debt instruments – British government securities, etc. – to their holders should in theory be matched by a rise for the generality of taxpayers in the present value of their tax liabilities. In practice this is not likely to happen.

2 *i.e.* absorbing stock when the gilt-edged market is weak, and selling stock when prices are rising.

and housing,[1] all of which are probably less sensitive to interest rate changes in the United Kingdom. There is, however, need for additional work in this country, to examine how changes in financial conditions affect expenditure decisions. Making use of the improved information that has become available during the last decade or so, further research in this field is being planned in the Bank. One recurrent problem is how to estimate the level of real interest rates, when only nominal rates can be observed.

The less that alternative financial liquid assets were felt to be close substitutes for money balances, the greater would the variation in interest rates on such assets need to be to restore equilibrium between the demand for and supply of money, after an initial disturbance: the larger, therefore, would be the effect on expenditures, *via* changes in interest rates, of open-market operations undertaken by the authorities – given the climate of expectations in the economy, The greater the degree of substitution between money and other financial assets, the less would be the expected effect from any given change in the money supply. In conditions where other financial assets were very close substitutes for money balances, it would be possible, in principle, to envisage adopting a policy of enforcing very large changes in the money supply in order to affect the level of interest rates and thus expenditure decisions. But there would still be severe practical difficulties – for example, in maintaining an efficient and flexible system of financial intermediation – and such a policy would require considerable faith in the stability of the relationship between changes in the volume of money available and in the rate of interest.

If there were a high degree of substitution between money and other financial assets, which could be estimated with confidence, then a change in the money supply would have a small, but predictable, effect on interest rates on substitute financial assets. If financial assets were not good substitutes for money balances, on average, but the relationship seemed subject to considerable variation, then changes in the money supply would have a powerful but erratic effect.

There is, therefore, a close relationship between the view taken of the degree of substitution between money and alternative financial assets, and the stability of that relationship, and the importance and reliance that should be attached to control over the quantity of money. At one pole there is the view expressed in a passage in the *Radcliffe Report* "In a highly developed financial system . . . there are many highly liquid assets which are close substitutes for money", so "If there is less money to go round . . . rates of interest will rise. But they will not, unaided, rise by much . . ." (para. 392). It is only logical that the Committee should then go on to conclude that control over the money supply was not "a critical factor" (para. 397). At the opposite pole there is the monetarist view, of which Professor Friedman is the best known proponent.

1 One of the most carefully researched studies of monetary effects in recent years came as part of the Federal Reserve – MIT econometric model of the United States. The results of this study, reported by de Leeuw and Gramlich in the *Federal Reserve Bulletin,* June 1969 show a sizable and fairly rapid wealth effect (*via* changes in stock exchange prices) on consumption, and a sizable and fairly rapid cost-of-capital effect on residential construction. There is also a significant, but considerably lagged, cost-of-capital effect on business fixed investment. No evidence that inventory investment is sensitive to such monetary effects was found.

'Monetarist' analysis

In the monetarist view money is not regarded as a close substitute for a small range of paper financial assets. Instead money is regarded as an asset with certain unique characteristics, which cause it to be a substitute, not for any one small class of assets, but more generally for all assets alike, real or financial.

> The crucial issue that corresponds to the distinction between the 'credit' [Keynesian] and 'monetary' [monetarist] effects of monetary policy is not whether changes in the stock of money operate through interest rates but rather the range of interest rates considered. On the 'credit' view, monetary policy impinges on a narrow and well-defined range of capital assets and a correspondingly narrow range of associated expenditures . . . On the 'monetary' view, monetary policy impinges on a much broader range of capital assets and correspondingly broader range of associated expenditures.[1]

In simple terms this means that if someone feels himself to be short of money balances, he is just as likely to adjust to his equilibrium position by forgoing some planned expenditure on goods or services, as by selling some financial asset. In this case the interest-elasticity of demand for money with respect to any one asset, or particular group of assets, is likely to be low, because money is no more, nor less, a substitute for that asset – real or financial – than for any other. More formally, all goods and other assets which are not immediately consumed may be thought of as yielding future services. The relationship between the value of these future services and the present cost of the asset can be regarded as a yield, or rate of return, which is termed the 'own-rate of interest' on the asset concerned. Keynesians and monetarists agree that asset-holders will strive to reach an equilibrium where the services yielded by a stock of money (convenience, liquidity, etc.) are at the margin equal to the own-rate of interest on other assets. Keynesians by and large believe that the relevant own-rate is that on some financial asset, monetarists that it is the generality of own-rates on all other assets. Keynesians, therefore, expect people to buy financial assets when they feel that they have larger money balances than they strictly require (given the pattern, present or prospective, of interest rates), whereas monetarists expect the adjustment to take place through 'direct' purchases of a wider range of assets, including physical assets such as consumer durables.

According to a monetarist's view the impact of monetary policy will be to cause a small, but pervasive, change on all planned expenditures, whether on goods or financial assets. The impact of changes in the quantity of money will be widely spread, rather than working through changes in particular interest rates. A rise in interest rates, say on national savings or on local authority temporary money, would not cause a significant reduction in the demand for money – because these assets are not seen as especially close substitutes for money balances. Such changes in interest rates would rather affect the relative demand for other marketable assets, including real assets. Expenditure on assets, real and financial, is viewed as responding quite

1 Friedman and Meiselman, "The relative stability of monetary velocity and the investment multiplier in the United States, 1897–1958", Research Study Two in *Stabilization Policies*, Prentice-Hall, 1964, page 217. This section provides an excellent statement of the theoretical basis of the monetarist viewpoint.

sensitively to variations in relative own-rates of interest; indeed monetarists generally regard most expenditure decisions as responding more sensitively to variations in interest rates than Keynesians are prone to believe. The generalised effect of monetary policy in influencing all own-rates of interest will, however, tend to be outweighed in each individual case by factors special to that asset (changes in taste, supply/demand factors particular to that market, etc.), so that no single interest rate can be taken as representing adequately, or indicating, the overall effect of monetary policy. As monetary changes have a pervasive effect, and as their effect is on relative 'real' rates, it is a fruitless quest to look for *the* rate of interest – particularly the rate on any financial asset – to represent the effect of monetary policy.

The crucial distinction between the monetarists and the Keynesians resides in their widely differing view of the degree to which certain alternative financial assets may be close substitutes for money balances; and in particular whether there is a significantly greater degree of substitution between money balances and such financial assets than between money balances and real assets. An example may help to illustrate the importance of this difference of view. Assume that the authorities undertake open-market sales of public sector debt (effectively to the non-bank private sector). The extreme Keynesian would argue that interest rates would be forced upwards by the open-market sales (and by the resulting shortage of cash in relation to the volume of transactions to be financed). Interest rates would not rise by much, however, because an increase in rates on financial assets, such as finance house deposits, which were close substitutes for money, would make people prepared to organise their affairs with smaller money balances. The authorities would, therefore, have reduced the money supply without much effect on financial markets. Because expenditure decisions would be affected, not directly by the fall in the quantity of money, but only by the second round effect of changes in conditions in financial markets, there would be little reason to expect much reduction in expenditures as a result – both because the interest rate changes would be small and because of the apparent insensitivity of many forms of expenditure to such small changes in interest rates.

The extreme monetarist would agree that interest rates on financial assets would be forced upwards by the initial open-market sales. This increase in rates would not, however, tend to restore equilibrium by making people satisfied to maintain a lower ratio of money balances to total incomes, or to wealth. The initial sales of financial assets (as part of the open-market operation), resulting in higher interest rates, would only bring about a short-run partial equilibrium in financial markets. In other words, because of the fall in their price, people would wish to hold more of these financial assets, and this would be achieved through the open-market sales. But the counterpart to the desire to hold more of the cheaper financial assets would not, probably, be to hold smaller money balances, but rather to hold less of other goods. It follows, therefore, that open-market transactions

enable people to make the desired changes in their portfolio of non-monetary financial assets, but leave them holding too little money. Full equilibrium, in the market for goods as well, would only be re-established when the desired ratio of money balances to incomes was restored. This would be achieved (and could only be achieved) by a reduction in real expenditures. Which expenditures would be cut back would depend on the response to the changing pattern, overall, of prices (yields) on the full range of assets, set in motion by the initial monetary disturbance. In sum, monetary policy, by causing a reduction in the quantity of money, would bring about a nearly proportionate fall in expenditures elsewhere in the economy. In the meantime interest rates, initially forced upwards by the authorities' activities in undertaking open-market sales, would have drifted back down, as the deflationary effect of the restrictive monetary policy spread over the economy, affecting both the demand for capital (borrowing) in the markets and the rate of price inflation.

Thus, if alternative financial assets were very close substitutes for money balances, monetary policy (in the restricted sense of operating on the quantity of money in order to alter rates of interest) would be feeble; if they were not, it could be powerful. The issue is almost as simple as that. Furthermore, as was pointed out earlier, if people appear to treat all liquid, capital-certain, assets as close substitutes for each other, it makes it extremely difficult to attach any useful meaning to that sub-set of such assets which may be arbitrarily defined as money. Thus, the questions of the definition and of the importance of money each hang on the empirical issue of whether it is possible to identify a sub-set of liquid assets with a high degree of substitutability among themselves, but with a much lower degree of substitutability with other alternative liquid financial assets. Whatever the composition of this sub-set, it must include those assets commonly used for making payments, namely cash and demand deposits.

Testing the alternative views

The first stage in any exercise to establish the importance of control over the money stock must, therefore, be an attempt to discover whether money is a unique financial asset, without close substitutes, or is simply at one end of a continuous liquidity spectrum, with a number of very close substitutes. The empirical findings on this matter should help to settle the major difference between the theoretical position of the Keynesians on the one hand and the monetarists on the other. The usual method of estimating the extent of substitution between any two assets is to observe the change in the quantities of the two assets demanded as the relative price (rate of interest) on these assets varies, other things being equal. In the case of money balances, where there is no explicit interest paid on cash and current accounts, the normal procedure, to test whether money is a close substitute for other financial assets, is to examine how much the quantity of money demanded varies in response to changes in the price (rate of interest) of other financial assets, which are thought to be potentially

close substitutes. If the demand for money should be shown to vary considerably in response to small changes in the price (rate of interest) of alternative financial assets, this finding would be taken as strong evidence that money was a close substitute for such assets. This relationship is usually described, and measured, in terms of the interest-elasticity of demand for money, which shows the percentage change in the money stock associated with a given percentage change in interest rates on alternative assets. A high interest-elasticity implies that a large percentage fall in money balances would normally accompany a small percentage rise in interest rates on alternative financial assets, and so suggests a high degree of substitution.

There have been in the last decade a large number of statistical investigations designed, *inter alia*, to provide evidence on the degree to which 'money', usually defined as currency and bank demand deposits – M_1 – or as currency plus bank demand and time deposits – M_2 – is a close substitute for other financial assets. A survey of this evidence is presented in Appendix I. Most of these empirical studies are concerned to discover the factors that influence and determine the demand for money. In these studies on the nature of the demand for money, the total of money balances is usually related to the level of money incomes and the rate of interest ruling on some alternative financial asset, for example, on Treasury bills. Alternatively, the ratio of money balances to money incomes (the inverse of the income velocity of money) may be taken in place of the total of money balances, as the variable to be 'explained'. In most important respects, these two methods of approach are interchangeable. There are, however, a considerable number of optional variations in the precise manner in which these equations are specified, which form the subject of fierce debate for the *cognoscenti.*

In particular there is dispute over the form of the income (or wealth) variable which should be related to the demand for money. This issue is, however, peripheral to the question of the extent of substitution between money balances and other financial assets. Evidence on this latter question is deduced from the statistical results of fitting these equations and examining the estimated coefficient measuring the apparent change in money balances associated with a change in interest rates, which is interpreted as the interest-elasticity of demand for money.

Most of the statistical work of this kind has been done using data from the United States,[1] but the results of similar studies using U.K. data[2] give broadly confirmatory results, though there seems, perhaps, some tendency for the estimated stability of the relationships and the statistical significance of the coefficients to be slightly less. Considering, however, that these studies cover a number of differing periods and employ a range of alternative variables, the main results of these exercises show a fair similarity and constancy in both the United States and the United Kingdom.

1 The source of the monetary data used in these studies is shown in each case in the selected survey of empirical results presented in Appendix I.

2 The results of work using U.K. data are also presented in Appendix I, including some early results of studies under way in the Economic Section of the Bank.

