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MONEY DEMAND AND MONEY MULTIPLIER COMPONENTS IN THE UNITED KINGDOM : 1871 - 1969

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ABSTRACT

This thesis sets out estimates of the money demand and the money supply functions in the United Kingdom over the period 1871-1969. The stability of these functions over time and the precise roles played by income, prices and interest rates, are important considerations in determining whether monetary control is useful and feasible, and whether it is better effected by interest rate or monetary base targeting. Because of their importance, many disparate studies of money demand and supply functions already exist. The contribution of this thesis is, however, novel in two respects. First, the data base used is new, of high quality, and covers a period of history of sufficient length to allow us to assess the stability of money demand and supply over widely differing conditions. Second, the properties of the data are investigated within the framework of a consistent econometric modelling strategy, which starts from a general specification, and lets the data decide which coefficent restrictions should be imposed in order to reach the final functional form.

The main conclusions of this study are: first, stable money demand and money multiplier functions can be identified for the pre World War One and post World War Two periods, but not for the interwar years. Second, although similar in their long run properties, the short run dynamics of these functions differ from period to period, probably because of differing expectations about government policy. Third, both money demand and, more surprisingly, supply prove to be negatively related to the general level of interest rates. The demand function is, however, more elastic so that the money market is stable. Finally, the interest-elasticity of demand has not, as some authors have suggested, become larger over time. In spite of growth in money substitutes monetary control is therefore still feasible.

SYMBOLS and ABBREVIATIONS

AD	Autoregressive dynamic
ARMA	Autoregressive - moving average
ARIMA	Autoregressive - integrated - moving average
IV	Instrumental variable
OLS	Ordinary least squares
2SLS	Two stage least squares
3SLS	Three stage least squares
ΔX_t	$X_t - X_{t-1}$
$\Delta^k X_t$	$(X_t - X_{t-1})^k$
$\Delta_k X_t$	$X_t - X_{t-k}$
$L(X_t)$	X_{t-1}
$L^k X_t$	X_{t-k}

Introduction and Overview

This thesis attempts to model the money adjustment process, the relationship between money, prices, income and interest rates, and the components of the money multiplier - the currency and reserve ratios. As these functions are amongst the most important for the purposes of monetary control, a detailed empirical investigation for the United Kingdom over the period 1871-1969 using recently developed quantitative techniques should be of value for monetary economics.

Chapter one examines demand and supply of money in a theoretical framework and sets out the empirical issues to be addressed in the thesis. The following chapters discuss what might currently constitute a best-practice approach to the estimation of these functions. This involves discussing the type of estimation and the kind of strategy to be adopted for modelling the functions. Following Geweke (1978), Granger (1969), and Sims (1972) a test is derived in order to check the validity of 'single-equation' estimation and the adequacy of Ordinary Least Squares estimators. The pros and cons of 'Simple to General' and 'General to Specific' methods are discussed (see Hendry, 1980) and a three stage procedure is suggested for estimating the adjustment equations.

The period of investigation stretches over 100 years from 1871 to 1969. This is a period covering two World Wars, various exchange rate regimes - fixed, floating and managed - years of great stability and years of turbulence. For the purposes of empirical investigation we divide the period into three sub-periods. These are: the long period of the gold standard from 1871 to 1913; the interwar period, from 1922 to 1939; and the post World War II period, running from 1955 to 1969. Chapter three analyses the main features of the data over these sub-periods. The frequency of the data is annual for the first period and quarterly thereafter. The data base on monetary aggregates M1 and M2 was created as part of the Monetary History Project (see Capie and Webber, 1985) and the present author has been involved with their collection and analysis from the beginning of that project. Most of the other series required - income, prices and interest rates - are readily available, except for the interwar period where proxies have necessarily been used.

In chapter four we set out to determine whether the money adjustment equation relating money to income, prices and interest rates does in fact exist, and then whether such a relationship can be estimated with Ordinary Least Squares. The results show that, first, the money adjustment equation can be established for all periods except for the interwar period, where the endogeneity of broad money (M2) is rejected with respect to its arguments. Second, the absence of simultaneity confirmed OLS to be the appropriate estimator except for the period 1871-1913 where we found evidence of simultaneity between M2 and income.

The following three chapters are devoted to estimating the adjustment equation over the three sub-periods.

The interesting results emerging from these chapters can be listed as follows. First, the results relating to money adjustment equations:

(1) In spite of the simultaneity between M2 and income, it seems that there is not much to be gained in terms of regression results from using an Instrumental Variable method.

(2) The three-stage procedure gives statistically more robust results than the partial adjustment method.

(3) Both M1 and M2 balances behave in the manner found in earlier empirical studies (see Laidler, 1969) in that they both exhibit unitary long run income and price elasticities. An exception is the interwar period, where no steady-state can be defined.

(4) The long-run interest elasticities seem to lie between -0.04 and -0.5, these being relatively higher for M1, and for the long term interest rate.

(5) Three more variables, - the wage rate, the growth of income and of prices - are found to be important.

(6) Time lags are important in the money demand function, and the final specifications show long periods of adjustment.

(7) The functions are stable in the long-run, their dynamics presumably depend upon expectations process which in turn depend upon the ruling government policy.

Second, the components of the money multiplier:

(1) All three components - the currency ratio, the time deposit ratio and the reserve ratio - exhibit stable relationship with respect to other economic variables in the long run. (The only exception is the currency-ratio which showed parameter instability over the interwar period). The dynamics of the ratios seem to be governed by the conditions that give rise to the formation of the expectations process.

(2) The rate of growth of deposits is found to have important effects on all three functions. This implies that the level of deposits should appear in the general specifications.

(3) The interest rates are found to be important explanatory variables for the currency and time deposit ratios. The reserve-ratio, however, is not influenced by this variable. This then implies that the money multiplier is negatively related to interest rates.

(4) Both the currency and time deposit ratios are positively related to real income and negatively to the price level.

(5) Financial uncertainty, the rate of growth of income and that of prices are found to have important affects on these ratios.

For monetary policy, these foregoing results seem to suggest that monetary control is feasible (for the demand for money is stable) and the expansion of non-bank financial intermediaries do not render this policy impotent (for the interest elasticities of money balances are not increasing through time).

Finally, the predictability and stability of the money multiplier imply that the monetary policy could be implemented via a monetary base approach.

CHAPTER ONE

A Survey of the Literature

This chapter is in three sections. The first section discusses different definitions of money in a theoretical and empirical framework. The second section looks at the money demand function. The importance of demand for money is analysed within an IS/LM framework, and a summary of theoretical considerations governing the specification of the money demand function is given. In this respect three main areas will be emphasized; the regressors in the function with the sign and magnitude of their partial derivatives; the functional form; and the role of expectations in the function. We then outline the necessary simplifications necessary in order to carry out empirical work. Finally existing empirical studies for the UK and US are surveyed, in so far as their results pertain to key issues such as the elasticities of money demand with respect to the regressors in the function, the length of time lags, and the stability of the estimated coefficients over time.

The final section carries out a similar exercise for the supply of money. First, the money multiplier theory of the money supply process is set out. This framework is then compared with the currently used credit-counterparts approach. The theoretical considerations governing the choice of variables to appear in models of money multiplier components are then outlined. The section ends with a survey of US and UK empirical studies on money multiplier components.

1.1 Defining Money

"Money is one of those concepts which, like a teaspoon or an umbrella, but unlike an earthquake or a buttercup, are definable primarily by the use or purpose which they serve". This observation by Hawtrey (1982) brings out the problem of defining 'money'. Since money serves many purposes, some comment on these purposes is appropriate. The object of this section is, then, first to consider the most commonly used definitions of money in the United Kingdom and second to discuss their theoretical and empirical status in order to decide which aggregates should form the focus of this study.

Our problem is that, while money is used in an abstract sense in economic theory, we have at our disposal the particular set of aggregates which are currently published by the Bank of England. Table 1.1 sets out the main monetary aggregates for money published in the UK. The question that arises is which of these is most analytically and empirically useful. To answer this, we start by considering a number of views of the essential characteristics of money. These all derive from the functional approach to the definition of money but differ in the emphasis they place on the various functions of money. This approach lists the functions of money as being a medium of exchange, a store of value and a unit of account; and this approach has been the most popular one in the modern history of monetary thought. However, empirically there is a problem since the definition is given in terms of functions which could be interpreted in a number of ways. Take, for example, the medium of exchange function. The most widely used interpretation of this is that money should be generally acceptable in exchange (Fisher, 1985). But in recent years the need for money as a means of payment arising from the existence of uncertainty has become the popular view. (See Brunner and Meltzer, 1971).

Davidson (1972), for example, lists the following characteristics of a real world monetary economy to illustrate how different interpretations of the medium of exchange function arise: uncertainty, fallibility, covenants, institutions, commerce, finance and trust.