The conclusion seems to be, quite generally, that there is a significant negative relationship between movements in interest rates and money balances (*i.e.* that the higher the interest rate, the lower will be the quantity of money balances associated with any given level of money incomes), but that the interest-elasticity of demand appears to be quite low. The results, as shown in Table A of Appendix I, generally lie within the range –0·1 to –1·0. This range is, however, rather wide. An interest-elasticity of –1 means that an upwards movement in interest rates of 10%, for example from 4·0% to 4·4% (not from 4% to 14%), would be associated with a decline in money balances of 10%. At present levels, this would amount to £1,500 million, which would imply a considerable response of money balances to changing interest rates. On the other hand, an interest-elasticity of –0·1 would imply a much smaller response, of only £150 million. This range, however, exaggerates the diversity of the findings, because the intrinsic nature of the data causes the estimated interest-elasticities to vary depending on the particular form of the relationship tested. If M_2 (money supply defined to include time deposits), rather than M_1 is the dependent variable, the estimated interest-elasticity will be lower, because part of the effect of rising interest rates will be to cause a shift from current to time deposits. If short-term rates rather than long-term rates are used, the estimated elasticity will also be lower because the variations in short-term rates are greater. If the data are estimated quarterly rather than annually, there again appears to be a tendency for the estimated elasticity to fall, probably because full adjustment to the changed financial conditions will not be achieved in as short a period as one quarter. In fact statistical studies using annual data with M_1 as the dependent variable and a long-term rate of interest as an explanatory variable do tend to give an estimate for the interest-elasticity of demand for money nearer to the top end of the range of results, and those with M_2 and a short-term rate of interest will tend to give an estimate nearer the bottom end. Even so, there still remains quite a considerable range of difference in the results estimated on a similar basis, but with data for different periods or for different countries.

The findings, however, do seem sufficiently uniform to provide a conclusive contradiction to the more extreme forms of both the Keynesian and the monetarist theories. The strict monetarist theory incorporated the assumption of a zero interest-elasticity of demand for money, so that adjustment to a (full) equilibrium after a change in money balances would have to take place entirely and directly by way of a change in money incomes (rather than by way of a variation in interest rates). On the other hand, the estimated values of the interest-elasticity are far too low to support the view that the result of even a substantial change in the money supply would be merely to cause a small and ineffectual variation in interest rates.

The area of agreement

The considerable efforts expended upon the statistical analysis of monetary data in recent years have produced

empirical results that have limited the range of possible disagreement, and have thus brought about some movement towards consensus. It is no longer possible to aver, without flying in the face of much collected evidence, that the interest-elasticity of demand for money is, on the one hand, so large as to make monetary policy impotent, or, on the other hand, so small that it is sufficient to concentrate entirely on the direct relationship between movements in the money stock and in money incomes, while ignoring inter-relationships in the financial system.

Any summary of the area of agreement must inevitably be subjective. Nevertheless the following propositions would, perhaps, be widely accepted:

(i) The conduct of monetary policy by the authorities will normally take place by way of their actions in financial markets, or through their actions to influence financial intermediaries. To this extent it is really a truism, but nevertheless a useful truism, to state that the initial effects of monetary policy will normally occur in the form of changes in conditions in financial markets.

(ii) Monetary policy, defined narrowly to refer to operations to alter the money stock, will normally have quick and sizable initial effects upon conditions in financial markets. It is not true that operations to alter the money stock would only cause a small change in interest rates without any further effect, nor that the velocity of money will vary without limit.

(iii) Open-market sales of debt by the authorities raise the return, at the margin, both on holdings of money balances and on holdings of financial assets. Any subsequent effect on expenditures, on the demand for real assets, results from the attempt to restore overall portfolio balance, so that rates of return on all possessions are equal at the margin. In this sense monetary policy is always transmitted by an interest rate effect.

(iv) The initial effect of monetary policy upon nominal interest rates may tend to be reversed after a period. For example, any increased demand for physical assets, encouraged by the lower rates of return on financial assets (including money balances), will stimulate additional borrowing in financial markets, thus driving up interest rates again, and the extra money incomes generated by such expenditures will cause an additional demand for money balances. If the increased demand for physical goods leads to a faster expected rate of price inflation, the resulting rise in nominal returns from holding financial assets and money balances will be reduced in real terms, so that the subsequent increase in nominal interest rates will have to be all the greater to achieve equilibrium.

(v) The strength of monetary policy depends mainly on the elasticity of response of economic decision-makers – entrepreneurs, consumers, etc. – to a

divergence between the rates of return on financial assets, including the return on money balances, and the rate of return on real assets. Some empirical studies of the elasticity of response of various kinds of expenditures – company fixed investment, stock-building, housebuilding, consumer spending on durable goods, etc. – have found evidence, particularly when working with U.S. data, that demand does respond significantly to variations in nominal interest rates. But these estimated effects, although significant statistically, do not seem to be very large, and they appear to be subject to lengthy time-lags in their operation.

(vi) Although these statistical findings, of the fairly slight effect of variations in nominal interest rates on expenditures, are widely accepted, the inference that monetary policy is relatively impotent is not generally accepted. It is argued, and is becoming widely agreed, that variations in nominal interest rates may be a poor indicator of changes in real rates. As was already suggested in proposition (iv), an expansionary monetary policy is consistent with, and can lead directly to, rising nominal rates of interest, while real rates remain at low levels. If nominal rates of interest do provide a poor index of monetary conditions, many of the studies purporting to estimate the effect of changes in financial variables on expenditures become subject to serious error. This raises the problem of how to measure approximately variations in the real rates of interest facing borrowers and lenders, as these cannot be simply observed from available data.

A qualification

The evidence from the empirical studies shows that there is a statistically significant association between variations in the size of the money stock and in interest rates on alternative financial assets. This relationship is, however, neither particularly strong nor stable.[1] These results are often interpreted as evidence that money balances and such financial assets are not especially close substitutes, and that there may also be a significant degree of substitution between money balances and other assets, including real assets. This, taken together with the much closer statistical association between the money stock and economic activity, induces belief in the importance of controlling the money stock.

The observed loose association between changes in interest rates and in the money stock may, however, be due in part to another cause. It may well be that the relationship between interest rates and the demand for money is obscured by the volatile nature of expectations about the future movement of prices of marketable assets. Most of the statistical studies of the demand for money have related the total of money balances to the calculated yield to redemption

1 Although the ratio of the estimated value of the coefficient of the interest-elasticity of demand to the estimated standard error of that value (as measured by the t statistic), is large enough in almost all cases to show that the coefficient is significantly different from zero, the confidence interval frequently covers rather a wide range.

of marketable financial assets, e.g. Treasury bills or gilt-edged stocks. This procedure implicitly assumes that the redemption yield is a good guide to the expected yield over the holders' relevant planning period; an assumption which will be generally invalid. People may, at certain times and in certain conditions, expect prices in the market to continue changing in the same direction as in the (recent) past for some (short) time (*i.e.* they hold extrapolative expectations). Or they may expect past price movements to be reversed over some future period, usually when this implies some return to a 'normal' level of prices (*i.e.* they hold regressive expectations).[1]

If people expect a fall in the price of an asset to continue even for a short time, and sell because of that expectation, then the calculated yield to redemption would be rising, while the real yield over the immediate short future could well be falling. This could mean that the effect of rising interest rates in causing some people to economise on money balances was being partly offset, or more than offset, by their effect in causing others to go liquid in anticipation of even higher rates. If market expectations were volatile, one might expect to observe quite large swings in interest rates associated with small changes in the level of money balances, or vice versa, sometimes even in a perverse direction (*i.e.* that rises in interest rates would be associated with increases in desired money balances). This result need not, however, imply that such financial assets were not good substitutes for money, but rather that the calculated yields did not always provide a good unbiased approximation to the true yields on which investors based their portfolio decisions.

There are, therefore, certain complications involved in the use of the yield (to maturity) on any marketable asset, with a varying capital value, as an index of the opportunity cost of holding money. It should, however, be feasible to observe more accurately the true relative return on holding assets with a fixed capital value – for example building society shares and deposits, national savings, local authority temporary money[2] – rather than money, because there is no problem of estimating the expected change in capital values.[3]

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1 It is quite possible, indeed probably fairly common, to find that expectations of price changes in the near future are generally extrapolative, while expectations for price changes in the more distant future are regressive.

2 If there are additional penalties imposed for encashment of an asset before some predetermined time period has elapsed, then the alternative yields on such assets cannot be properly estimated without further knowledge of the expected holding periods. Moreover in some cases the rates offered, for example on building society shares and deposits, can be varied at short notice, while in other cases the rates may be fixed over the expected holding period. These are, however, probably lesser complications.

3 An exercise is under way in the Economic Section of the Bank which attempts to estimate the extent to which persons, and companies, vary their holdings of money, as a proportion of their portfolio of assets whose capital value is certain in money terms, as relative interest rates (on these fixed value assets) change. It is hoped that it will be possible to produce estimates of the elasticity of substitution (for persons and companies separately) between all pairs of capital-certain assets, including money balances. The preliminary results of this exercise have already been reported in a paper on "Substitutions between assets with fixed capital values", read by A. R. Latter and L. D. D. Price at the Association of University Teachers of Economics meeting in April 1970 in Belfast. Only short series of quarterly data are available. going back to 1963, and the sectoral allocation of the various assets is not adequate for the exercise in hand in some respects. For these and other reasons, the preliminary results of this exercise must be treated as extremely tentative. These results, however, suggest an interest-elasticity of demand for current accounts, the main component of M_1, of about 0·5, which is higher than the estimates in some other studies of the demand for money using U.K. data, but which remains well within the range of results obtained in a number of studies using U.S. data, as reported in Appendix I.

It is still, however, difficult to refer to *the* opportunity cost of holding money because, when interest rates are generally increasing – and widely expected to continue increasing – the expected return (over the near future) on holding marketable assets may be falling, at the same time as the return on alternative capital-certain assets is rising.

It might, perhaps, be thought otiose to distinguish between these alternative reasons (volatile expectations or a limited degree of substitution) for finding a low response of the demand for money balances to changes in interest rates. As long as open-market operations cause a significant change in interest rates in financial markets, where the initial effect must occur, it could be argued that the fundamental reason for this reaction, whether it be a low extent of substitution or volatile expectations, was of secondary importance : what mattered was that the change could be foreseen and was large. On the other hand, in so far as market expectations of a volatile nature are regarded as having an important influence on developments in the market, the emphasis of policy under actual working conditions of uncertainty and changing circumstances will be inevitably transferred to market management, away from simple rules of operation on monetary quantities. Furthermore the importance, indeed the existence of any useful definition, of money depends largely on finding a break (of substitution) in the liquidity spectrum between money and other financial assets. If the finding of a fairly low interest-elasticity of demand is not taken as incontrovertible evidence of such a break in the spectrum, the issue of the central importance of the money stock as compared with some wider set of financial assets (even, perhaps, the much maligned concept of liquidity) remains open. It may indeed be questioned whether it is helpful to assign crucial importance to any one single financial variable. The need is to understand the complete adjustment process.

The stability of the income velocity of money

It is not possible to observe with any clarity either the real rates of return on asset holdings, which decision-makers in the economy believe that they face, or the precise process of portfolio adjustment. It is, therefore, difficult to chart and to measure the transmission of the effects of monetary policy. If, however, the sole aim of monetary policy is to affect the level of money incomes, it does not necessarily matter whether it is possible to observe and to understand the transmission mechanism in detail. It is enough to be able to relate the response of a change in money incomes to a prior change in the level of the money stock.

The statistical evidence

So the next stage in the analysis is usually to examine the direct statistical relationship between changes in the money stock and changes in money incomes. As was to be expected – for such a result would be predicted by almost all monetary theorists, irrespective of their particular viewpoint – movements in the money stock and movements in money incomes are closely associated over the long term. Over the last fifty

or so years the demand for money appears to have grown at more or less the same rate as the growth of incomes. There have, however, been long spells within this period during which money balances have been growing faster or slower than money incomes. The American evidence suggests that money balances were growing at a faster rate than incomes before 1913, and the reverse has been the case for both the United States and the United Kingdom since about 1947.

The apparent fall in the velocity of circulation of money in the early part of this century in the United States may have been due to higher incomes enabling people to acquire proportionately more of the convenience (mainly in carrying out transactions) which the holding of larger money balances allows. The recent rise in velocity, in both the United Kingdom and the United States, may in turn have been brought about by people, especially company treasurers, seeking to obtain the benefit of economies in monetary management, spurred on by the rise in interest rates.

Alternatively these trends may have been associated with underlying structural changes, for example in the improvement of communications, in the change to a more urban society, in the growth and increasing stability of the banking system, in the emergence of non-bank financial intermediaries issuing alternative liquid assets and competitive services, and in technical developments in the mechanism for transmitting payments. In general it is not possible to ascribe the changing trends in the relative rates of growth of money balances and money incomes to any one, or any group, of these factors with any certainty; nor is it possible to predict when the trend of several years, or decades even, may alter direction. By definition, however, these trend-like movements are slow and quite steady. Only at or near a turning point is the relationship between movements in money incomes and in the stock of money balances likely to be misjudged.

The existence of a significant statistical relationship between these two variables does not of itself provide any indication of the causal mechanism linking the two series. The monetarists, though, usually argue that the money stock has been determined exogenously, meaning that the money supply is determined without regard to the value of the other variables, such as money incomes and interest rates, within the economic system. As the money stock is thus assumed to be determined in such a fashion that changes in money incomes do not influence changes in the money stock, it follows that the existence of a statistical relationship between changes in the money stock and changes in money incomes must be assumed to reflect the influence of changes in the money stock on incomes.[1]

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1 In a slightly more sophisticated version of this approach the cash (reserve) base of the monetary system (the cash reserves of the banks, including their deposits with the central bank, together with currency held by the public outside the banking system—high powered money in Professor Friedman's terminology) is taken as exogenously determined while certain functional relationships (*e.g.* the public's desired cash/deposit ratio), which determine the total volume of the money stock consistent with a given cash base, are treated as behavioural relationships influenced by other variables in the system (*i.e.* they are endogenous). This minor variation in the approach makes no fundamental difference to the analysis.

For the moment this basic assumption that the money stock is determined exogenously will be accepted, so that the relationship between changes in the money stock and in money incomes can be treated as cause and effect, running from money to money incomes. On this assumption it is possible to measure both the extent of the effect of a change in the money supply upon money incomes and the extent of variation in this relationship.[1] These results generally show that the residual variation in the relationship between changes in the money stock and in money incomes is large as a proportion of short-run changes in these variables – over one or two quarters – but much smaller as a proportion of longer-run changes, over two or more years.

The interpretation, which has been drawn by monetarists from similar work done in the United States, is that the statistical significance of the relationship between changes in the money stock and in money incomes provides evidence of the importance of monetary policy. But the considerable extent of residual variation in the relationship, especially in the short term, combined with the likely existence of long and possibly variable time-lags in operation, prevents monetary policy – in the restricted sense of control over the money supply – being a suitable tool for 'fine tuning' purposes. From this appreciation of the statistical results comes Professor Friedman's proposal for adopting a rule of maintaining a constant rate of growth in the money stock.

In Keynesian theory changes in the money supply initially affect interest rates on financial assets, and these interest-rate variations subsequently influence the demand for capital goods (investment). Once the level of autonomous expenditure is set,[2] the level of money incomes is determined through the multiplier process. As monetary policy is but one factor affecting the level of autonomous expenditures, in particular fixed investment, one should, perhaps, expect to see a closer relationship between autonomous expenditures and money incomes than between the money stock and money incomes. The monetarists instead believe that expenditures on all goods and assets are pervasively affected by monetary policy (though the transmission process can still be regarded as taking place through interest rate changes in the process of restoring portfolio equilibrium). Thus, if the stock of money remains the same, an increase in demand at one point in the economy ('autonomous' or 'induced'; indeed the monetarists are sceptical about the value of this distinction) will have to be broadly matched by a fall in demand elsewhere in order to maintain equilibrium. Therefore they would expect changes in money incomes to vary more closely with exogenous changes in the money supply than with autonomous expenditures. The next step is usually to see which relationship appears to have a closer statistical fit. A commentary on, and critique of, such exercises is given in Appendix I; it is suggested there that such exercises do not provide a satisfactory method of discriminating between the alternative theories.

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1 The empirical results of such an exercise are reported in Appendix II.

2 'Autonomous' is defined as meaning those expenditures, generally taken to be exports, government expenditures and fixed investment, that are not largely determined by the contemporaneous value of other variables within the economic system.

The crux of this whole approach, of drawing conclusions from the statistical relationship between movements in the money stock and in money incomes, lies in the assumption that the money supply, or more precisely the monetary base,[1] is exogenously determined. This assumption allows a simple statistical association to be translated into a causal sequence. Is this crucial assumption justified? Clearly some of the factors which result in changes in the money supply/monetary base are endogenous (*i.e.* determined by the contemporaneous value of other variables within the economic system). Thus a large domestic borrowing requirement by the central government or a balance of payments surplus tends to enlarge the money supply. As a large borrowing requirement (fiscal deficit) and balance of payments surplus also result in expansionary pressures in the economy, there are reasons to expect increases in money incomes and in the money stock to be associated, without there being any necessary causal link running from money to money incomes.

But, in theory, a central bank can undertake such open-market operations that, whatever the extent of increase in the money supply/monetary base caused by endogenous, income-associated factors, the final level of the money supply is whatever the central bank wants it to be. In this sense the level of the money supply can be a policy instrument. A policy instrument is not, however, *ipso facto* an exogenous variable; it would only be so if policy were not influenced by the contemporaneous (or anticipated) value of other variables within the system, such as the level of incomes and interest rates. This clearly is not the case.

Obviously, if an increase in incomes causes the authorities to alter the money supply/monetary base, then the existence of a simple statistical association between movements in money incomes and in the money supply does not allow one to distinguish the strength of the intertwined causal mechanisms. In order to investigate whether this raises a serious problem, it is necessary to examine the factors which have apparently led the authorities to cause, or to accept, changes in the money supply/monetary base.

In the United Kingdom a general aim of policy has been to reduce the size of variations in interest rates, while at the same time moving towards a pattern of rates that would seem appropriate in the overall economic context. In so far as a policy of stabilisation of financial markets is pursued, the money supply must tend to vary with money incomes – without necessarily having any causal effect on incomes. An increase in incomes relative to money balances will cause some tightening of liquidity; people will be induced to sell financial assets to restore their liquidity, thus pushing interest rates up; the authorities, to a greater or lesser extent (depending on their view about the preferred pattern of interest rates), will 'lean into the wind' and take up these assets; the money supply increases. There may even be a tendency for changes in market conditions to precede changes in

1 The monetary base includes those assets that either are, or could be, used by the banks as cash reserves. It consists of the cash reserves of the banks, including their deposits with the central bank, together with currency held by the public outside the banking system.

money incomes, in so far as people are able to predict changes in the rate of inflation and activity accurately, and to make their asset dispositions in the light of their expectations. If this were the case an increase in inflationary pressures would be preceded by weakness in financial markets and an increase in the money supply.

There is little doubt that changes in the levels of certain key variables within the system (income levels and interest rates, for example) have brought about changes in the money supply. Therefore the money supply is not exogenous, and the statistical association between changes in the money supply and in money incomes cannot be advanced as evidence in itself of the importance of a quantitative monetary policy. Moreover, as the statistical relationships derived from the past depended on the particular kind of policy aim pursued by the authorities over the period considered, there would be no guarantee of their exact continuation in the future, should that policy be altered. In other words, although velocity has been fairly stable in the past this would be no guarantee of its stability in the future if the authorities chose to alter the rules of the game.

Post hoc, ergo propter hoc ?

There is, therefore, a two-way relationship between movements in the money stock and in money incomes, with causal influences running in both directions. It may, however, still be possible to isolate and to estimate the strength of the causal relationships separately. It will be easiest to do so if the interactions are not simultaneous, but consecutive. Thus, if the money supply responds to changes in money incomes only after a time-lag, or if money incomes respond to changes in the money stock only after a time-lag, it may be possible to distinguish the separate relationships.

In particular, if changes in the money stock cause changes in money incomes, then changes in the money stock would be expected to precede the resulting changes in money incomes with perhaps a rather long lead, depending on the duration of the transmission process. If, however, money stock variations result in part automatically from increases in autonomous expenditures – for example in exports, fiscal expenditures or investment – and in part from the authorities' response to pressures in financial markets, then money incomes would be expected to rise more or less simultaneously with the stock of money. Thus, investigation of the extent to which changes in the money stock lead, or lag, changes in money incomes could be of considerable importance in any attempt to distinguish the main direction of causality.

The preliminary results of research done in the Bank suggest that in the United Kingdom movements in the money stock have preceded movements in money incomes. The pattern of this lead/lag relationship is, however, intriguing, for the relationship between the two series appears to be bimodal, *i.e* to have two peaks. There was a fairly strong correlation between the two series when the monetary series had a very short lead over money incomes, of about two or three months. There seemed to be a further peak in the correlations indicating a much longer time-lag, with changes

in the money stock leading changes in money incomes by some four to five quarters. The correlations were generally stronger when the monetary series used was narrowly defined (M_1 rather than M_2).

There have been a fairly large number of other statistical studies attempting to determine whether changes in the money stock do have a significant lead over changes in money incomes. The tests have used different series, from different countries, over different time periods, and the lag relationships have been estimated in different ways. Practically without exception they show that changes in the money stock appear to lead changes in money incomes, but the calculated length of lead has varied quite widely between the various studies, though to some extent this may have been due to the different forms in which the relationship was estimated. Professor Friedman, for example, has claimed that there is evidence of a long and variable time-lag in movements of incomes after variations in the money stock. Other recent statistical work on this subject, both in the United Kingdom and in the United States, has tended rather to suggest that the interval by which the change in the money stock precedes the change in money incomes is quite short, a matter of months rather than of quarters.

A statistically significant lead, therefore, seems to exist even if it is quite short. Does this, then, make it possible to disentangle the causal effects of changes in money supply on money incomes, from those running in the opposite direction? It does not follow that the series which appears to lead always causes the change in the following series. There is a close association between visits to travel agents and tourist bureaux and trips abroad. The visit to the agent precedes the trip abroad, but does not cause it – though it facilitates it. Rather, the desire for travel abroad causes the initial visit to the travel agent. Analogously, desires for increased expenditure may be preceded by an accumulation of cash necessary to finance that expenditure. The demand for such additional money balances will cause pressure on financial markets, and so the authorities, seeking to maintain interest rates within some broad range, may in part accommodate the demand.

It is, however, unlikely that such accumulation of cash would take place far in advance of planned expenditures, for if the balances to be spent were at all sizable it would be generally economic to lend them at interest on higher yielding assets in the meantime. From this source, a lead of money stock over money incomes of only a few weeks might, perhaps, be expected; though rather longer in the United States where the custom of making loans (together with compensating balances), rather than overdrafts, could distort the observed timing between changes in money incomes and money balances.

There are, indeed, a number of other hypotheses which are consistent with a situation in which changes in the money stock precede, but do not cause, subsequent changes in money incomes. However, in the absence of evidence to the contrary, a consistent lead is a prima facie indication of causation.

Most detailed investigations, however, of the effects on expenditures resulting from interest-rate changes (including wealth effects) show quite long average time-lags of the order of one or two years between changes in the monetary base and changes in expenditures.[1] Furthermore, Professor Friedman suggested that changes in monetary conditions affect expenditures only after a long and variable lag. If the duration of the transmission process, whereby changes in monetary conditions affect money incomes, is as long as these studies suggest, it would seem implausible to attribute the finding of a fairly strong relationship between the money stock and money incomes with a very short lead mainly to the impact of monetary changes on money incomes.

The preliminary results of studies made in the Bank which indicated that the lag pattern in the relationship between the money stock and money incomes was a dual one – a very short lead of two to three months and a much longer lead of four to five quarters – further suggested that the relationship between these series might result from the existence of separate causal relationships, each with its own lag pattern, whereby the levels of the money stock and money incomes approached a joint equilibrium.[2]

These findings do not make possible any confident measurement of the relative contributions of the adjustment of the money stock to changes in money incomes, or of the adjustment of money incomes to changes in the money stock, toward the simple overall statistical association between the two series. Even so, some of these results, particularly the observed relationship between bank advances and investment, seem to suggest that changes in monetary conditions do have a significant effect upon expenditures. Equally, other results do not remove scepticism of the view that the simple relationship between movements in the money stock and in money incomes could be interpreted entirely, or even mainly, in terms of the direct impact of monetary conditions upon money incomes.