The store-of-value function is of special interest to the economist, for as Johnson (1962) put it: '.... the transition from the conception of money as a medium of exchange to money as a store of value has raised new problems .... these problems result from recognition of the substitutability between money and the wide range of alternative financial assets....'. The question is then: should money be defined in a narrow way as currency plus demand deposits (M1), or should it include financial assets that possess a high degree of <u>liquidity</u>? An asset is perfectly liquid if 100% of the original purchase price can be realised instantaneously. This means that liquidity has three dimensions attached to it: a probability, time and a ratio. An asset would be perfectly liquid if the probability of redeeming it for money (on demand) is one, the time lag is zero and 100% of its purchase price is realised. In general, liquidity is associated with acceptability or marketability. The

TABLE 1.1: DEFINITIONS OF THE UK MONEY SUPPLY

Definition	Constituents
Monetary Base	Notes in coin in circulation with the public plus banks' till money. plus bankers' deposits with Bank of England
Retail M1	Notes and coin in circulation with the public plus non-interest bearing sight deposits (current accounts) less 60% of transit items
M1	Retail M1 plus interest bearing sight deposits
Sterling M3	M1 plus private sector time deposits plus public sector sight and time deposits
M3	Sterling M3 plus UK residents' deposits in other currencies
Private Sector Liquidity 1 (PSL1)	Sterling M3 (but excluding public sector deposits) plus "Other money market instruments", (Treasury Bills, Bank Bills, Deposits with Local Authorities and Finance Houses net of Finance House holdings of money and other market instruments) plus Certificates of Tax Deposit
Private Sector Liquidity 2 (PSL2)	PSL1 plus shares and deposits with Building Societies, deposits with Trustee Savings Banks, deposits with the National Savings Bank and certain National Savings Securities; all expressed net.

degree of liquidity presents problems. A reasonable spectrum of liquidity would stretch from say Bank of England notes through liabilities of commercial banks and non-bank financial intermediaries to trade credit of firms. Economists who have investigated this problem of liquidity either by analysing the time between the decision to sell an asset and the actual sale of it, or by stressing that the subjective element in the individual owning the asset (taking as basis the computational cost of acquisition) found liquidity to be unmeasureable. Sayers (1960), for example, recognised that "the boundary for the class of assets which replace money has neither sharpness, nor certainty nor permanence".

Because of this type of difficulty the liquidity approach has been replaced by the substitutability approach for empirical investigation. The major task here is to assess the degree of substitutability among various financial assets. Friedman (1959), for example, argues that time deposits of commercial banks can be seen as perfect subsitutes for currency and demand deposits and as a result should be included in the definition of money. Gurley and Shaw (1960), on the other hand, stress the emergence and growth of numerous non-bank financial intermediaries whose liabilities should not be ignored when looking for a proper definition of money. The literature on the substitutability issue remains inconclusive. As Friedman and Schwartz (1970) point out the problem is knowing how large the size of elasticity of substitution should be before near monies can be counted as money, particularly since the desired degree of substitutability will differ depending on the purpose for which we are constructing the monetary aggregate. As far as empirical studies go, there is unanimity in allowing currency together with demand deposits to be treated as a single asset.

Besides these attempts to find a proper definition of money, two other attempts, both based on the medium of exchange concept, are worth mentioning, those by Pesek and Saving and by Newlyn.

Pesek and Saving (1967) argue that what separates money from debt is the stream of benefits money yields to the owner in its use as a medium of exchange. This is a positive service flow (saving of time in a barter transaction) and as a result money should be included in the net wealth of a society. Debts however yield negative income of equal size to their creditor, and as a result should not make up part of net wealth. This reasoning led Pesek and Saving to say that money should be defined in terms of currency plus demand deposits because only these represent net wealth to the community while time deposits and the liabilities of other financial institutions do not. The argument is that, since time deposits bear interest, they are a debt of the bank, just as a bond is a debt of its issuer.

Newlyn (1971) develops a <u>neutrality</u> criterion that allows the distinction between money and near-moneys. He classifies an asset as money if the effect of paying with this neither alters its total quantity nor distorts the market for loans. This implies that time deposits at commercial banks should be included in the definition of money if all deposits (time or demand) are subject to the same reserve requirements.

The above discussion of theoretical issues brings out the disagreements among economists on the appropriate definition of money. In recent years, some attempts have been made to find some empirical underpinning for these theories. Of these, the following two appear most promising. (1) Defining 'money' with reference to rates of substitution between financial assets and (2) defining 'money' by evaluating its correlation with income.

Out of these two, the empirical evidence using the first criterion is to some degree conflicting. The most careful study on this issue is that of Feige (1964) who found that there was no close degree of substitutability between demand deposits, time deposits, savings and loan association share deposits, and mutual savings bank deposits. Feige concluded that a narrow definition of money was preferable to a broad one.

The second criterion has been used by Friedman and Meiselman (1963). They subjected various aggregates to a test of correlation with income. They found that currency and all deposits (demand and time) of commercial banks - M2 - together satisfied the condition better than narrower or broader concepts of money.

In conclusion, then, theoretical considerations and empirical studies seem to point to two distinct empirically identifiable items which are worth regarding as "money": namely, M1 and M2. In this thesis, therefore, wherever data permit, M1 will be treated separately from M2.

1.2 Demand for Money

The demand for money is probably one of the most studied subjects in monetary economics. This is not surprising considering that its form and its relationship with other economic variables are critical to the performance of a large number of macroeconomic models. Its interest-sensitivity is crucial for the effectiveness of the conduct of monetary policy and its stability provides the basis for most monetarist arguments.

The purpose of this section is first to establish the importance of the money demand function in Keynesian - Monetarist controversy by reference to the IS/LM framework. In doing so, it is hoped that the discussion will bring out its importance not only in relation to the effectiveness and predictability of monetary policy, but also in deciding whether monetary theory is more correctly formulated in terms of 'the equation of exchange approach' or 'the income-expenditure approach'.

This will be followed by a short summary of the theoretical considerations which form the basis of empirical work on the demand for money. The discussion will be carried out by emphasizing three main areas: the regressors in the function with the magnitude and sign of their partial derivatives, the functional form, time lags and the distinction of long-run specification from that for the short-run.

The final part of this section will give a survey of the empirical studies for the US and the UK. The issues here will be: the role of interest rates - the selection of the appropriate rate and the magnitude of interest elasticity of the demand for money; the elasticity of the function with respect to the price level, income and wealth; the role of expected inflation and the wage rate; time-lags in the function; and the last but not least, the stability of the function.

1.2.1 The importance of the demand for money in macro-economics

The controversial issue in Monetarist/Keynesian arguments is whether monetary theory is more usefully formulated in terms of the demand for and supply of money - the equation-of-exchange approach - or of the influence of money on expenditure and income - the income - expenditure approach. In this controversy two important empirical issues are of particular interest in relation to the demand for money function. The first concerns the relationship between the demand for money and the rate of interest, and the other, the stability of the function.

The first issue can be explained by using the IS/LM model. The IS and LM curves show the equilibrium relationships between the rate of interest and the level of income in the goods market and in the money market respectively. In this framework an expansionary monetary policy shifts the LM curve downwards to the right because in order to match this increased supply of money with an increased money demand, either the interest rate must fall or income must rise. An expansionary fiscal policy shifts the IS curve outwards to the right. Figures (1.1) and (1.2) show these movements for interest - inelastic and interest

Figures (1.1) and (1.2)

Expansionary fiscal and monetary policies with interest-inelastic and interest-elastic demand for money

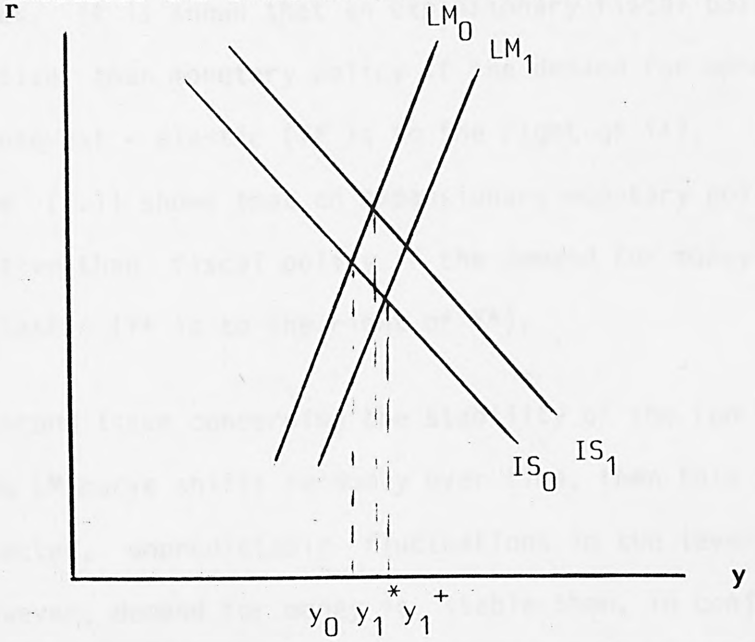

Figure (1.1) Interest - inelastic demand for money

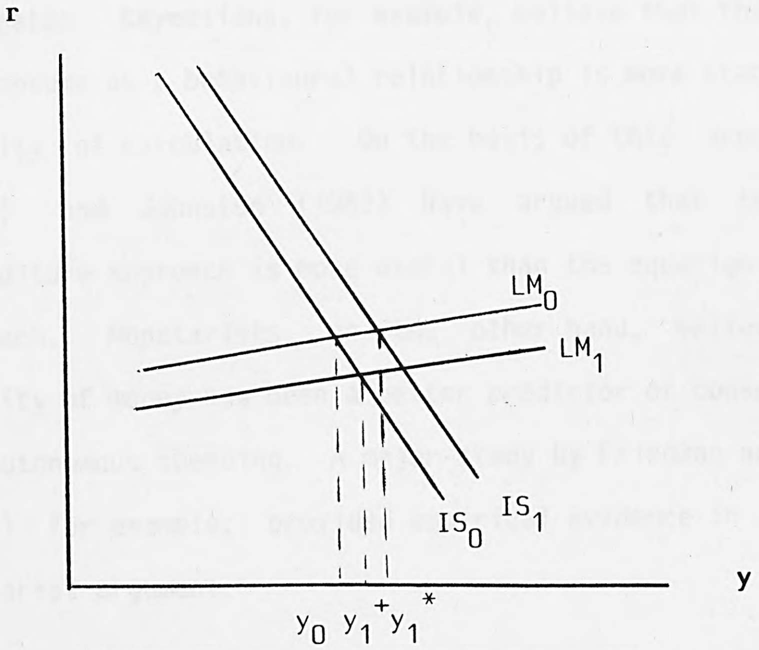

Figure (1.2) Interest - elastic demand for money

r = rate of interest

y = income

- elastic demand for money functions respectively. In these figures, it is shown that an expansionary fiscal policy is more effective than monetary policy if the demand for money function is interest - elastic (Y* is to the right of Y+). In contrast, figure (1.1) shows that an expansionary monetary policy is more effective than fiscal policy if the demand for money is interest - inelastic (Y+ is to the right of Y*).