It follows that these studies of the simple statistical relationship between movements in the money stock and in money incomes can by themselves provide very little information about the strength of monetary policy. The statistical relationship is quite close, but this may reflect to a very large extent the accommodation of movements in the money

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1 See, for example, the F.R.B.–M.I.T. model as reported by F. de Leeuw and E. M. Gramlich in "The Channels of Monetary Policy", *Federal Reserve Bulletin*, June 1969. Tables 1 and 2, pages 487–88.

2 In order to examine this proposition further, the series were disaggregated into their main components to discover whether the estimated relationships between the component series were significantly different from those of the aggregate series. The preliminary results of this exercise, which is still in hand, suggested that this was indeed the case. The relationship between the money stock and consumption appeared to be strongest when the two series were synchronous. The relationship between the money stock and investment suggested that changes in the money stock preceded investment with a long lead of some four to five quarters. When the monetary series was disaggregated into two components – advances to the private sector and other assets (mainly holdings of public sector debt) – movements in bank advances appeared to have a long lead over movements in money incomes, while the relationship between holdings of public sector debt and money incomes was strongest when the two series were synchronous. Indeed the relationship between the two series when bank holdings of public sector debt led money incomes was, perversely, negative. Finally, an examination of the relationship between bank advances and investment suggested the presence of a long (four to five quarters) lead over investment.

supply to autonomous changes in money incomes (given the authorities' policy aims and operational techniques). If the authorities should make an abrupt change in their operations (altering the 'rules of the game') the old-established regularities might cease to apply.

Conclusions

The monetary authorities are in a position to alter financial conditions decisively by their operations in certain key financial markets. These market operations can have a considerable influence upon interest rates and also upon the climate of expectations. The existence of financial intermediaries other than banks, which are not so closely controlled, does not, in practice, prevent the authorities from bringing about sharp and considerable changes in financial conditions. Rather the danger is the other way around – namely, that aggressive actions by the authorities in markets subject to volatile reactions could cause exaggerated and excessive fluctuations in financial conditions.

The effect of these operations in financial markets is to cause disequilibria in portfolios. Expansionary monetary policy (narrowly defined to refer to operations to increase the money stock) will cause rates of return on a very wide range of assets, including stocks of all real goods, to be higher, at the margin, than the return available on money balances and other financial assets. In this general sense, monetary policy is transmitted to expenditure decisions via interest rates.

Attempts to measure the effect on expenditures of changes in interest rates on financial assets have on occasions shown these effects to be significant, though relatively small and often subject to long time-lags. There are, however, reasons for believing that these studies may underestimate the strength of monetary policy. In particular, most of these studies use calculated nominal rates of return as an indicator of the impact of monetary policy. Expenditure decisions, however, are affected by relative real interest rates, and these cannot be directly observed. A strongly expansionary monetary policy, which would maintain low real rates of interest, might well be associated, after an initial decline, with rising nominal interest rates.

On the other hand, attempts to measure the effects of monetary policy by correlating changes in the money stock with changes in money incomes probably greatly overestimate the strength of monetary policy. There is a two-way relationship between these variables. It is not correct to regard changes in the money stock as having been determined independently of changes in money incomes; for example, the actions of the authorities in financial markets, which will directly affect the money supply, will usually be strongly influenced by current and expected future developments in the economy. Attempts to disentangle this two-way interaction by considering, for example, the lead/lag relationship, reinforce the view that monetary policy has some causal impact on money incomes, but do not allow this to be clearly isolated and quantified.

Monetary policy is not an easy policy to use. The possibility of exaggerated reactions and discontinuities in application must condition its use. We are not able to estimate the effects of such policy, even in normal circumstances, with any precision. Such effects may well be stronger than some studies undertaken from a Keynesian approach, relating expenditures to changes in nominal interest rates, would suggest, but weaker than some of the monetarist exercises may be interpreted as implying. Furthermore there are probably quite long time-lags in the operation of monetary policy, before it affects most kinds of expenditure. These considerations underline the difficulties of using monetary policy for short-run demand management.

A particular problem, perhaps, is to distinguish what the thrust of monetary policy is at any time. Indeed, it may be harder to decipher what effect monetary policy is having at any moment than to decide what effect should be aimed at. The level of nominal interest rates is not a good indicator of the stance of monetary policy. Rising nominal interest rates are quite consistent with falling real rates of interest. Professor Friedman has argued that the rate of change of the money supply would be a better indicator of the thrust of monetary policy than variations in the level of nominal rates. To the extent that price stability ceases to be an accepted norm, and expectations of inflation, or even accelerating inflation, become widespread, this claim that the rate of growth of the money stock may be a better indicator of the direction of policy than the level of interest rates takes on a certain merit. As, however, there will always be multiple objectives – for example the balance of payments, the level of employment, the distribution of expenditure, etc. – no single statistic can possibly provide an adequate and comprehensive indicator of policy. And basing policy, quasi-automatically, upon the variations in one simple indicator would lead to a hardening of the arteries of judgment.

Appendix I

The evidence of empirical investigations

References in bold type are listed on page 190

Professor Friedman [**15**] has redefined the Quantity Theory as a theory of the demand for money. Many economists have therefore turned to the estimation of the money demand function (and its analogue, the velocity function) to test the theories advanced by monetarists. These tests have been designed to throw light on a number of issues, some of which – for example, the appropriate definition of money, whether income or wealth is the main determinant of desired money balances, and whether money is a luxury good – are not the really critical issues in the current debate between 'Keynesians' and 'monetarists'.[1] Other questions are, however, vitally important to this debate, and in this review the following are isolated:

(i) the basic predictability of the demand for money;
(ii) the role of interest rates in the demand-for-money function; and
(iii) the relative importance of short-term and long-term interest rates in explaining the demand for money.

Empirical tests have been successful in partially confirming some, at least, of the monetarists' theories. This has encouraged further work designed to compare the stability of Keynesian and monetary relationships. Commentary on, and criticism of, such tests is provided in the final section of this appendix.

The predictability of the demand for money

Although there is nothing in Keynes' work to suggest that the demand for money should be unpredictable (except at very low interest rates), a widespread feeling grew up amongst Keynesians in the post-war period that the availability of money substitutes would render the money–income relationship too volatile to be of much practical use for economic management or forecasting. This was the view that was challenged by the monetarists. Friedman and Schwartz, in their monetary history of the United States[**19**], demonstrated that real income and real money balances were connected in a reasonably predictable way over the period 1867–1959. Since then, the work of Meltzer[**31**], Chow[**9**], Laidler[**25**], and Courchene and Shapiro[**11**], among others, have borne out the contention that the demand-for-money function for the United States is fairly well determined over the long period, with coefficients of determination[2] in the range 0·9–0·99. The pioneering long-range study for the United Kingdom carried out by Kavanagh and Walters[**24**], for the period 1877–1961, established a coefficient of determination of 0·98 in the demand-for-money function.

It is, however, relatively easy to establish an apparently close-fitting relationship when there are strong trends in both dependent and independent (explanatory) variables. A possibly more searching test of the strength of the basic relationship is its predictability when estimated using changes in, rather than levels of, the data. Using changes reduces dramatically the coefficient of determination. For example, in Laidler's very comprehensive study based on U.S. data, the coefficient of determination in a typical equation was lowered from 0·99 to 0·51 when the data were transformed into first differences (*i.e.* changes). For U.K. data, the coefficient of 0·98 by Kavanagh and Walters, noted above, was reduced to 0·49 by first differencing.

The use of lagged dependent variables[3] is another way by which the danger of inferring false relationships from trend-dominated variables can be reduced, though similar dangers are raised in interpreting the lagged term. Most tests using lagged dependent variables (including the models reported in Appendix II) have shown the estimated co-

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1 As in the main paper, the terms 'Keynesian' and 'monetarist' are used to characterise views that would not necessarily be held by all, or even most, members of each school of thought.

2 The coefficient of determination, or R^2 statistic, is the proportion of the variance of the dependent variable in an equation which can be associated with, or 'explained' by, changes in the independent variables.

3 Where one of the factors explaining the level of the dependent variable is its level in the previous time period.

efficient of the lagged variable to be highly significant, while the explanatory power of other variables has been correspondingly lower. One explanation of these findings is the presence of time-lags in the process by which a dependent variable adjusts to an equilibrium; but an equally plausible one is the existence of first order serial correlation in the residuals;[1] both influences are probably present to some extent.

The empirical evidence suggests that the demand for money is more predictable than, say, the Radcliffe Committee would have imagined, but probably not predictable enough to be used as an instrument of short-term policy. Furthermore the predictability of the relationship in a period when control of the money supply was not a major feature of policy will not necessarily be a good guide to its predictability under conditions when it was more actively used.

The role of interest rates in the demand-for-money function

The next important point of dispute is the relationship between the level of interest rates and the quantity of money. Many Keynesians have supposed that the interest-elasticity of the demand for money would be relatively high[2] whilst monetarists have believed the elasticity would be low, because money was seen by them as a general substitute for all assets, rather than a specific substitute for interest-bearing financial assets.

In his early writings, Friedman[**16**] conceded that interest rates might feature in the demand-for-money function but, on the basis of empirical work, contended that in practice they did not. Thus, it was argued that the observed relationship between money and incomes must be a 'direct' one. It has since been shown, however, that interest rates do play a significant role in the demand for money. Of all the studies of this subject published since Friedman's, and which are noted in Table A, only those by Heller[**22**] for the United States, and by Fisher[**13**] for the United Kingdom indicate an inability to find a significant role for interest rates.[3] The volume of evidence is now quite widely accepted, at least among Keynesians and some monetarists, as contradicting the view that 'only money matters'. However, the fact that interest rates are significant in the demand-for-money function undermines only the extreme version of the quantity theory, namely that there is a fixed short-term link between the stock of money and money incomes. It leaves open the question of the *relative* importance of income and interest rates in determining desired money holdings.

Nearly all the work that has been done on *levels* of data has shown income to be much more important than interest rates in determining the demand for money. Partial coefficients of correlation[4] are not generally given, but it may reasonably be inferred that incomes are more important from the fact that the margins of error in the estimates of coefficients are relatively much lower for income variables than for interest rates.[5]

That this should be so in the long term is not surprising, because there are long-term trends in both incomes and money. It is in this context more revealing to look at models which are estimated in first difference form (using changes, rather than levels, of data), or with the use of a lagged dependent variable. The study of U.S. data by Laidler[**25**] showed that the significance of an income variable was much reduced

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1 The residuals associated with any estimated relationship are defined as:

$u_t = y_t - \hat{y}_t$ where y_t = the observed value of the dependent variable at time t

$\hat{y}_t$ = the value of the dependent variable at time t calculated from the estimated relationship.

First order serial correlation in the residuals is the correlation between u_t and u_{t-1}.

2 See for example the *Radcliffe Report* [**33**].

3 See footnote *1* on page 184 for a possible explanation of Heller's finding.

4 The partial coefficient of correlation measures the degree of association between two variables, after allowing for the impact of other variables in the equation. Another means of measuring the relative strength of two separate effects is by beta coefficients (see Goldberger[**20**]).

5 It is convenient to compare margins of error by the use of 't' statistics (the ratio of an estimated coefficient to its estimated standard error). In general, the smaller the t statistic, the more subject is the estimated coefficient to sampling fluctuations (random errors), and conversely the higher the t statistic. It is because of sampling fluctuations that a non-zero coefficient may be recorded even though the true value of the coefficient may be zero.

when the data were transformed into first differences, though it was still somewhat greater than that of the interest rate variable. Hamburger[**21**], in a study using logarithmic first differences, found that the coefficient on incomes became insignificant.

Once a role has been conceded to interest rates the question becomes one of how large an interest-elasticity is consistent with according primary importance to money. There is no unambiguous answer to this question, since it hinges on the meaning that is given to words such as 'large', 'primary', etc. This is an example of how the two theories have, partly as a result of empirical testing, drawn together.

The numerical value of the interest-elasticity[*1*] that has been observed has generally been found to lie in the range −0·1 to −1·0. This is quite a wide band, but part at least of the variation is due to the different forms in which the demand-for-money function has been tested. Some economists, following the letter of Keynes, have used the bond rate in their equations as the opportunity cost of holding money. Others, recognising that Keynes was using a restrictive theoretical model, have suggested that in practice short-term financial assets are more likely to be thought of as substitutes for money, and so have used a short-term rate of interest. Short-term and long-term rates are closely linked as to the direction of movements; but fluctuations in short-term rates are perhaps two to three times larger. Thus, it is to be expected that a higher interest-elasticity will have been observed for long-term rates than for short-term rates.

Another difference lies in the definition of money which has been used. The usual definition in the United States restricts money to currency and demand deposits; but certain monetarists, particularly Friedman, have argued that the definition should be widened to include time deposits, on the grounds that these too are a "temporary abode of purchasing power". It is to be expected that the narrower definition would probably have the greater interest-elasticity, because the wider definition includes assets bearing a yield which moves broadly in line with other market rates.

For these reasons it is, perhaps, to be expected that models using a narrow definition of money and a long-term rate of interest would yield the highest interest-elasticities, and that those with a wide definition and a short-term rate of interest would yield the lowest elasticities. This is broadly the picture which emerges from the empirical results presented in Table A, certainly for those based on annual data. The highest[*2*] estimates of interest-elasticity are those of Meltzer[**31**], Brunner and Meltzer[**7**], Chow[**9**] and Courchene and Shapiro[**11**]; all are derived on the basis of the narrow definition of money and a long-term interest rate, and none is below −0·7. Laidler[**25**] specifically set out to test the relative elasticities using different specifications; and Tobin[**35**] did much the same thing using a velocity function. Using annual U.S. data from 1892–1960,[*3*] Laidler produced elasticity estimates ranging from −0·16 using a wide definition of money and short-term interest rates as an argument, to −0·72 using a narrow definition of money and long-term interest rates. Tobin's estimates were much the same, ranging from −0·12 to −0·55.

For the United Kingdom, the only study of note using annual levels of the money stock is that of Kavanagh and Walters[**24**]. They used a wide definition of money, and a long-term interest rate, and obtained an elasticity of −0·30 for the period 1877–1961; and of −0·50 for the period 1926–61. The relationships between interest-elasticities estimated using U.S. data suggest, perhaps, that had a short-term interest rate been used, the estimated elasticity for the shorter period would have been closer to −0·2.

Thus, despite the superficial appearance of diversity, most of the work done with long runs of annual data produces a fairly consistent

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1 The most commonly used measure of interest-elasticity measures approximately the percentage change in money balances resulting from a one per cent change in interest rates, a one per cent change being a change from, say, 4% to 4·04%. To produce equations with constant interest-elasticities, interest rates are usually put directly into logarithmic form. This implies that a change in interest rates from, say, ½% to 1% would have the same effect as a change from 4% to 8%.

2 In the sense of being furthest from zero.

3 The data for money on a narrow definition are available only from 1919.

picture. The elasticity of currency and demand deposits with respect to long-term interest rates is probably about −0·7, and with respect to short-term interest rates about −0·25. For a wider definition of money, the relevant figures are slightly lower, and seem to depend more on the particular specification of the model.

Those studies which have used quarterly data have tended to produce lower estimates for the interest-elasticity of the demand for money. Heller[**22**] was unable to detect any significant influence of long-term interest rates[1] on the demand for money and, when he used short-term rates, the estimated long-run elasticity fell between −0·1 and −0·2. Hamburger[**21**] used two interest rates (the equity yield and the long-term bond yield) in his study of the demand for money of the household sector, and the sum of their coefficients was about −0·3. Teigen's work[**34**], undertaken in the framework of a simultaneous equations model, produced long-run elasticities of less than −0·1; though when a similar equation for annual data was estimated, an elasticity of nearly −0·2 was recorded.

The use of quarterly data has presented a number of problems. Chief among these is the existence of time-lags in the adjustment process, the correct specification of which becomes of greater importance when quarterly rather than annual data are used. These time-lags are presumably not due primarily to imperfections in financial markets, because it is relatively easy to move into and out of money balances. It seems more likely that money holders take time to adjust their behaviour after changes in their incomes and in relevant interest rates.

Fisher[**13**], and Laidler and Parkin[**26**] found that the results of their quarterly models using U.K. data were much improved by the inclusion of lagged terms.[2] Furthermore, the coefficient of the lagged terms was generally large and significant, indicating quite long adjustment lags. A study using quarterly data for the period 1955–68, which is reported in more detail in Appendix II, bears out these conclusions. On average, around two fifths of the adjustment of money balances towards a new equilibrium seems to take place within the first year.

The existence of time-lags in the demand-for-money function implies that the restoration of equilibrium after an increase in the money supply would require a much greater change in the other variables (income and interest rates) in the short term than in the long term. This is because, at a point in time, the demand for money depends primarily on past values of incomes and interest rates (which by definition cannot be changed) and only to a relatively small extent on current values of these variables. It is, therefore, changes in current values of either income or interest rates which must in the first instance take the strain of adjustment to an exogenous monetary change. If the role of interest rates in the demand for money is considered to be of secondary importance, the response of incomes to a monetary change should be larger in the short run than in the long run, as Friedman[**17**] acknowledges; however, other evidence which he has produced[**19**] suggests that in practice changes in the money stock do not appear to affect income until after quite a long and variable time-lag. This inconsistency disappears if a transmission mechanism working via interest rates is postulated. If the demand for money responds slowly to changes in income and interest rates, a change in the stock of money could have a rapid and powerful effect on interest rates, which in turn could have a lagged effect on expenditure, causing income changes to follow an initial change in the money supply. Under these conditions, Burstein[**8**] has argued that rigid pursuit of a money supply target might lead to unnecessarily wide fluctuations in interest rates and hence in incomes.

The relative importance of long-term and short-term interest rates in the demand-for-money function

If money is simply the most liquid in a spectrum of assets, one would expect the demand for it to be most closely related to the yield on near substitutes, that is to say, on other short-term assets. If, on the other hand, money is an asset that is fundamentally different from other

1 These results, however, are partly due to the fact that the estimation period chosen includes the years prior to 1951 when interest rates were pegged. If these years are excluded, both long and short rates become highly significant.

2 It should be noted, however, that this improvement may owe something to serial correlation in the basic equation, as well as to the existence of time-lags.

assets there is no reason to expect the demand for it to be any more closely related to the yield on short-term than on long-term assets. These two hypotheses may perhaps be empirically distinguished by testing whether a short-term or a long-term interest rate gives rise to the highest coefficient of determination in a demand-for-money function. Laidler[**25**] suggests a further test: if the demand function for money is stable, the 'right' interest rate would be expected to show the same relationship to the demand for money in different time periods while the 'wrong' one need not.

Many of the studies noted in this appendix do not provide any direct evidence on this issue. Those that do, however, tend to support the view that in the United States money has been a closer substitute for short-term than for longer-term assets. Laidler finds that using the wide definition of money, the coefficient of determination is much greater for short-term rates than for long-term rates; though in first differences, the superiority of short-term rates is less marked. He also found that when his data were divided into sub-periods, the estimates of interest-elasticity were much more stable with respect to short-term rates than to longer-term rates. Confirmation is provided by the work of Heller[**22**] who, using quarterly data for the post-war period, detects a significant elasticity for short-term interest rates but not for long-term rates.[1] Lee[**29**], using differential rather than absolute rates, finds that the yield on savings and loan shares (an asset which may be thought of as being very close to money on the liquidity spectrum) explains the demand for money, under either a narrow or broad definition, better than the yield on longer-term assets.

The results of the study set out in Appendix II, which reports the estimation of demand-for-money equations from data for the United Kingdom, left almost nothing to choose between long-term and short-term rates. Long-term rates were marginally more significant when the definition of money was restricted to currency plus clearing bank deposits; but the short-term (local authority) rate appeared slightly better at explaining changes in money as defined in the Central Statistical Office's *Financial Statistics*. This may result from the deposits of the 'other' banks being more directly competitive with rates in the local authority market. When first differences were used, however, the short rate performed markedly better than the long rate. The estimated values of the coefficients corresponded much better with values recorded using levels, and the significance of the estimates was considerably greater.

Tobin's results[**35**] (based on Friedman's data) also suggest that there is little to choose between long-term and short-term rates, with long-term rates being marginally more successful in explaining the demand for 'narrow' money, and short rates slightly better for 'wide' money.

The relative stability of Keynesian and monetary multipliers

As noted earlier, a further means of testing the relative importance of Keynesian and monetarist hypotheses of income determination is provided by estimates of the direct relationship between incomes and money on the one hand and between incomes and autonomous expenditures on the other. This approach is open to the objection that it tests only a very simple representation of the underlying models, ignoring the improvements and refinements suggested by theoretical developments. As Johnson[**23**] has noted this may be defended on the grounds that the "test of a good theory is its ability to predict something large from something small, by means of a simple and stable theoretical relationship"; but it is nevertheless quite possible that the relative explanatory power of simple equations may be a poor guide to the explanatory power of more complex equations derived as reduced forms from a set of interacting relationships.

More specifically, such an approach requires that the explanatory variables introduced should be the main exogenous variables influencing the economy, and that they should not themselves be functionally related to the dependent variables, or else erroneous conclusions may be reached. In general, a single equation model, which is not derived as a reduced form from a full set of structural equations, may be open to question as to whether the explanatory variables included are,

1 Though see footnote 1 on page 184.

indeed, truly exogenous. In particular, these tests of the monetarists' hypothesis hang crucially on the assumption that the money supply is exogenously determined, a question which is treated more fully in the main paper.

Quite apart from these problems with the specification of single equations, such equations can only provide information on the behaviour of one variable – albeit a variable of great significance to the economy. No government can possibly be content to rely on a model which only provides a forecast of, say, money income. It is essential to be able to make an informed and consistent judgment on a whole range of other variables, for example, productivity, inflation, unemployment, the balance of payments, the allocation of resources between various kinds of expenditure, etc. Furthermore, the authorities need to have some understanding of the route whereby they affect money incomes by changing their policy instruments. For example, it makes a difference whether monetary policy has its effect overwhelmingly on, say, private housebuilding, or more widely over all forms of expenditure. For this reason a proper test of the adequacy of the alternative models must be whether they can provide information on the behaviour of all the variables which are of concern to the authorities and to economists.

The pioneering comparison of Keynesian and monetary models was that of Friedman and Meiselman[**18**] in their research study for the Commission on Money and Credit. Using U.S. data for a 62-year period (1897–1958), which was divided into a number of sub-periods, they found that consumers' expenditure was more closely linked with the money stock than with autonomous expenditure in every period except the depression years. For the post-war period, when quarterly data were available, the picture was much the same, though neither hypothesis was at all successful in explaining quarterly *changes* in gross national product (G.N.P.). However, in the long run, velocity appeared to be more stable than at least one definition of the autonomous expenditure multiplier.

But Ando and Modigliani[**2**], using a definition of autonomous expenditure that was more in line with modern theory, obtained an explanation of consumers' expenditure which was better[*1*] than the one Friedman and Meiselman had detected using monetary variables. Their main argument, however, was methodological – namely, that to say the average value of the monetary multiplier had been more stable than the autonomous expenditure multiplier over a long run of years did not necessarily make it a particularly useful policy tool. Stabilisation policy would need to take into account a much wider body of knowledge about how economic variables interacted; there was no reason to treat Keynesian and monetary measures as alternatives, nor any justification for picking a single independent variable – which was anyway not always truly independent – to represent each type of policy.

The same criticisms could be applied to a similar study based on U.K. data undertaken by Barrett and Walters[**5**], which, however, did not produce any very conclusive results. When levels of data were used, there was little to choose between the alternative hypotheses; though both achieved quite high correlation coefficients because of strong trends in all series. When first differences of data were used, the estimated explanatory power (as measured by the coefficient of determination) of both hypotheses was low, though the autonomous expenditure 'explanation' of consumers' expenditure was somewhat better than the monetary explanation for the inter-war years; and the monetary explanation was better before 1914 (when, however, the data are not entirely reliable). Barrett and Walters also showed that when money and autonomous expenditures were jointly considered as predictors of consumers' expenditure, the coefficient of determination was significantly increased, suggesting that, whether or not it is the major determinant, money does play some significant role.

A slightly different approach, followed by Andersen and Jordan[**1**] compared the impact on G.N.P. of fiscal and of monetary measures respectively. Given the limitations of single-equation models, the tests used were subtle ones. Changes in G.N.P. were separately related to

1 As judged by the higher coefficient of determination.

changes in the full-employment budget balance, to changes in the money supply, and also to changes in the money base, which was assumed to be more nearly exogenous than the money supply.