The second issue concerning the stability of the function is that if the LM curve shifts randomly over time, then this will lead to unexpected, unpredictable fluctuations in the level of income. If however, demand for money is stable then, in conjunction with the supply of money, it can provide a good explanation of observed systematic movements in monetary income and other aggregates. Keynesians, for example, believe that the propensity to consume as a behavioural relationship is more stable than the velocity of circulation. On the basis of this argument Klein (1958) and Johnston (1962) have argued that the income-expenditure approach is more useful than the equation-of-exchange approach. Monetarists, on the other hand, believe that the quantity of money has been a better predictor of consumption than has autonomous spending. A major study by Friedman and Meiselman (1963) for example, provided empirical evidence in support of monetarist argument.

The foregoing discussion indicates some of the key issues surrounding the details of the demand for money function. They are not the only empirical problems that will be studied in this thesis but they may help to illustrate the importance of the function in a macro-economic context.

1.2.2 Theoretical Considerations

This section will survey the theories that form the basis of empirical work, first with respect to the regressors in the demand for money function, and then with respect to the functional form and the importance of time lags in the function.

A natural approach to the analysis of the aggregate demand for money is to ask what factors determine the amount of money individuals desire to hold. This is the basis of the Cambridge Cash Balance Theory (see Pigou, 1917). This approach postulated that nominal demand for money was proportional to nominal income; in other words the ratio of nominal income to money stock - velocity - was constant. The importance of the income foregone by holding a sterile asset was recognised and it was argued that the demand for money in nominal terms was proportional to nominal income which was itself thought to be in a constant relation to the potential purchases of individuals. This approach focused on money as a medium of exchange. Keynes' liquidity preference theory gave greater prominence to the other aspect of money, namely, its store of value property. In his analysis of the demand for money, Keynes emphasized the motives for holding money. The transactions and precautionary motives depended (positively) on the level of income and the speculative motive depended negatively on the interest rates, destroying the assumption of constant velocity of circulation implicit in the Cambridge approach. This theory was refined in the Baumol (1952) - Tobin (1956) analysis where it was held that the demand for cash balances was proportional to the square root of the value of transactions. An important implication of this approach was the existence of economies of scale in the use of cash, since the demand for cash was seen to rise less than in proportion to the volume of transactions. This was, however, only the transactions aspect of their approach. With respect to the speculative motive, Tobin attempted to show how people's desire to hold money may be derived from their attitudes towards the risk involved in holding bonds. For Tobin, there is risk involved in bond holding since uncertainty as to the future rate of interest means uncertainty to the future values of bonds. Consequently people holding bonds are unsure whether they will make a capital gain or loss. Tobin's analysis can explain why some people might have a positive relationship between their demand for money and the rate of interest, at least over some ranges of interest. That is, an interest rate rise can be seen as an incentive to take more risk as the opportunity costs of security increase. This could induce a shift away from security to expected return and can be seen as a substitution effect. In addition there is a wealth effect as the increased interest rate gives an opportunity to enjoy more security along with more yield. Thus it is possible that a higher demand for money may result from a higher rate of interest if this substitution effect is outweighed by their wealth effect. An upward sloping demand for money function is then possible, but unlikely if an asset holder already has Consols in his portfolio. If when interest rates rise, individuals want fewer bonds in their portfolios, this happens automatically as the price of bonds falls with an interest rate rise. Tobin's theory also provides an explanation of why portfolios are usually diversified, containing both bonds and cash; at the same time providing an explanation for non-diversified (all cash or all bonds) portfolios. This theory can be seen as part of a more complete approach - the Portfolio Balance Approach - where a variety of differences in risks and returns between assets is recognised. The extent to which assets - bonds, equities, deposits with financial intermediaries or real physical assets - are substitutes or complements in the portfolios of wealth holders, and the composition of these, will then depend upon the risk aversion of wealth holders.

So far, all these theories have focused their analysis on the motives that prompt people to hold money. A rather different view was proposed in the Modern Quantity Theory. This theory is primarily associated with the name of Friedman and with the "Chicago School". The followers of this approach do not analyse closely the motives for holding money but simply note that money yields flow of services, and go on to apply to the demand for money, the theory of the demand for durable goods.

There are two groups of agents who demand money. First, there are the ultimate wealth holders who demand money as one way in which to hold their wealth. For them, the demand for money will depend upon:

(1) the expected rates of return on the various components of total wealth;

(2) the household's total wealth expressed as an annuity equivalent, Friedman's notion of permanent income;

(3) the distribution of total wealth between marketable and non-marketable (human) capital;

(4) the tastes and preferences of a household for the different forms of assets making up its total wealth.

Secondly, there are business enterprises who demand money as a productive resource, just like plant and machinery, or any other asset that contributes towards production. They are not subject to wealth constraints because the business has the opportunity of varying the amount of capital it owns by recourse to the capital market. Nevertheless the size of the enterprise must have some influence on its demand for money. Similarly this division of total wealth between marketable and human wealth is not a relevant factor for commercial demand for money but in all other respects the demand for money function will be the same.

So in real terms

$$\frac{M^*}{P} = f\,(r_m, r_b, r_e, G_p, Y_p, W, U) \qquad (1.1)$$

where M* = desired nominal money balances, P = price level, and the regressors are returns on money, bonds, equities, and physical goods; permanent income; wealth, and tastes, respectively. In this approach, wealth is the present discounted value of the expected income stream generated by the optimal combination of assets.

Some of the rates of return that appear in equation (1.1) are observable. For example the difference between the real return on bonds and the own rate of return of money (minus the expected rate of inflation) can be measured simply as the nominal market rate of return on bonds. Klein (1974), however, formulated an alternative approach whereby the own rate of return on narrow money is calculated as a weighted average of the zero rate on currency and his estimates of the competitive rate on demand deposits. In this pure theoretic exposition of the demand for money he found the 'competitive' rate to be significant whether entered directly or indirectly in the function and suggested that studies that ignored the own rate of return on money underestimated the interest elasticity of money balances. In a later study, Klein (1977) calculated another series that measured changes in the variability of the price level in order to capture fluctuations in the liquidity of money. His results confirmed the importance of this price uncertainty variable in money demand functions.

Similarly, efforts have been made in order to proxy other rates of return in money demand functions. Consumption goods, for example, yield a return in kind in the form of convenience and security. The latter return however is fundamentally different from the former if money is defined as a medium of exchange. Pierson (1967) for example, argues that, while the utility derived from the use of consumption goods is dependent upon the quantity consumed, the utility effect of money is largely unrelated to the quantity of money in use. That is, the non-pecuniary service of money - saving time and effort and greater efficiency in transactions - occurs at the beginning, when money is introduced, and then the contribution of money becomes very little, unrelated to its quantity.

Subsequent theoretical advances explored the relationship between payment habits, inflation and the transactions demand for money. These have been emphasized mainly by Niehans (1978) and Akerlof and Milbourne (1980). But by and large these basic theories continue to provide basic arguments in the demand for money function for empirical work, leading to a relationship of the following form:

$$M^* = f\,(Y,\ r,\ r_m,\ \dot{p},\ P) \qquad (1.1A)$$

That is, the amount of money desired M*, varies directly with real income, Y, which reflects either the transactionary motive or proxies for wealth. Price level, P, is normally included as a scale variable to indicate that transactors are concerned with the real purchasing power of money balances. Desired balances are expected to vary inversely with interest rates, r, on alternative financial assets since these provide alternative forms in which wealth may be held. Finally a negative relationship is expected between desired money balances and the expected rate of inflation, $\dot{p}$, relative to the own interest rate, r_m, paid on money balances since real assets can also constitute alternative ways of holding wealth.

One more variable the wage rate, has recently been proposed as an additional argument to the ones in equation (1.1). Dutton and Gramm (1973) suggest the inclusion of the wage rate in the demand for money function. In their own words ".... if the use of money saves transactors time, it increases the amount of leisure. This suggests an additional determinant of the demand for money, the consumer's valuation of time, i.e. the wage rate .... in equilibrium the marginal valuation of an hour of leisure must be equal to the wage rate". Similarly Karni (1974) attempts to incorporate the value of time into the theory of demand for money, the relationship between desired money holdings and the value of time measured by the wage rate reflecting the attempts by households and firms to save on time when they conduct their exchange activities.

1.2.3 Simplifying Theory for Empirical Purposes

A lot of work has been done to find the empirical counterpart of the theoretical variables considered in the previous section. Most studies tended to use a simplified version of equation (1.1) in their empirical research. Very few used an extended version of it incorporating the wage rate and the volume of trade. Among the large number of interest rates, usually one representative long rate, such as (in the U.K.) the yield on Consols and/or one short rate, such as (in the U.K.) the Local Authority rate, have been selected. Further, the impact of the inflation rate has frequently been assumed to be taken up by the nominal interest rate; and most empirical studies assumed the absence of money illusion making the dependent variable, desired 'real' balances.

With all these considerations a simplified version of equation (1.1) or (1.1A) can be obtained:

$$M*/P = f(Y^P, r_s, r_L, r_m) \qquad (1.2)$$

Assuming further that the function has unitary income elasticity, yields the 'inverse - velocity' equation*:

$$\frac{M*}{PY} = (r_s, r_L, r_m) \qquad (1.3)$$

where the desired money to (nominal) income ratio is related to measures of the opportunity costs of holding money.