The results obtained by Andersen and Jordan on U.S. data indicated that monetary changes had an impact on G.N.P. which was greater, more certain and more immediate than that of fiscal changes. de Leeuw and Kalchbrenner[**30**] challenged these conclusions on the grounds that the independent variables had been mis-specified; but although the alternative definitions proposed appeared to re-establish a role for fiscal policy, the case made by Andersen and Jordan for the importance of monetary factors was not refuted. Davis[**12**], however, showed that if the period to which the tests related was split into two equal sub-periods, the earlier part of the period (1952–60) showed very little relationship between money and incomes; the relationship discovered in the latter period (1960–68) might well have been due to common trends among the variables during these years.

For the United Kingdom, Artis and Nobay[**3**] have carried out tests very similar to those of Andersen and Jordan. In their study, fiscal policy was found to be more effective than monetary policy; but again little confidence can be attached to the results, because, as the authors themselves point out, these are critically dependent on the assumption that the authorities' fiscal and monetary policy actions are not functionally related to the level of money incomes. As much of the purpose of government action is to reduce deviations of actual incomes from some desired level, these assumptions must be suspect. Thus, if policy is used to offset a change in G.N.P. deriving from another source, it appears as though the policy measure has no effect. Perfect anti-cyclical fiscal policy would produce the *statistical* conclusion that fiscal policy was impotent.

Table A

For reasons of space, this selection of empirical work has had to be extremely compressed. As far as possible, representative equations have been chosen from the work of each author, though often other equations have produced somewhat different coefficients. No reference is made to the other variables, besides interest rates, included in the equations.

Where the equations contain lags, the implied long-run elasticity is given; these equations are marked † and no t statistic is given as its meaning would be ambiguous.

Author	Data used	Definition of money[a]	Interest rate used	Interest-elasticity[b]	t statistic[c]
Demand-for-money equations					
Bronfenbrenner and Mayer [6]	Annual: U.S.: 1919–56	Narrow	Short	−0·33	†
Chow [9]	Annual: U.S.: 1897–1958	Narrow	Long	−0·73	17
Meltzer [31]	Annual: U.S.: 1900–58	Narrow	Long	−0·92	22
,,	,,	Broad	Long	−0·48	10
,,	Annual: U.S.: 1930–58	Narrow	Long	−1·15	12
,,	,,	Broad	Long	−0·70	7
Brunner and Meltzer [7]	Annual: U.S.: 1930–59	Narrow	Long	−1·09	19
,,	,,	Broad	Long	−0·73	15
Laidler [25]	Annual: U.S.: 1919–60	Narrow	Short	−0·21	12
				(−0·11)	(3)
,,	,,	Narrow	Long	−0·72	12
				(−0·33)	(3)
,,	Annual: U.S.: 1892–1960	Broad	Short	−0·16	16
				(−0·10)	(5)
,,	,,	Broad	Long	−0·25	4
				(−0·26)	(3)
Lee [29]	Annual: U.S.: 1951–65	Narrow	Short	−0·41	4
,,	,,	Broad	Short	−0·67	3
Motley [32]	Annual: U.S.: 1920–65 (Households only)	Broad	Short	−0·16	5
Courchene and Shapiro [11]	Annual: U.S.: 1900–58	Narrow	Long	−1·00	16
,,	,,	Broad	Long	−0·58	10
Teigen [34]	Quarterly: U.S.: 1946–59	Narrow	Long	−0·07	†
,,	Annual: U.S.: 1924–41	Narrow	Long	−0·20	†
Heller [22]	Quarterly: U.S.: 1947–58	Narrow	Short	−0·12	4
,,	,,	Broad	Short	−0·18	4
,,	,,	Narrow	Long	*	..
,,	,,	Broad	Long	*	..
Hamburger [21]	Quarterly: U.S.: 1952–60 (Households only)	Narrow	Long	−0·16	2
,,	,,	Narrow	Equity yield	−0·13	3
Kavanagh and Walters [24]	Annual: U.K.: 1880–1961	Broad	Long	−0·31	3
				(−0·22)	(3)
,,	Annual: U.K.: 1926–61	Broad	Long	−0·50	6
				(−0·25)	(3)
Fisher [13]	Quarterly: U.K.: 1955–67	Narrow	Short	−0·11	†
,,	,,	Broad	Short	*	†
,,	,,	Narrow	Long	−0·3	†
,,	,,	Broad	Long	*	†
Laidler and Parkin [26]	Annual: U.K.: 1953–67	Broad	Short	−0·26	†
Bank of England [4]	Quarterly: U.K.: 1955–69	Narrow	Short	−1·05	†
,,	,,	Narrow	Long	−0·80	†
,,	,,	Broad	Short	−0·09	†
,,	,,	Broad	Long	−0·35	†

For footnotes see opposite page.

Author	Data used	Definition of money[a]	Interest rate used	Interest-elasticity[b]	t statistic[c]
Velocity equations					
Latané [**27**]	Annual: U.S.: 1919–52	Narrow	Long	−0·80	..
Latané [**28**]	Annual: U.S.: 1909–58	Narrow	Long	−0·77	..
Christ [**10**]	Annual: U.S.: 1892–1959	Narrow	Long	−0·72	..
Meltzer [**31**]	Annual: U.S.: 1950–58	Narrow	Long	−1·8	30
,,	,,	Broad	Long	−1·3	20
Tobin [**35**]	Annual: U.S.: 1915–59	Broad	Short	−0·12	7
,,	,,	Narrow	Short	−0·24	9
,,	,,	Broad	Long	−0·24	6
,,	,,	Narrow	Long	−0·55	10
Frazer [**14**]	Quarterly: U.S.: 1948–65	Narrow	Long	−0·8	27
,,	,,	Broad	Long	−0·37	12
Kavanagh and Walters [**24**]	Annual: U.K.: 1877–1961	Broad	Long	−0·20	2
				(−0·44)	(6)
,,	Annual: U.K.: 1923–61	Broad	Long	−0·55	9

* not significant, or wrong sign.

.. not available.

a The 'narrow' definition of money is usually currency plus demand deposits; 'broad' money includes time deposits.

b Values shown in brackets are obtained using first differences.

c The t statistic is the ratio of the estimated coefficient to its estimated standard error.

References

1 **Andersen, L. C. and Jordan, J. L.** "Monetary and fiscal actions: a test of their relative importance in economic stabilisation" *Federal Reserve Bank of St. Louis Monthly Review,* November 1968

2 **Ando, Albert and Modigliani, Franco** "The relative stability of monetary velocity and the investment multiplier" *American Economic Review,* September 1965 pages 693–728. See also other papers on the subject in the same issue

3 **Artis, M. J. and Nobay, A. R.** "Two aspects of the monetary debate" *National Institute Economic Review,* August 1969 pages 33–51

4 **Bank of England** Appendix II to this paper

5 **Barrett, C. R. and Walters, A. A.** "The stability of Keynesian and monetary multipliers in the United Kingdom" *Review of Economics and Statistics,* November 1966 pages 395–405

6 **Bronfenbrenner, Martin and Mayer, Thomas** "Liquidity functions in the American economy" *Econometrica,* October 1960 pages 810–34

7 **Brunner, Karl and Meltzer, A. H.** "Some further investigations of demand and supply functions for money" *Journal of Finance,* May 1964 pages 240–83

8 **Burstein, M. L.** *Economic theory: equilibrium and change* Wiley, London 1968 esp. pages 289–326

9 **Chow, G. C.** "On the long-run and short-run demand for money" *Journal of Political Economy,* April 1966 pages 111–31

10 **Christ, C. F.** "Interest rates and 'portfolio selection' among liquid assets in the U.S." *Studies in memory of Yehunda Grunfeld* Stanford, 1963

11 **Courchene, T. J. and Shapiro, H. T.** "The demand for money: a note from the time series" *Journal of Political Economy,* October 1964 pages 498–503

12 **Davis, R. G.** "How much does money matter?" *Federal Reserve Bank of New York Monthly Review,* June 1969

13 **Fisher, Douglas** "The demand for money in Britain: quarterly results 1951–67" *The Manchester School of Economic and Social Studies,* December 1968 pages 329–44

14 **Frazer, W. J.** "The demand for money, statistical results and monetary policy" *Schweizerische Zeitschrift für Volkswirtschaft und Statistik,* March 1967

15 **Friedman, Milton** "The quantity theory of money: a restatement" *Studies in the quantity theory of money* M. Friedman, ed. University of Chicago Press, 1956 pages 3–21

16 **Friedman, Milton** "The demand for money: some theoretical and empirical results" *Journal of Political Economy,* August 1959 pages 327–51

17 **Friedman, Milton** "The demand for money: some theoretical and empirical results" *Journal of Political Economy,* August 1959 page 347

18 **Friedman, Milton and Meiselman, David** "The relative stability of monetary velocity and the investment multiplier in the United States, 1897–1958", in "Stabilization policies" *C.M.C. Research Papers* Prentice-Hall, 1964 pages 165–268

19 **Friedman, Milton and Schwartz, A. J.** *A monetary history of the United States 1867–1960* Princeton, 1963

20 **Goldberger, A. S.** *Econometric theory* Wiley, New York, 1966 pages 197–200

21 **Hamburger, M. J.** "The demand for money by households, money substitutes, and monetary policy" *Journal of Political Economy,* December 1966 pages 600–23

22 **Heller, H. R.** "The demand for money: the evidence from the short-run data" *Quarterly Journal of Economics,* May 1965 pages 291–303

23 **Johnson, H. G.** "Recent developments in monetary theory: a commentary" *Money in Britain* D. R. Croome and H. G. Johnson, eds. Oxford, 1970 pages 83–114

24 **Kavanagh, N. J. and Walters, A. A.** "Demand for money in the U.K. 1877–1961: some preliminary findings" *Bulletin of the Oxford University Institute of Economics and Statistics,* May 1966 pages 93–116

25 **Laidler, David** "The rate of interest and the demand for money—some empirical evidence" *Journal of Political Economy,* December 1966 pages 543–55

26 **Laidler, David and Parkin, Michael** "The demand for money in the United Kingdom 1956–67: preliminary estimates" *University of Essex Discussion Paper* unpublished

27 **Latané, H. A.** "Cash balances and the interest rate: a pragmatic approach" *Review of Economics and Statistics,* November 1954

28 **Latané, H. A.** "Income velocity and interest rates: a pragmatic approach" *Review of Economics and Statistics,* November 1960

29 **Lee, T. H.** "Alternative interest rates and the demand for money: the empirical evidence" *American Economic Review,* December 1967 pages 1168–81

30 **Leeuw, Frank de and Kalchbrenner, John** "Monetary and fiscal actions: a test of their relative importance in economic stabilisation—comment" *Federal Reserve Bank of St. Louis Monthly Review,* April 1969

31 **Meltzer, A. H.** "The demand for money: the evidence from time series" *Journal of Political Economy,* June 1963 pages 219–46

32 **Motley, Brian** "A demand-for-money function for the household sector—some preliminary findings" *Journal of Finance,* December 1967 pages 405–18

33 **Radcliffe Report** *Committee on the Working of the Monetary System,* Cmnd. 827, August 1959 para. 392

34 **Teigen, R. L.** "Demand and supply functions for money in the United States: some structural estimates" *Econometrica,* October 1964 pages 476–509

35 **Tobin, James** "The monetary interpretation of history" *American Economic Review,* June 1965 pages 464–85

Appendix II

The demand for money and money multipliers

The demand for money

Both in the main paper and in Appendix I a number of issues were raised about the nature of the demand function for money,[1] which are crucially important in assessing the role of money in the economy, and which are subject to empirical testing. These were:

(i) the basic predictability of the function;
(ii) the role of interest rates in the function; and
(iii) the relative importance of long-term and short-term interest rates.

This appendix reports a number of statistical tests of the demand function for money, using quarterly U.K. data over the period from 1955 to 1969. It begins by considering a very simple model, and examines the empirical implications of modifying it to take account of theoretical refinements.

Perhaps the simplest model of the demand for money is

$$M = a_0 + a_1 Y + a_2 r + u \qquad (1)$$

where

M = money stock;
Y = income;
r = some interest rate; and
u = an error term demonstrating the relationship to be a behavioural one.

This single-equation model was estimated using the technique of ordinary least squares. Three definitions of the money stock, and two kinds of interest rate were considered. The results are given in Table B. The precise variables used are:[2]

M_1: Currency and net current account deposits of the London clearing banks[3] (quarterly average of monthly observations), seasonally adjusted, £ millions.

M_2: Currency and net deposits of London clearing banks[3] (quarterly average of monthly observations), seasonally adjusted, £ millions.