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*In equation (1.2) Y^P represents permanent income and in (1.3) Y represents actual national income. In order to go from one to the other one needs to account for Y/Y^P or some measure of transitory income. For details, see Bordo and Jonung (1981).

Most empirical work in the U.K. and U.S. has used one of the above (1.1) - (1.3) functional relationships. Further, a large number of these studies used a semi log linear function where the interest rate variable is entered in level form rather than in logarithm as the other variables. This, of course, is more appropriate since a doubling in the interest rate from 1% to 2%, for instance, is not likely to have the same proportionate effect on the demand for money as will a doubling from 10% to 20%. (See for example the studies by Haache, 1974 and Hendry, 1980b)

The studies of the long-run assumed equality between actual and desired balances. The equality of actual nominal money balances to desired nominal balances, M = M*, implies that the nominal amount of money is determined by demand alone.

If, however, one assumes:

$$\frac{M}{P} = \frac{M^*}{P} \text{ or } \frac{M}{PY} = \frac{M^*}{PY}$$

then the adjustments to desired levels would be obtained from movements in P or Y as well as in M.

In order to investigate the theoretical issues empirically most studies found it necessary to simplify the content of the function and secondly to assume a specific form for its dynamics.

In relation to the arguments in the function, two related simplifications are often made. First, as mentioned above some variables are largely ignored; for example, the own rate of return on money and the expected rate of inflation. Those studies that have taken account of the own rate of return on money showed that ignoring it biased the interest-elasticity results. Among these, Lee (1967) analysed the importance of this variable in a study of the effects of the rate of return on near monies. Klein (1974) confirmed this finding by using the interest differential between money and other assets as a single variable. In conformity with Klein's results, Barro and Santomero (1972), in a study of the U.S. household section, found further evidence that the studies that ignored the own rate of return underestimated the sensitivity of the demand for money to the opportunity cost of holding it. Similarly, studies that have taken account of expected inflation found that the variations in it systematically influenced the demand for money. (See studies by Vogel, 1974; Lerner, 1956; Shapiro, 1973; Goldfeld, 1973; and Hendry, 1980b.) The expected rate of inflation in these studies has frequently been measured either as an exponentially weighted average of current and past values of the actual inflation rate (Cagan, 1956), or by letting the data themselves find the weights to be attached to current and past rates of inflation (Shapiro, 1973). Less frequently, some studies used data on inflation expectations generated by opinion surveys (Goldfeld, 1973). In contrast to all these studies, some of the early ones on the U.S. (Selden, 1956 and Friedman, 1959) could not find any significant

effect for the rate of inflation on the demand for money. These results were later attributed to the lack of variation in the inflation rate which made it difficult to identify its effect statistically.

The second simplification usually made in relation to the arguments in money demand function is with respect to the price level: most studies imposed a priori homogeneity restrictions with respect to prices. For empirical investigations a further simplification that is found to be necessary was with respect to the dynamics of the function. Since in such a function, we are dealing with time series data, there is a natural concern about the importance of lags which do not come out directly from theory. In this respect there are two sorts of dynamics that can be considered.

First, those arising from partial adjustment mechanism and second those arising from assuming specific forms for the formation of expectations.

With the partial adjustment equation used by Chow (1966) it is assumed that there are portfolio adjustment costs which prevent a full immediate adjustment of actual money holdings to desired levels. That is, money holdings are assumed to adjust proportionately to the gap between desired holdings and last period's holdings.

$$\text{Ln } m_t - \text{Ln } m_{t-1} = \lambda(\text{Ln } m_t^* - \text{Ln } m_{t-1}) \qquad (1.4)$$

(where m = M/P, and Ln denotes natural logarithm)

Assume a typical equation for the public's demand for real balances is the following:

$$m_t^* = f(X_t) \qquad (1.5)$$

where X is a vector comprising (some or all) the variables in equation (1.1A). With equation (1.4), it is nominal money that responds to exogenous changes in demand i.e. changes in income or in interest rates (that is a change in one of the variables of the X vector in (1.5)). A change in income, for example, will change actual real balances by some fraction (λ) of that change times the income elasticity of demand. It is therefore important to observe that changes in the arguments of the demand function might influence actual real balances either by their effect on M or on P or on both.

Combining (1.4) and (1.5) yields

$$\text{Ln } m_t = \frac{\lambda}{1- (1 - \lambda) L} \text{ Ln } f(Y_t) \qquad (1.6)$$

(where L is a lag operator, $L^k X_t = X_{t-k}$

since $\frac{\lambda}{1- (1 - \lambda) L} = (1 + (1 - \lambda) L + (1 - \lambda)^2 L^2 + \ldots)$

it follows that equation (1.6) can be re-written as

$$\text{Ln } m_t = \lambda \text{Ln } f(X_t) + (1 - \lambda) L \text{ Ln } m_t \qquad (1.7)$$

Equation (1.4) could be regarded as a sensible description of how an individual adjusts his cash position (assuming that the marginal costs of portfolio adjustment vary positively with the speed of adjustment). It is doubtful, however, whether equation (1.4) would be a sensible description of aggregate behaviour. One could dismiss such behaviour for the economy as a whole on the grounds that the opportunities available to individuals collectively may be different from those available to the individual (see Laidler, 1982, for details).

Furthermore the adjustment equation (1.4) implies a lagged adjustment to changes in income and interest rates but an instantaneous one to changes in the price level.

Goldfeld (1976) suggests an alternative adjustment equation where the percentage change in nominal money balances of the public is a constant fraction of the percentage discrepancy between the nominal money balances desired by the public, given the price level, and the inherited money balances of last period.

$$\text{Ln } M_t - \text{Ln } M_{t-1} = \lambda(\text{Ln } m_t * P_t - \text{Ln } M_{t-1}) \qquad (1.8)$$

In this approach, inflation is seen as a real phenomenon. In this specification, it is the nominal money stock that adjusts with a lag to changes in real demand and to exogenous changes in the price level (exogenous with respect to nominal money).

It is the passive supply by the monetary authorities of nominal money that equates the supply of nominal money to the nominal quantity of money demanded by the public at an exogenously given price level. Combining (1.6) and (1.8) yields:

$$\text{Ln } (M_t/P_t) = \lambda \text{Ln } f(X_t) + (1-\lambda) \text{ Ln}(M_{t-1}/P_t) \qquad (1.9)$$

It could be argued, however, that although individuals are free to adjust their nominal money balances, society as a whole is not. Hence, equation (1.9) is meaningless as an aggregate demand function during periods of monetary control, when the supply of money can be seen as exogenous.

An alternative adjustment process is suggested by Coats (1982) where inflation is seen as a monetary phenomenon. A similar view is taken by Walters (1965), Laidler (1982) and Fama (1982). According to this view, the percentage change in the price level is a constant fraction of the percentage discrepancy between the nominal money balances supplied by the monetary authorities and the nominal balances desired by the public at last period's price level:

$$\text{Ln } P_t - \text{Ln } P_{t-1} = \lambda \, (\text{Ln } M_t - \text{Ln } m_t * P_{t-1}) \qquad (1.10)$$

Again combining (1.6) with (1.10) yields:

$$\text{Ln } (M_t/P_t) = \lambda \text{ Ln } f\,(X_t) + (1-\lambda) \text{ Ln } (M_t/P_{t-1}) \qquad (1.11)$$

For specification (1.11) to hold, we must assume price flexibility. If, however, the price level is sticky, then the IS/LM model discussed earlier tells us that the variables in the X vector, e.g. interest rates and real income, will tend to change as the money market clears. If this is the case then single equation econometric techniques to estimate relationships such as (1.7), (1.9) and (1.11) can be criticised for ignoring simultaneity problems. Cooley and Leroy (1981), for example, have recently raised this issue and questioned the identifiability of the demand for money function. As a way out of this impasse, Laidler (1982) interprets the typical short-run demand for money function as a slightly mis-specified price level adjustment equation. That is, the short-run function is "a mixture of structural relationship and some reduced form of the whole economy". In such an interpretation, the adjustment parameter captures the process whereby the price level moves slowly towards equilibrium after monetary disturbance. These three different adjustment equations (1.4), (1.8) and (1.10) provide alternative functional forms for the demand for money, suitable for estimation.

We have seen that different partial adjustment mechanisms can introduce different dynamics into the demand for money function.

A major problem in empirical research is that similar dynamic properties can also arise from adaptive processes of expectation formation. For example, with adaptive expectations, agents form expectations of at least one of the arguments in the money demand function, namely permanent income in the following way:

$$Y^P_t - Y^P_{t-1} = \lambda\ (Y_{t-1} - Y^P_{t-1}) \qquad (1.12)$$

where Y^P refers to permanent income.

Adaptive expectations of this sort are rational only if Y is stationary. (For details, see Muth, 1961)

According to equation (1.12) expectations are revised by a constant fraction of the latest error made $(Y_{t-1} - Y^P_{t-1})$.

Re-arranging (1.12) yields:

$$Y^P_t = Y_{t-1} + (1 - \lambda)\ Y^P_{t-1} \qquad (1.13)$$

Repeated back substitution for the largest values of Y_t implies Y^P_t is a geometric distributed lag of current and past values of Y, that is

$$Y^P_t = \lambda \sum_{i=o}^{\infty} (1 - \lambda)^i\ Y_{t-i} \qquad (1.14)$$

If one assumes that the relevant variables in the X vector (in equation (1.5)), for example, both income and interest rates, to be expected values, then one common device for replacing these unobservable values with their measured counterparts would be to assume the expectation to be of 'adaptive' form. Substituting equation (1.12) for the regressors in equation (1.5) and assuming the variables to be in logarithms leads to an equation of the form (1.7). But λ now has a different interpretation. Further there is no reason to assume that expectations for different variables are formed analogously. This would lead to a model with richer lag structure than (1.7). In fact, even greater generality can be obtained if, for example, one allows adjustments to be in different proportions to two or more of the previously observed forecasting errors:

$$Y_t^P - Y_{t-1}^P = \lambda_1(Y_t - Y_{t-1}^P) + \lambda_2 (Y_{t-1} - Y_{t-2}^P) \quad (1.15)$$

These would incorporate some further lags into the function. It is, of course, possible to combine the adaptive expectations with partial adjustment models thereby introducing another lag for all the variables.

One possible route would be to start from a general specification such that all these alternative specifications are nested in it. Such a methodology has been suggested by Hendry (1979). He finds that for quarterly data a general specification incorporating four lags for each of the variables (for the regressors and for the regressand) is the most suitable dynamic money adjustment equation:

$$\text{LnM}_t = \beta_o + \sum_{i=o}^{4} (\alpha_j \text{ LnY}_{t-j} + \gamma_j \text{ LnP}_{t-j} + \delta_j \text{ Lnr}_{t-j}$$

$$\beta_j \text{ LnM}_{t-j-1}) \quad (1.16)$$

Such an over-parameterized model embodies as special cases many short-run conventional models. In this respect, therefore, it is more general than the previous models considered and has therefore advantages as a starting point for empirical work. Unfortunately, however, this methodology is ad hoc in its selection of different lag structures. Thornton and Batten (1985) for example investigated the extent to which rules of thumb, arbtitrary lag specifications, and statistically determined lag structures can be relied upon in testing Granger causality between money and income. They concluded that Akaike's (1970) 'final prediction error' criterion performed better than the others. One can not, however, assess the extent to which these results are data specific.

The conclusion that emerges from the foregoing discussion is that there appears to be no single way of testing whether the results obtained from the above-mentioned general to specific methodology are not critically dependent upon the choice of the lag structure, care must therefore be taken in interpreting them.

1.2.4 Empirical Evidence

Having discussed the theoretical issues let us now survey the results of the empirical studies on the demand for money function.

The issues to be addressed here are as follows:

1. The role of interest rates. Two related issues are the selection of the appropriate rates of interest and the magnitude of the interest rate elasticity of the demand for money.

2. The elasticity of the function with respect to the price level.

3. The role of the wage rate in the function.

4. The choice of the scale variable - income or wealth - and the elasticity of the function with respect to that variable. Any evidence of economies of scale?

5. The role of expected inflation in the money demand function.

6. The importance of time lags in the function: two issues - the lags in the regressors and the distinction of short-run specification from that of the long-run.

7. The stability of the function.

In the large number of long-run studies that have been carried out most researchers have employed a demand for money function of the form (1.12).

With respect to the first issue, the evidence from these studies point strongly to the demand for money being negatively and significantly related to the rate of interest. For American and British studies on annual data the general pattern has been:

the variables	the range of interest elasticities
(a) $M_1 + r_L$	-0.7 to -1.10
(b) $M_2 + r_L$	-0.45 to -0.75
(c) $M_1 + r_s$	-0.20 to -0.45
(d) $M_2 + r_s$	-0.00 to -0.20

Where M_1 and M_2 refer to narrow and broad definitions of money respectively, r_s and r_L to short and long-term representative rates of interest. Cooley and Leroy (1981), however, show that this range of interest elasticities can be considerably wider (i.e. -1.6 to +1.4) and that care must be taken in reporting these empirical results since, they argue, researchers seem to be building in their conclusions when they report their findings.

Table (1.2) gives a list of some summary results for the U.S. and U.K.

Table (1.2)

Summary of studies of the long-run (annual) demand for money function in the U.S. and U.K.

Study	Data Used	Definition of money	Interest rate used	Interest Elasticity
Meltzer (1963)	Annual: U.S. (1900-1958)	Narrow Broad	Long Long	-0.92 -0.48
Meltzer (1963)	Annual: U.S. 1930-1958	Narrow Broad	Long Long	-1.15 -0.70
Brunner & Meltzer (1964)	Annual: U.S. 1930-1959	Narrow Broad	Long Long	-1.09 -0.73
Courchene & Shapiro (1964)	Annual: U.S. 1900-1958	Narrow Broad	Long Long	-1.00 -0.58
Chow (1966)	Annual U.S. 1897-1958	Narrow	Long	-0.73
Laidler (1966)	Annual: U.S. 1919-1960	Narrow Narrow	Short Long	-0.21 -0.72
Laidler (1966)	Annual: U.S. 1892-1960	Broad Broad	Short Long	-0.16 -0.25
Lee (1967)	Annual: U.S. 1951-1965	Narrow Broad	Short Short	-0.41 -0.67
Motley (1967)	Annual: U.S. 1920-1965	Broad	Short	-0.16
Klein* (1974)	Annual: U.S. 1880-1970	Broad	Long Short Own Rate	-0.06 -0.3 0.3
Klein* (1974)	Annual: U.S. 1919-1970	Narrow	Long Short Own Rate	-0.13 -0.17 0.17
Klein* (1977)	Annual: U.S. 1880-1972	Broad	Long Short Own Rate	-0.06 -0.3 0.3
Klein* (1977)	Annual: U.S. 1919-1970	Broad	Long Short Own Rate	-0.03 -0.2 0.2
Klein* (1977)	Annual: U.S. 1919-1972	Narrow	Long Short Own Rate	-0.13 -0.17 0.18

Kavanagh & Walters (1966)	Annual: U.K. 1880-1961	Broad	Long	-0.31
Kavanagh & Walters (1966)	Annual: U.K. 1953-1957	Broad	Long	-0.26
Huffman & Lothian (1980)	Annual: U.K 1833-1880	Short	Short	-0.6 -0.15

*These refer to semi-elasticities

*For details of some of the above studies see Goodhart and Crockett (1970).

Similar results confirming the importance of the interest rates have been reported for most other countries. (See Fase and Kure, 1975, for a summary of various studies on 13 different countries). These investigations, however, did not establish whether similar relationship between the demand for money and the interest rates could be relied upon for shorter periods of time. For this purpose an examination of (possibly) quarterly data and the introduction of lags into the equation were found to be necessary.

Consequently one of the equations of the form (1.7), (1.9) or (1.11) was seen to be appropriate. Table (1.3) presents some of these results for the U.S. and U.K.

Again the range for interest elasticities can be shown as follows:

(a) $M_1 + r_L$	-0.05 to -0.80
(b) $M_2 + r_L$	-0.30 to -1.46
(c) $M_1 + r_s$	-0.06 to -1.07
(d) $M_2 + r_s$	-0.008 to -0.36

In fact, there are very few studies that have failed to find a significant negative relationship between the rate of interest and the demand for money. Friedman (1959) for example studying the demand for money the in U.S., for the period 1869-1957, attempted to fit a demand for money function to data that he abstracted from the business cycle. His results however were later found to be unreliable on the grounds that his method of abstracting data from the cycle was invalid (See Laidler, 1969).

Table (1.3)

Summary of studies of the short-run demand for money function in the U.K. and U.S.

Study	Data Used	Definition of money	Interest rate used	Interest Elasticity
Bronfenbrenner & Meyer (1960)	Annual: U.S. 1919-1956	Narrow	Short	-0.33
Teigen (1964)	Quarterly: U.S. 1946-1959	Narrow	Long	-0.07
Teigen (1964)	Annual: U.S. 1924-1941	Narrow	Long	-0.20
Goldfeld (1976)	Quarterly: U.S. 1952-1973	Narrow	Short	-0.06
Hamburger (1977)	Quarterly: U.S. 1955-1972	Narrow	Short Long	-0.22
Laumas & Spencer (1980)	Quarterly: U.S. 1954-1973	Narrow	Short	-0.20
Fisher (1968)	Quarterly: U.K. 1955-1967	Narrow	Short	-0.11
Fisher (1968)	Quarterly: U.K. 1955-1967	Narrow	Long	-0.30
Goodhart & Crockett (1970)	Quarterly: U.K. 1955-1969	Narrow	Short Long	-0.05 -0.80
Goodhart & Crockett (1970)	Quarterly: U.K. 1963-1969	Broad	Short Long	-0.21 -0.51
Laider & Parkin (1970)	Quarterly: U.K. 1956-1967	Broad	Short	-0.008
Price (1972)	Quarterly: U.K. 1964-1970	Broad	Long Short	-0.30
Haache (1974)	Quarterly: 1963-1972	Narrow	Short Long	-0.06 -0.21
Artis & Lewis (1976)	Quarterly: U.K. 1963-1973	Narrow	Long	-0.66

Table (1.3) (cont'd)

Study	Data used	Definition of money	Interest rate used	Interest Elasticity
Artis & Lewis (1976)	Quarterly: U.K 1963-1973	Broad	Long	-1.46
Hamburger (1977)	Quarterly:U.K. 1963-1970	Narrow	Short	-1.07
Coghlan (1978)	Quarterly: U.K. 1964-1976	Narrow	Short	-0.30
Mills (1978)	Quarterly: U.K. 1963-1974	Narrow	Short Long	-0.24 -0.45
Boughton (1979)	Quarterly: U. . 1963-1974	Narrow	Short	-0.51
Rowan & Miller (1979)	Quarterly: U.K. 1963-1977	Narrow	Short	-0.08
Hendry (1980)	Quarterly: U.K. 1963-1972	Narrow	Short	-0.36
Mills & Wood (1982)	Annual: U.K. 1880-1913	Borad	Short	-0.02

For a detailed discussion of the U.S. studies see: Judd and Scadding (1982), and Feige and Pearce (1977); of the U.K. studies see: Artis and Lewis (1981), and Coghlan (1978).