M_3: Currency and net deposits of U.K. residents with the U.K. banking sector (end-quarter figures), seasonally adjusted, £ millions.[4]

Y: Average of the three official estimates of gross domestic product at factor cost, separately derived from output data, expenditure data and income data, seasonally adjusted, £ millions. (Before 1958 it was only possible to take the average of income and expenditure-based estimates.)

r_S: The ratio of 100 plus the interest rate on 3-month local authority debt[5] to 100.

r_L: The ratio of 100 plus the yield on $2\frac{1}{2}$% Consolidated Stock to 100.

Functions for M_1 and M_2 are estimated for the period including the third quarter of 1955 to the third quarter of 1969; and M_3 for the period including the second quarter of 1963 to the third quarter of 1969.

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1 It is largely optional whether the function is cast in demand-for-money or in velocity form. In fact, if income is included as a determinant of velocity, the two functions would be equivalent when cast in logarithmic form.

2 The data used in the equations reported in this appendix may be obtained on application to the Economic Section, Bank of England, London, EC2.

3 London clearing bank data were chosen primarily because of limitations in other series. However, it can also be argued that the liabilities of the 'other' banks are significantly less liquid than those of the L.C.B.s, so that their omission would be justified on theoretical grounds. In 1955, almost 90% of U.K. residents' deposits with the U.K. banking sector were with the L.C.B.s; in 1969, some 65%.

4 Data for M_3 were also adjusted for day-of-the-week variations. M_3 is only available on an end-quarter basis, so that observations of this variable are not properly in phase with those of the independent variables in the equation. A half-quarter lag is thus built into the adjustment process. (It was not thought appropriate to average adjacent observations, since this would introduce serial dependence.)

5 The yield on 3-month local authority deposits was chosen in preference to the Treasury bill rate, on the grounds that in recent years the local authority market has attracted a wider range of active participants and has been less dominated by the direct influence of the authorities than has the Treasury bill market. The local authority rate is also somewhat suspect, however, because of the 'thinness' of the market in the early part of the estimation period. (Indeed the first two observations in the series are not directly available, and have been estimated from changes in other short-term rates.)

All the variables have been expressed in logarithmic form. The only departure from usual practice is that the interest rate variable has been taken as the ratio of future to present value so that an interest rate of 4% is expressed as 104/100 = 1·04.[1] This means that a percentage point change in interest rates is assumed to have much the same effect on the demand for money whether the level of rates is high or low; and so differs from the more conventional formulation, where the logarithm of the interest rate itself is used. A disadvantage of this latter approach is that it implicitly regards the conceptual floor to interest rates as being zero, and so cannot admit negative rates of return. However, to simplify comparison with other published work, elasticities have also been calculated on the conventional basis.[2]

Table B
Estimated forms of equation (1)

Dependent variable	Estimated coefficients of: Constant	Nominal income	Interest rate: Short	Interest rate: Long	Coefficient of determination[a]	Standard error of estimate[b]	Durbin-Watson statistic[c]
M_1 (nominal)	4·57	0·47 (0·02)	0·28 (0·32)		0·959	0·0244	0·30
	4·40	0·50 (0·03)		−0·36 (0·79)	0·959	0·0245	0·28
M_2 (nominal)	3·34	0·66 (0·01)	0·78 (0·26)		0·987	0·0196	0·35
	3·50	0·64 (0·03)		1·31 (0·66)	0·986	0·0204	0·26
M_3 (nominal)	−1·50	1·22 (0·06)	−0·45 (0·46)		0·983	0·0168	0·93
	−0·75	1·13 (0·08)		0·58 (0·95)	0·982	0·0170	0·84

Note: Standard errors of the estimated coefficients are shown in brackets.

a $\bar{R}^2$, the coefficient of determination adjusted for degrees of freedom.

b The standard error of the observed value of the dependent variable from its estimated value.

c This is a measure of serial correlation in the residuals (see footnote *1* on page 182). In general, the closer the statistic is to a value of 2, the greater the confidence with which the hypothesis of serial correlation can be rejected.

Clearly the estimates shown in Table B suggest that the simplest formulation of the demand-for-money function is inadequate. It is true that the coefficients of determination are high and the income-elasticity of demand for money – though a little low for M_1 and M_2 in comparison with other studies – is not altogether implausible[3] but these results can be accounted for by common trends in the variables. More disturbing are the perverse signs on the interest rate variables, and the strong evidence of first order serial correlation in the residuals as indicated by the very low values of the Durbin-Watson statistic. It seems likely, therefore, that this simple model mis-specifies the demand-for-money function in one or more important ways.

Lagged adjustment

One possible source of specification error is the implicit assumption in this simple model that adjustment to equilibrium is achieved within a single time period (in this case, one quarter). This seems unduly restrictive, for it may take time for money holders to become aware of changed external circumstances, and accordingly to rearrange their asset portfolios. A lagged process of adjustment to equilibrium suggests a two-equation

1 The logic of this approach may be seen more easily by considering interest as a measure of the future value of present assets. If the interest rate is 4%, today's £1 will be worth £1·04 a year hence. If the interest rate rises to 5%, the future value of today's £1 has increased by 1/104 (or very nearly 1%) not by 25%.

2 The equations reported in this appendix were also estimated using logarithms of the interest rates *i.e.* log r rather than log (1+r). The elasticities computed on this basis were very similar to those reported in Table D, and there was little change in the fit of the equations or in the significance of the estimated interest rate coefficients.

3 Most studies using U.S. data have found the income-elasticity of demand for money to be in the range 1·0–1·5.

model, defining not only the equilibrium relationship, but also the adjustment mechanism. One such model is:

$$M_t^* = a_0 + a_1 Y_t + a_2 r_t + u_t \quad (2)$$

$$M_t = M_{t-1} + b(M_t^* - M_{t-1}) + v_t \quad (3)$$

where M^* = desired (or equilibrium) money balances – all the other variables being defined as before – and b is a constant representing the average proportion of the discrepancy between actual and equilibrium money balances eliminated during a quarter. Combining equations (2) and (3) the following reduced form is obtained:

$$M_t = ba_0 + ba_1 Y_t + ba_2 r_t + (1 - b)\, M_{t-1} + w_t \quad (4)$$

where $w_t = bu_t + v_t$, a composite error term.

This equation was estimated using the earlier definitions of money stock and interest rates, and the results are presented in Table C.

Table C
Estimated forms of equation (4)

Dependent variable	Estimated coefficients of: Constant	Nominal income	Interest rate Short	Long	Lagged dependent variable	Co-efficient of deter-mination	Standard error of estimate	Durbin-Watson statistic
M_1 (nominal)	−0·05	0·05 (0·02)	−0·77 (0·14)		0·96 (0·05)	0·994	0·0093	1·75
	0·03	0·12 (0·03)		−1·61 (0·32)	0·89 (0·05)	0·994	0·0097	1·76
M_2 (nominal)	0·29	0·10 (0·03)	−0·20 (0·10)		0·87 (0·04)	0·998	0·0067	1·31
	0·11	0·12 (0·02)		−0·73 (0·22)	0·89 (0·04)	0·999	0·0063	1·60
M_3 (nominal)	−0·54	0·24 (0·14)	−0·58 (0·25)		0·83 (0·11)	0·995	0·0092	2·03
	−0·47	0·17 (0·14)		−0·91 (0·58)	0·89 (0·13)	0·994	0·0097	2·13

Note: Standard errors of the estimated coefficients are shown in brackets.

The properties of these estimated equations are considerably better than those shown in Table B. The coefficients on interest rates have the right sign, the fit of the function is better, and the standard error is reduced. Although the Durbin-Watson statistic has a different distribution where an equation contains a lagged dependent variable, it is possible to adjust for this. When this is done, it is clear that in all cases serial correlation has been markedly reduced (though it is still present).[1]

The implied long and short-run interest-elasticities using the conventional definition of elasticity[2] are given below.

Table D
Interest-elasticities

	r_S Short-run	Long-run	r_L Short-run	Long-run
M_1	−0·04	−1·05	−0·09	−0·80
M_2	−0·01	−0·09	−0·04	−0·35
M_3[a]	−0·03	−0·21	−0·06	−0·51

Note: Since the interest-elasticity, under this definition, is not constant in equation (4), its value has been calculated at the mean value of the interest rate.

[a] As data for M_3 are end-quarter, the 'short' run refers to a slightly different period than for M_1 and M_2.

1 See J. Durbin, "Testing for serial correlation in least squares regressions when some of the regressors are lagged dependent variables", *Econometrica*, May 1970.
The Durbin two-stage test was also applied, and produced results very favourable to the hypothesis of partial adjustment rather than serial correlation.

2 See page 192.

These elasticities are well within the range of values reported in the survey of empirical evidence in Appendix I, and they suggest that the experience of the United Kingdom has not been markedly different from that of the United States in this respect.

Standard errors of estimate (expressed as percentages) are lowest for the broader definition of money, M_2, although the absolute size of the error is not much different because, of course, M_2 is larger than M_1. There is little to choose between the explanatory power of short and long rates; but whichever is used, its statistical significance is usually much the same as that of the income variable.

Although the equations in Table C gave quite satisfactory results,[1] the lagged adjustment model embodies a number of theoretical assumptions which can be questioned. Changes in income are implicitly assumed to have the same effect on the demand for money whether they result from changes in real output or in prices. As mentioned in the main paper,[2] there are plausible reasons for expecting real money balances to increase either faster than real incomes, if money is considered a 'luxury good', or slower than incomes, if there are economies of scale in cash management; but there is no sound reason for expecting a change in the price level or a change in population size to have an effect on the equilibrium money/income ratio. This line of reasoning suggests that the appropriate formulation of the demand-for-money equation is one which explains real *per capita* money balances in terms of real *per capita* incomes. It is quite a simple matter to adapt the variables in equation (4) to take account of this. Thus, money and incomes are each divided by np, where n is the adult population of the United Kingdom (obtained by interpolation of annual population estimates)[3] and p is the price level (the G.D.P. deflator).[4] The results of the equations run in real *per capita* terms are given in Table E.

Table E

Estimated forms of equation (4) in real *per capita* terms

Dependent variable	Estimated coefficients of: Constant	Real *per capita* income	Interest rate Short	Interest rate Long	Lagged dependent variable	Co-efficient of deter-mination	Standard error of estimate	Durbin-Watson statistic
$\frac{M_1}{np}$	0·30	0·06 (0·03)	−0·80 (0·16)		0·89 (0·04)	0·940	0·0116	1·78
	0·27	0·14 (0·04)		−1·82 (0·35)	0·83 (0·04)	0·941	0·0115	1·73
$\frac{M_2}{np}$	0·65	0·09 (0·02)	−0·21 (0·14)		0·80 (0·05)	0·908	0·0096	1·60
	0·45	0·14 (0·03)		−0·76 (0·28)	0·79 (0·04)	0·915	0·0092	1·69
$\frac{M_3}{np}$	−0·83	0·29 (0·23)	−0·59 (0·32)		0·89 (0·14)	0·966	0·0110	2·16
	−0·46	0·18 (0·23)		−0·63 (0·71)	0·92 (0·16)	0·962	0·0116	2·06

Note: Standard errors of the estimated coefficients are shown in brackets.

1 As noted in Appendix I, a more searching test of the strength of a relationship where trends are present is its explanatory power when the variables are transformed into first differences. The equations presented in Tables B and C were therefore estimated in first difference form. None of the results of these tests could be taken as contradicting the results obtained using levels of the data, but neither do they provide strong confirmation. Coefficients of determination were uniformly low, with a maximum of $\bar{R}^2=0{\cdot}22$. The short-term interest rate was always more significant than the long-term rate, giving some support to the hypothesis that money is more substitutable for short-term than for other assets.

2 Page 159.

3 The population over fifteen years of age was chosen as the series which most closely approximated the number of potential independent money-holding units. Total population includes children, who will in general not hold money, and working population excludes pensioners, who probably are significant money holders. A more appropriate series might have been the numbers of households, but data are not available.

4 The choice of this deflator follows immediately from the fact that we have been working with G.D.P. as our income estimate. As there is no separate deflator for income-based G.D.P., nor a quarterly deflator for output-based G.D.P., it follows that p is derived from the G.D.P. estimates made from the expenditure side.

Somewhat surprisingly, these estimates are rather worse[1] than those presented in Table C, but the reason is not far to seek. Deflating both money and income by prices implies not only that the demand for money is homogeneous in prices in the long run, but also in the short run. In other words, this last set of estimated equations implies that the demand for money will adjust almost immediately to an increase in aggregate money incomes due to a rise in population or in the price level, but only after a long time-lag will it adjust to a rise in real *per capita* incomes. The fact that the estimated equations in Table E have higher standard errors of estimate than those of Table C suggests that this assumption is unjustified.