Similarly, for Great Britain, Laidler and Parkin (1970) found (with quarterly data) an insignificant relationship between the demand for money and the Treasury Bill rate over the period 1955-1967. However, as before, their study was later criticized on the grounds that their choice of variable for the interest rate was inappropriate. (See Goodhart and Crockett, 1979).

The evidence from the foregoing discussion establishes the importance of the rate of interest in the demand for money function. It does not, however, show which rate should be chosen. For long runs of data, there seems to be no difference between a long and a short rate as far as their significance is concerned. With quarterly data for the U.S. the evidence seems to favour rates of return on close substitutes for money (for details see Feige, 1974, and Laidler, 1969). For a narrow definition of money, time-deposit rate was also found to exert a systematic influence. (See for example Goodhart and Crockett, 1970, and Goldfeld, 1973). Further, the yields on corporate stock (Hamburger, 1966), and on government bonds (Teigen, 1971) were also shown to have significant effects on both narrow and broad definitions of money.

Let us now discuss the second issue, the elasticity with respect to the price level. The evidence in this case is not very strong partly due to the fact that most studies did not investigate the matter directly, assuming a priori, that the demand for nominal balances is proportional to the price level. Among the few studies that investigated the matter directly, however, - for the U.S., the studies by Meltzer (1963), and by Goldfeld (1973) and for the U.K. those by Goodhart and Crockett (1970), Hendry (1980), and Mills and Wood (1982) - confirmed the hypothesis of a unitary price elasticity.

Similarly, there are very few studies that investigated directly the importance of the wage rate in the money demand functions. Among these, two papers by Dutton and Gramm (1973) and Karni (1974), using annual U.S. data over the period (1919-1958) and (1919-1968) respectively found a wage variable to have a systematic influence on the demand for money. These results of course provide no conclusive evidence in the matter concerned but they are highly suggestive in that they seem to have unearthed one other important factor influencing money holdings.

On the question of the most appropriate scale variable in the money demand equation, the main findings from the empirical studies seem to favour wealth or permanent income rather than a current measured income variable. This particular evidence seemed to be invariant as to how money, wealth or the rest of the regressors have been defined in the function. Most of these studies proxied wealth or permanent income by an exponentially weighted average of current and past levels of income. Among such studies on the U.S. data, those by Meltzer (1963), Brunner and Meltzer (1963), Laidler (1966), and by Chow (1966), for example found that: first , wealth rather than current income explained more of the variation in the demand for money; secondly it provided a more stable function; and thirdly it gave more accurate predictions of the velocity of circulation. Similar results have been obtained on the U.K. data by Laidler (1971), Grice and Bennett (1984), and by Laidler and Parkin (1970).

The evidence so far seems to suggest that wealth rather than actual income should be the appropriate scale variable in the money demand function. The interesting question that arises is whether the source of those lags introduced to proxy the wealth variable lies in the way in which income expectations respond to changes in current income or in long delays in the public's adjustment of its money balances towards new equilibrium levels.

One important consequence of including lagged values of income in the money demand function has been the uncovering of a direct effect of changes in income on the level of money balances. Since the variables are in natural logarithms, if changes in income appear significant in the final specification then this means that the rate of growth of income affects money balances. An example is Hendry and Mizon's (1978) study where they find a negative relationship between money balances and the rate of growth of income for the post World War Two period. Although there are no other major empirical studies examining this relationship, Gurley and Shaw (1967), in their discussion of economic development imply that the demand for money increases more rapidly at low as opposed to high levels of development. At higher levels of development, alternative possibilities for storing wealth appear in the form of more varied financial assets, and these grow at a faster rate than money balances. This ultimately reaches a point where money balances and income growth are negatively related.

A similar U-shaped pattern is observed by Bordo and Jonung (1981) in their examination of the long run behaviour of velocity in five industrial countries over the period 1870 and 1975. They concluded that the general U-shaped pattern obtained (with the exception of the UK) could be explained in the following way: the downward trend was due to a process of monetization which followed a decline in payments in kind and the growth of the commerical banking sector; and the upward trend was a result of two elements. One was increasing financial sophistication, by which they mean the emergence of close substitutes for money and other means of economising on money balances, and the other was improved economic stability.

Their analysis, however, is based on the medium of exchange function of money and not the store of value function as in Gurley and Shaw (1967).

This question of introducing time lags into the function will be taken up again in more detail later on. Before we do that, however, let us discuss the evidence on the elasticity of the function with respect to the scale variable.

The evidence from both U.K. and U.S. studies relating to long periods of time indicates the absence of economies of scale - see studies by Laidler (1966), Meltzer (1963), and Friedman (1959) for the U.S. and those by Kavanagh and Walters (1966), and Laidler (1971) for the U.K. But when one considers the studies relating to the post World War Two period then the evidence would seem to suggest that the demand for money over this period increased less then proportionately with income - see the studies by Laidler (1971), Goldfeld (1973), and Shapiro (1973) for the U.S., and for the U.K. those by Laidler and Parkin (1970), and Goodhart and Crockett (1970). There are, however, several cross section studies (e.g. Meltzer, 1963b for the U.S.; De Alessi, 1966 for the U.K.) and some more recent studies by Hendry (1980) and by Coghlan (1978) on the U.K. data that have found no evidence of economies of scale in money holdings. In short, then, for the U.S. there seems to be enough evidence for the existence of economies of scale. For the U.K., however, the evidence seems to be indecisive in that respect. (See Table (1.4) for summary results of income elasticities for major U.K. studies).

There are no major studies that examined the importance of inflationary expectations in the money demand functions. In some cases inflation is used as a proxy for this variable. We will

Table (1.4)

Demand for money in the United Kingdom: summary of results

Author	Data	Money	Interest Rate	Income Variable	Income Elasticity (a)
Kavanagh & Walters (1966)	Annual: 1980-1961	Broad	Long	GNP	1.149
	1926-1961	Broad	Long	GNP	
Laidler (1966)	Annual: 1900-1965	Broad	Long	GDP	0.795
	1900-1913	Broad	Long		1.241
	1920-1938	Broad	Long	GDP	0.793
	1946-1965	Broad	Long	GDP	0.684
Mills & Wood (1982)	Annual: 1880-1913	Broad	Short	GDP	1.00
Crouch (1967)	Quarterly: 1954-1965	LCB Deposits (total)	Long	GNP	1.08
Fisher (1968)	Quarterly: 1955(1)-1967(2)	Narrow	Short	PDI	0.686
		Broad	Short	PDI	0.742
		Narrow	Long	PDI	0.686
		Broad	Long	PDI	0.742
Goodhart & Crockett (1970)	Quarterly: 1955(1)-1969(3)/1963(2)-1969(3)	Narrow	Short	GDP	1.25
		Narrow	Long	GDP	1.09
		Broad	Short	GDP	0.77/1.50(b)
		Broad	Long	GDP	1.09/1.89(b)

Table (1.4) (cont'd)

Author	Data	Money	Interest Rate	Income Variable	Income Elasticity
Laidler & Parkin (1970)	Quarterly: 1955(3)-1967(4)	Broad	Short	GDP (perm)	0.68
Price (1972)	Quarterly: 1964(1)-1970(4): Persons	Broad Broad	Short Long	GDP	2.29
	Quarterly: 1954(1)-1970(4): Companies	Broad Broad	Short Long	GDP	2.77
Haache (1974)	Quarterly: 1963(4)-1971(3)	Narrow	Short Long	TFE	0.391
		Broad	Short Long	TFE	0.450
	Persons	Broad	Short Long	PDI	0.927
	Companies	Broad	Short Long	TFE	0.511
	Quarterly: 1963(4)-1972(4)	Narrow	Short Long	TFE	0.697
		Broad	Short Long	TFE	
	Persons	Broad	Short Long	PDI	1.081
	Companies	Broad	Short Long	TFE	2.206
	Quarterly: 1963(4)-1972(4)	Broad	Short Long Own rate	TFE	0.995
	Companies	Broad	Short Long Own rate	TFE	1.003

Table (1.4) (cont'd)

Author	Data	Money	Interest Rate	Income Variable	Income Elasticity
Artis and Lewis (1974)	Quarterly: 1963(2)- 1970(4)	Narrow	Long	GDP	0.77
	1963(2)- 1971(4)	Narrow	Long	GDP	0.95
	1963(2)- 1973(1)	Narrow	Long	GDP	1.24
	1963(2)- 1970(4)	Broad	Long	GDP	1.42
	1963(2)- 1971(4)	Broad	Long	GDP	1.48
	1963(2)- 1973(1)	Broad	Long	GDP	4.27
Coghlan (1978)	Quarterly: 1964(1)- 1976(4)	Narrow	Short	TFE	1.01
Mills (1978)	Quarterly: 1963(2)- 1974(4)	Narrow	Short	TFE	0.39
			Long		0.92

Key

* A Long run unitary price elasticity imposed.
GNP = Gross national product
PDI = Personal disposable income
TFE = Total final expenditure

(a) These are the long-run elasticities
(b) Results for money on a broad definition for both M1 and M3 respectively

For a detailed discussion on some of these studies see Coghlan (1978) therefore examine those studies that examined the role of inflation in the demand for money functions.

From Cagan's (1956) study of European hyperinflations it seems that the expected rate of inflation should be incorporated as an additional explanatory variable into the function. Some other studies, specifically those by Friedman (1969) and Selden (1956), however, could not find any systematic influence of this variable on the demand for money with the U.S. data. In view of these somewhat mixed findings Johnson (1972) attributes the absence of American evidence (on the significance of the rate of change of prices in the demand for money function), to the relative mildness of U.S. inflations. But more recent studies on post-World War II U.S. data by Shapiro (1973), Goldfeld (1973) and those on inter-war U.K. data by Brown (1939) and on the post-World War II U.K. data by Hendry (1980) have found evidence of significant effects for such a variable.

The difficulty with such a variable is that, on the one hand, at a theoretical level, there is enough reason to include it as a separate variable. Money serves as an alternative to physical goods giving the expected rate of price change a prominent role. On the other hand, inflationary expectations will be reflected in nominal interest rates; thus, most studies assumed that in the estimation of the money demand function, the nominal rate of interest will be picking up the net effect of variations in the real return on both financial and real assets. Laidler and Parkin (1975), for example, confirm that they in fact do so. But the other studies cited above found a role for the inflation variable even if the function contained also a nominal interest rate variable.

As in the case of the wealth variable, inflationary expectations are usually measured as a weighted average of past actual rates of inflation. The problem here again is identifying the source of these lags since both, the adjustment of money balances to new equilibrium levels and the variables proxying for expectations, require such lags.

In section (1.2.3) we have discussed the adjustment equations of actual money holdings, to desired level, of the type used by Chow (1966), Goldfeld (1976) or Coats (1982) - equations (1.4), (1.8) and (1.10). We have seen how these introduce time lags into the function. Similarly, we have seen how the way in which expectations are formed affects the dynamics of the function. Empirically there are very few studies that tried to investigate the source of time lags in the function. Among these, Feige (1967), using annual US data for the period (1915-1963), found the coefficient of adjustment λ in equation (1.4) to be equal to one, implying no adjustment lag was present but that the lags in the function were due to "expectation lags". Similarly, with quarterly data, Shapiro (1973) and Goldfeld (1973), both found the expectation variables to be of considerable importance for post World War Two U.S. data. Laidler and Parkin (1970), however, using quarterly British data for the period 1955-1967 found that both expectation and adjustment lags were present in the money demand function.

The important questions that arise from this study are:

Should there be expectation lags in the function? Which adjustment equation is more appropriate? What are the appropriate representative variables for the determinants?

An important consideration in deciding which variables should appear in the money demand function is whether the estimated function with these variables produces coefficients that are stable over time. In the U.K. after 1971, most empirical studies provided evidence suggesting that demand functions of the conventional kind broke down for both definitions of money. That is, not only did the conventional equations not predict accurately but further the estimated parameters also changed abruptly after 1971. Artis and Lewis (1981) give a survey of these studies which is reproduced and elaborated in Table (1.5).

Similar instability is observed over the post 1973 period for the U.S. (see Judd and Scadding, 1982, for a survey of the post 1973 studies). This instability in the U.S. has been attributed to financial innovations, changes in the regulations concerning interest rate ceilings on the deposits of banks and thrift institutions, increases in the rate of inflation and interest rates and the greater emphasis on monetary aggregate targeting by the Federal Reserve. Gordon (1984), for example, attributes the post 1973 instability in the short run money demand function to such supply shocks in 1973-1975.

In the same way, various explanations have been put forward to explain the instability observed in the U.K. Haache's (1974)

Table (1.5)

Stability of Short Run Demand for Money: summary of results

Function :M1

Study	Data Period	Income Elasticity		Interest Elasticity		Comments
		GDP	TFE	RS	RL	
Goodhart & Crockett (1970)	1955(3)-69(3)	1.25		-1.05		
		1.09			-0.80	
Haache (1974)	1963(4)-72(4)		0.70	-0.06	-0.21	
Artis & Lewis (1976)	1963(2)-73(1)	1.24			-0.66	Instability in 1971
Coghlan (1978)	1964(1)-76(4)		1.01		-0.30	Complex adjustment lags no instability
Mills (1978)	1963(2)-74(3)		0.39	-0.24		
			0.92		-0.45	
Boughton (1979)	1963(2)-77(3)	1.32		-1.51		Instability in 1971
Function: M3						
Goodhart & Crockett (1970)	1963(2)-69(3)	1.41		-0.21		
		1.54			-0.51	
Price (1972)	1964(1)-70(4)	2.29			-0.30	(a) Personal sector
		2.77		-0.36		(b) Corporate sector

Table (1.5) (cont'd)

Function: M3

Study	Data Period	Income Elasticity		Interest Elasticity		Comments
		GDP	TFE	RS	RL	
Haache (1974)	1963(4)-72(4)		* 1.00	* -0.25		(i) Standard equation (ii) Inserting interest rate variable for shift after 1971
Artis & Lewis (1976)	1963(2)-73(1)	3.89			-1.46	(1) Standard equation
		1.21			-0.34	(2) Interest rates adjustment equation
Mills (1978)	1963(2)-74(4)		* 11.29	*	-3.74	Instability evident
Boughton (1979)	1963(2)-77(3)	*			*	Instability evident

Notes: * Coefficent on lagged dependent term exceeds unity
GDP = Gross Domestic Product
TFE = Total Final Expenditure
RS = representative short rate of interest
RL = representative long rate of interest

Source: Artis and Lewis (1981)

view was that it was due to a shift in the demand function caused by the introduction of Competition and Credit Control, an institutional reform aimed at the removal of restraints on competition in the banking sector. Artis and Lewis (1976), on the other hand, pointed out that variations in supply conditions might have created a disequilibrium. This means that recent observations were off the demand curve, possibly lying somewhere above it. In their subsequent study, Artis and Lewis (1981), found evidence of instability even when they included additional variables modelling these institutional developments. Moreover, they claimed that even the demand function for a narrow definition of money which should not have been affected by the reforms, presented evidence of instability. These results, they claimed, showed the implicit assumption of the underlying methodology - namely that the money stock is demand determined - to be of doubtful nature. Thus, Artis and Lewis reversed their initial assumption, and considered the money stock to be exogeneously determined by the authorities. They developed single equation models in which either the money income ratio or the interest rate responds to fluctuations in money - thus reversing the causal relationship implied in the conventional demand for money function.

Recent studies that continued to employ the conventional approach provided evidence for stability in contradiction to Artis and Lewis' findings. Mills (1978), for example, generalising the functional form (with the Box and Cox family of power transformations), found narrow money to be stable and relatively insensitive to functional form. Laumas (1978) provided further evidence of stability for narrow and broad definitions by splitting the data into two periods. More recently all these conventional partial-adjustment methods came under severe criticism by Hendry and Mizon (1978) and Courakis (1978) where an unrestricted rational lag structure was used as a baseline. This relatively new approach starts from a specification that is rather general and rich in its lag structure and any testing is nested within that. This relatively new methodology has been used in a large number of studies in the recent years. Among these, Hendry and Ericsson (1983), in a study of the demand for narrow money on the U.K. annual data from about 1870, reported some temporal instability in the relationship. This result was contrary to the earlier findings of Friedman and Schwartz (1982). More recently however, Holly and Longbottom (1985) showing the dangers involved in using Hendry's methodology, derive a demand function that is statistically superior and stable over a long period of time. Similarly Klovland (1985) confirmed this result obtained by Holly and Longbottom and provided evidence that the rate of interest on bank deposits was superior as a measure of the own yield to the Klein (1974) notion of the competitive return on money.

These results lead to the conclusion that perhaps a stable money demand function can be extracted from historic data on the UK provided that the econometric issues are properly handled (Desai, 1981). The evidence on the stability issue is currently unsettled. It is hoped that the econometric investigations undertaken in this thesis may help to decide the matter one way or another.

1.3 Supply of Money

The object of this section is first to derive the model which theorists have most commonly used to describe the money supply process - the monetary base approach. This approach will then be compared with the PSBR-money-debt framework currently used in the U.K. The advantages that the former approach offers will then be analysed first with respect to money supply control - the monetary policy that most western countries seem to be adopting more and more - and then in the context of identifying the sources of money creation - whether this is from the banking sector, the public or the government.

The following section will deal with an important issue: is 'base money' controllable and if it is, does it necessarily imply the controllability of broader monetary aggregates? The first question will be answered by analysing the exchange rate regime. For the second one, however, a discussion of the behaviour of the components of the multiplier is necessary. The question then is, can one regard these components as being functions of a small number of other economic variables? Further, are these relations stable over time?

The section ends with a survey of studies which have analysed these questions empirically.

1.3.1 Theory of the Money Supply Process

The monetary base approach, where the money supply is related to base money by a multiplier, has a long pedigree. It dates from the time when money consisted of notes issued which were partially backed by gold. The idea was that, since the relationship between the amount of gold and the size of note issue was stable, any increase in gold holdings would bring about a multiple change in note issue. Subsequently with the growing use of demand and time deposits for monetary functions, the question of how many deposits an individual bank and the banking system could create for a given change in its cash reserves, became the central issue of concern. See, for example, the studies by Phillips (1920), Rogers (1933), and Angell and Ficek (1933). From then onwards, attempts have been made to extend this multiplier approach to allow for the different reserve requirements against time and demand deposits and the demand for money by financial intermediaries.

Let us then, define this approach of the money multiplier using two definitions of money stock, a narrow definition, M1, and a broader definition, M2.