It therefore seems appropriate to allow for a gradual adjustment to price changes. Since it was argued earlier that the effect of a change in real incomes may be different from the effect of a change in prices, the price level was included as a separate explanatory variable. The estimated equations when this is done are set out in Table F. In principle, population might also be included as an additional independent variable, but there is little theoretical justification for expecting lagged adjustment in the case of the population variable.[2] Thus in Table F, money and income are expressed in *per capita* terms, *viz.*:

$$\left(\frac{M}{n}\right)_t = ba_0 + ba_1\left(\frac{Y}{np}\right)_t + ba_2 r_t + ba_3 p_t + (1-b)\left(\frac{M}{n}\right)_{t-1} + w_t \quad (5)$$

Table F
Estimated forms of equation (5)

Dependent variable	Estimated coefficients of: Constant	Real *per capita* income	Price	Interest rate: Short	Interest rate: Long	Lagged dependent variable	Coefficient of determination	Standard error of estimate	Durbin-Watson statistic
$\frac{M_1}{n}$	0·11	−0·02 (0·09)	0·07 (0·04)	−0·82 (0·16)		1·02 (0·07)	0·990	0·0096	1·78
	0·11	0·07 (0·09)	0·14 (0·05)		−1·74 (0·36)	0·93 (0·07)	0·990	0·0099	1·82
$\frac{M_2}{n}$	0·26	0·07 (0·05)	0·10 (0·04)	−0·21 (0·11)		0·90 (0·05)	0·998	0·0070	1·26
	0·22	0·06 (0·05)	0·13 (0·04)		−0·87 (0·24)	0·92 (0·04)	0·998	0·0064	1·62
$\frac{M_3}{n}$	0·62	0·09 (0·23)	0·37 (0·19)	−0·49 (0·27)		0·81 (0·11)	0·995	0·0091	1·96
	1·08	−0·04 (0·22)	0·38 (0·20)		−0·83 (0·57)	0·86 (0·12)	0·994	0·0093	2·11

Note: Standard errors of the estimated coefficients are shown in brackets.

For the first two definitions of the money stock, Table F shows rather less satisfactory results than Table C; standard errors of estimate are greater. This is a little surprising, for the only changes introduced that would have any effect on the standard errors are the separate specification of price and real income as explanatory variables and the specification of income and money holdings in *per capita* terms. The first change would if anything tend to reduce the standard errors if the effects of prices and real incomes differ; indeed, it is evident from new estimates of equation (5) with money and real incomes no longer expressed in *per capita* terms that it is the latter adjustment which has caused most of the deterioration. This result casts doubt on the assumption that the demand for money is homogeneous in population, but it is also possible

1 Not only are the coefficients of determination lower (this could be explained by the lower initial variance in the dependent variable), but the standard errors of estimate are larger.

2 Additions to the population will not affect the behaviour of existing money holders; nor are they likely to "adjust gradually to their own existence".

that the population series used is inappropriate.[1] Failing a more appropriate series, it seems preferable to use totals of money and of incomes, at least with regard to the relatively short time-series we are using.

The estimated coefficient of the real income variable in equation (5) is never statistically significant,[2] though for the price variable it is significant, or nearly so, and has the expected positive sign. But there is some degree of collinearity between the price and real income variables (the simple correlation coefficient is 0·972) so that not much can be read into these results. Furthermore, the implied long-run price elasticity is in some cases implausibly high, suggesting that the estimates are attributing to the price variable some of the effect on money holdings that should properly be accounted for by real incomes.

Models which included interest rate differentials and the annual rates of change in prices of goods and services as explanatory variables were also tested. The interest rate differential employed was the interest rate on three months' local authority deposits minus Bank rate.[3] The estimated coefficient of this variable was statistically significant and of the expected negative sign when it was the only interest rate variable appearing in the equation; but when included with the level of the local authority rate, multicollinearity was encountered, and implausible results were obtained. The rate of change of prices was included as a measure of the relative return on real as against financial assets.[4] The estimated coefficients attaching to this variable were rarely significant and the results obtained are not presented here.

All the results presented so far have indicated the importance of time-lags, but little attention has been paid to the precise nature of the lag. An exponential adjustment mechanism has been used, but, while computationally easy, it is not necessarily the correct specification. It implies that a constant proportion of any disequilibrium will be eliminated in a given time period, irrespective of:

(i) the source of the disequilibrium; and

(ii) the size of the disequilibrium.

If the reason for time-lags is the existence of transactions costs associated with compositional changes in a portfolio, there is no reason to expect the speed of adjustment to be influenced by the *source* of the initial disequilibrium. But the speed of adjustment might well be influenced by the *size* of the disequilibrium.

It is not necessary, however, to attribute the presence of time-lags wholly to transactions costs. Indeed, it would seem more likely that transactions costs were relatively low in financial markets. A more plausible explanation might be that people take time to become aware that changes in incomes and interest rates made revisions in their money holding habits appropriate.[5] If these 'awareness' or 'inertia' lags are important, then it is not clear that the speed of adjustment can be regarded as invariant to the source of the disequilibrium. In other words, people may become aware of changes in their real income faster, or slower, than they become aware of changes in the price level or in interest rates.

All this implies a much more complex model incorporating a separate pattern of adjustment for each independent variable; but the estimation of such a model raises a number of problems. Unlike a common exponential adjustment lag, which can be simply estimated by taking into account lagged values of the dependent variables, a variety of lags would make the equation over-identified unless restrictions were placed on the values of the coefficients of the variables. Using exponential lags, different speeds of adjustment could be assumed to apply to different explanatory variables in the hope of finding some unique combination

1 The sharp post-war rise in births led to a rapid increase in the adult population in the early 1960s—a period not included in the data used to estimate the equations for M_3. It seems plausible to suppose that this rapidly increasing younger proportion of the population held less money than the average for the adult population as a whole.

2 As throughout this work, 'statistically significant' is intended to imply that the estimated coefficient is significantly different from zero at the 5% probability level. In other words the estimated value is not attributable to sampling fluctuations.

3 Bank rate was used as a proxy for the interest rate paid on deposit accounts.

4 Inflation would tend to make real assets more attractive than financial, and thus cause a switch out of money; though it could also be argued that rising prices would generate expectations of rising interest rates and thus cause a switch into money.

5 It should be remembered that three quarters of clearing bank deposits are held by the personal sector, and 'persons' may well be slow to adapt to changes in interest rates.

of lags which gave the best results. Alternatively, the Almon technique[1] could be employed, and a finite lag structure estimated for each variable. Work is in hand using both these techniques of estimation.

Money multipliers

Although it is clearly of considerable importance to understand the factors governing the demand for money, the estimation of a demand-for-money equation does not immediately provide any indication of the response of an economy to changes in the money stock.

In this connection, it is more relevant to consider relationships where income is the dependent variable, and money the explanatory variable. Despite the many shortcomings of such a highly simplified approach, which are discussed in more detail in the main paper and in Appendix I,[2] it may be of interest to see whether such an approach provides any general indications about the strength and predictability of the relationship between the money stock and income levels.

Using the same data and definitions as in the earlier part of this appendix, two separate models were tested:

$$Y_t = a_0 + a_1 M_t + a_2 Y_{t-1} + u_t \quad (6)$$

and $$Y_t = a_0 + a_1 M_t + a_2 M_{t-1} + \ldots + a_8 M_{t-7} + v_t \quad (7)$$

Both these equations were subject to very severe multicollinearity problems when estimated in levels, and little confidence could be attached to the results obtained. Using first differences of the data, no role for money could be detected in the estimated form of equation (6), which embodies an exponential adjustment lag. As a result attention was concentrated on equation (7).

This was estimated in two forms: with and without a constant term.[3] All variables whose estimated coefficients were not significantly different from zero at the 20% probability level were excluded. In addition to the series for G.D.P. used in the estimation of the demand-for-money functions reported earlier in this appendix, a variable attempting to measure the output of the industrial sector of the economy was used – consisting of the index of industrial production converted to current prices by the wholesale price index.[4] The estimates of all these equations are given in Table G. Both in terms of the coefficients of determination and of the shape of the lag-profiles, the industrial output variable performs much better than the G.D.P. measure. This suggests that money may have a closer association with industrial activity than with other sectors of the economy – private and government services and agriculture.

The 'official' definition of the money stock, M_3, appears to give the best explanation of changes in output whichever output measure is used, but this may be due to the fact that the data for M_3 cover a rather shorter time-period, during which there may have been a chance stability in the relationship. It will be recalled that M_3 performed no better than M_1 and M_2 in the estimates of the demand-for-money functions reported earlier.

In those equations in Table G where the constant term is suppressed, the estimated coefficients of the independent variables are generally increased, because some of the influence of the (normally positive) constant term is being attributed to them, and so the estimates of the long-run money multiplier tend to be larger.[5] Without a convincing explanation of what determines the size of the constant term, it is impossible to say which of the two estimates of the long-run multiplier is the more accurate. Indeed, the possibility cannot be dismissed that the apparent connection between changes in money and changes in output is merely a reflection of cyclical influences acting on both variables, with no direct causal connection.

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1 Shirley Almon, "The distributed lag between capital appropriations and expenditures", *Econometrica*, January 1965.

2 See pages 173 and 185.

3 The transformation of equation (7) into first difference form does not yield a constant term. The existence of a non-zero constant term would imply that income would rise (or fall) at a steady rate if the money stock were unchanged.

4 The resulting series was expressed in £ millions.

5 The coefficients of determination of equations estimated with and without the constant term should not be compared directly.

Table G
Estimated first difference forms of equation (7)

Money series	Estimated coefficients of: Constant	ΔM_0	ΔM_{-1}	ΔM_{-2}	ΔM_{-3}	ΔM_{-4}	ΔM_{-5}	ΔM_{-6}	ΔM_{-7}	Estimated money multiplier[a]	Coefficient of determination	Standard error of estimate	Durbin-Watson statistic
Dependent variable—G.D.P.													
M_1	77·1		0·42 (0·15)	−0·38 (0·16)	0·40 (0·15)		0·33 (0.15)	−0·27 (0·15)		0·50	0·216	70·6	2·69
(1957: 2-1969: 3)	suppressed	0·35 (0·17)	0·28 (0·18)		0·49 (0·15)		0·63 (0·17)	−0·39 (0·20)	0·45 (0·18)	**1·81**	0·565	83·7	2·17
M_2	64·6	0·25 (0·14)					0·37 (0·17)	−0·29 (0·16)		0·33	0·086	76·1	2·72
(1957: 2-1969: 3)	suppressed	0·34 (0·12)			0·27 (0·15)		0·49 (0·16)	−0·45 (0·19)	0·27 (0·16)	0·92	0·629	77·3	2·47
M_3	91·7			0·19 (0·13)	−0·36 (0·13)	0·27 (0·13)		*b*	*b*	0·10	0·343	73·9	2·79
(1964: 3-1969: 3)	suppressed			0·28 (0·11)	−0·31 (0·12)	0·32 (0·12)	0·20 (0·11)	*b*	*b*	0·49	0·742	74·4	2·54
Dependent variable—industrial output													
M_1	21·9	0·11 (0·05)	0·17 (0·05)	0·15 (0·06)		0·12 (0·06)				0·55	0·276	37·0	1·82
(1953: 2-1969: 3)	suppressed	0·14 (0·06)	0·22 (0·06)	0·18 (0·06)	0·12 (0·06)	0·15 (0·06)	0·09 (0·06)			0·90	0·588	39·0	1·64
M_2	14·9		0·22 (0·06)		0·10 (0·07)					0·32	0·212	38·6	1·53
(1953: 2-1969: 3)	suppressed	0·09 (0·07)	0·22 (0·07)		0·14 (0·06)					0·45	0·585	39·1	1·49
M_3	−57·0	0·08 (0·06)	0·09 (0·05)	0·23 (0·06)		0·12 (0·06)		*b*	*b*	0·53	0·516	34·2	1·46
(1964: 3-1969: 3)	suppressed		0·07 (0·05)	0·20 (0·05)				*b*	***b***	0·27	0·772	36·3	**1·51**

Note: Standard errors of the estimated coefficients are shown in brackets.

a The sum of the estimated coefficients of ΔM_0 to ΔM_{-7}, measuring the expected effect of a change in the money stock during the first eight quarters from its occurrence.

b These variables were not included in the estimation.