The monetary base consists of all assets acceptable as ultimate means of settlement between banks. In practice this means that the monetary base, B, (or 'high-powered money') consists of cash (issued by monetary authorities) in the hands of the banking system together with bankers balances at the Central Bank (R) and of cash in the hands of the non-bank public (C).

$$B = R + C \qquad (1.17)$$

The monetary aggregate M1 is made up of the non-bank public's holdings of notes and coin (C) and their holdings of demand deposits (DD).

$$M1 = DD + C \tag{1.18}$$

From equations (1.17) and (1.18), M1 multiplier m^1 can be derived:

$$m^1 = \frac{M1}{B} = \frac{DD + C}{R + C} \tag{1.19}$$

Dividing the numerator and denominator by DD:

$$m^1 = \frac{1 + C/DD}{R/DD + C/DD} = \frac{1 + c'}{r' + c'} \tag{1.20}$$

The multiplier m^1 is greater, the smaller is the cash-demand deposit ratio, c', and the reserve-demand deposit ratio, r'. From equation (1.20) it can be seen that if the monetary base is raised by an amount, x, then M^1 can increase a maximum amount $[(1 + c')/(r'+ c')]x$. That is:

$$M1 = m^1 B \tag{1.21}$$

A broader definition of money supply, M2, would include time deposits as well as demand deposits. M2 is defined as M1, plus time deposits, TD:

$$M2 = DD + TD + C \tag{1.22}$$

If the reserve requirements are the same with respect to time deposits as to demand deposits, then the M2 multiplier, m^2, is the same as m^1. One would expect, however, banks to hold smaller reserves or the monetary authorities to impose lower rate of reserve requirements on time deposits, since their rate of withdrawal fluctuates less than for demand deposits. Then m^2 will be as follows:

$$m^2 = \frac{M2}{B} = \frac{DD + TD + C}{R + C} \qquad (1.23)$$

Dividing the numerator and the denominator through by DD gives:

$$\frac{1 + (TD/DD) + (C/DD)}{\frac{r'DD + r'' \; TD}{DD} + C/DD} \qquad (1.24)$$

That is, $\frac{1 + t + c'}{r' + r''t + c'}$ (1.25)

where $r' = \frac{R^{DD}}{DD}$; $r'' = \frac{R^{TD}}{TD}$; $R = R^{DD} + R^{TD}$; $t = \frac{TD}{DD}$

R^{DD} and R^{TD} are reserves held for demand and time deposits respectively. Comparing (1.25) with (1.20), it can be seen that m^2 is larger than m^1. This means that a given addition to B will increase the broader aggregate M2 by more than M1. Again a multiplier m^2 is greater, the smaller is the ratio of cash to demand deposits, c', and reserve to time deposits, r''. Further, if reserves held for time deposits, r'', are equal to or less than for demand deposits, r', then m^2 is higher, the greater is the amount of time deposits relative to demand deposits, t.

In summary, then, the lower the proportion of money held in currency and the lower the proportion held in demand deposits rather than time deposits, the more M1 and M2 can expand. Similarly, the lower the reserves held against deposits the higher the monetary aggregates, M1 or M2.

A simplified version of (1.25) would be of the following form:

$$m^2 = \frac{C/D + 1}{C/D + {}^R/_D} = \frac{1 + c}{r + c} \qquad (1.26)$$

where D consists of both time and demand deposits.

Substituting the equation (1.26) for the multiplier in $M2 = m^2 B$, the following identity is obtained:

$$M2 = \frac{1 + c}{r + c} B \qquad (1.27)$$

According to this explanation, the proximate determinants of the money supply are: (1) the public's currency ratio (=c), (2) the bank's reserve ratio (=r) and (3) the monetary base or high powered money (=B). Equation (1.27) is the money supply identity which is true for any set of values for B, m and M. It is not a behavioural equation.

The attractiveness of this expression for the purposes of investigation is that it relates a variable that the authorities often want to control, M, to a variable over which they may have control, B. Furthermore (1.27) brings out the importance of the behaviour of the three sectors . The course of B (the base) reflects the behaviour of the monetary authorities. The non-bank public's behaviour affects the distribution of the base between itself and the banking sector, $({}^C/_D)$. And the banks affect the money stock by their decisions on the level at which to maintain the ratio of reserves to deposits $({}^R/_D)$. It should of course be emphasized that the behaviour of the three elements is related. Once ${}^C/_D$ and ${}^R/_D$ are given a behavioural description - that is they are made explicitly dependent on other variables of the economic system - then it follows that the money supply is indirectly determined by them.

The monetary base approach is a theoretical framework used for discussing the money supply theory. Its importance can further by seen with Brittain (1984):

> 'If we are to believe that the government cannot control interest rates, it cannot under current procedures, control the money supply either: and what then becomes of its central strategy......... As there is some relation between banks' reserves at the Bank of England and the rate at which they choose to expand their assets and liabilities, these reserves are often known as "high-powered money". The Bank could determine the amount of high-powered money by its own market operations; and this method of influencing the money supply is known as "monetary base control".

For purposes of designing monetary policy, however, the framework that is used in the U.K. is not the monetary base approach but the PSBR - Money - Debt approach.

1.3.2 <u>Comparison with PSBR - Money - Debt Framework</u>

According to PSBR - Money - Debt framework of money supply control, the authorities try to forecast (at a given level of interest rate and exchange rate) the growth of all those items in their own balance sheet, and in the balance sheet of the consolidated banking system, except the money stock.

The following equation gives the relationship between money supply (M3) growth and the items that the authorities try to predict:

change in M3 = PSBR + the change in the volume of lending to the private sector.
+ change in the nation's reserves of gold and foreign currencies.
- change in the holdings of government debt held by non-bank U.K. and overseas agents (1.28)

If, for example, the predictions of the authorities led them to believe that there will be excessive money supply growth, then they will have to counteract this by allowing either interest rates or exchange rates to change.

The problems associated with this approach have been well summarized by Griffiths (1979a). The first problem is the relative unpredictability of all those individual items in equation (1.28) that back the money supply. The second problem arises when the money stock is rising and the interest rates are at high levels. Under these conditions, the authorities might be reluctant to raise interest rates further to choke off the demand for bank loans. They will then be obliged to try an alternative: limiting directly the banking system's ability to make loans. The evidence from past experience of these controls show that they create distortions on financial markets.

The first advantage that the monetary base approach offers relative to the PSBR - Money - Debt framework is that, as Batchelor (1983a) points out, it would allow the authorities to separate their own contribution to monetary expansion from the contributions of the bank and the non-bank public. Such a distinction, of course, is not possible with the PSBR - Money - Debt accounting framework. Although both equations (1.21) and (1.28) are identities and therefore can not explain why changes are occuring, the former money - base identity is very insightful in that it isolates the behaviour of those agents - namely the public, the banks and the monetary authorities - for whom we have well developed economic theories.

Secondly, the monetary base approach is helpful in understanding long term trends in the money stock. For example as the banking system develops, a new money substitute providing a more acceptable means of payment and medium for savings than money start to emerge. A comparison of the M1 multiplier with the M2 multiplier will show that money multipliers tend to get higher for financial systems at higher stages of development (for details, see Dow and Earl, 1982). This means that a contractionary policy, inducing further innovation, will allow the multiplier to increase. The increase will not subsequently be reversed even if the tight monetary policy is lifted.

The third aspect of the approach is its use in controlling the money supply. As we have seen above, this framework relates a variable that the authorities want to control, M, to a variable over which they may have control, B. The conventional approach on the other hand focusses on credit rather than money for purposes of monetary policy (for a further investigation, see Batchelor, 1983b). Whether control is feasible within the money multiplier framework, however, is an empirical matter. It depends, on, first, whether the base is indeed controllable and, second, whether the money multiplier components are predictable.

1.3.3 Determinants of the Money Supply Components

Money supply depends on monetary base and on the components of the money multiplier. The first issue is the determination of the base.

The size of the monetary base depends on government policy. If the target of the authorities is the base then this implies that the base and hence the money supply are exogenous. If, however, the target is the interest rate or the exchange rate, then the base will change in order to achieve the desired level of the target. In such circumstances the base and the money supply will become endogenous.

Components of the monetary base can be derived from consolidation of the balance sheet of Bank of England, Royal Mint and the Exchange Equalisation Account. Under fixed exchange rates, since the price of the domestic currency in terms of the foreign currency is fixed, the monetary authorities are committed to buy and sell foreign exchange for the home currency at a fixed price. Under these circumstances a balance of payments deficit (surplus), will lead to a decrease (increase) in the monetary base. This is better understood if one analyses the base from its 'sources' side rather than its 'uses' side that was shown in equation (1.17).

'Sources' of Base: Gold + foreign exchange reserves
+ credit to private sector
+ special deposits
(Griffiths, 1979b)
(1.29)

Any net flows thus affect the base, inflows of funds increasing it and outflows decreasing it. In the case of a balance of payments deficit, residents will have to pay with home currency for the foreign exchange they require. This will therefore lead to a decrease in the monetary base. The opposite will happen in the case of a balance of payments surplus, leading to an increase in the base. The movements of course can be offset by the open-market operations of the monetary authorities. It is argued, however, that the authorities cannot sterilise balance of payments for any significant period of time. (For a detailed discussion, see Vane and Thompson, 1979). The foregoing discussion implies that under a fixed exchange rate regime the course of the base reflects only partially the behaviour of the monetary authorities; it is mostly the balance of payments that influences the base. A similar argument can be made for a regime of managed flexibility where the authorities fix and support the exchange rate.

Equally when the policy of the authorities is to control bank lending via interest rates then the base will adjust accordingly, becoming endogenous.

In the late 1950s, a debate began over whether the authorities could control the supply of money via their control over the base under flexible exchange rates. Subsequently Newlyn (1971), and some of his followers came to the conclusion "that there is a definite though not rigid, multiple relationship between the stock of money as a whole and the liabilities of the Central Bank. So long, therefore, as the Central Bank can control its own liabilities it can control broadly, the total stock of money." That is, controllability of the base leads to that of the money supply. This, then, brings us to the second issue whether the components of the multiplier are stable or predictable over time, since the multiplier tells us how each of the monetary aggregates is expected to grow for a change in reserves on the assumption that its various components are stable over time.

In the long run, it can be observed that the components of the multiplier, currency to demand deposits ratio, c', and reserve to demand deposits ratio, r', have tended to fall, while time to demand deposits ratio, t, tended to rise. This is mainly due to two developments: the growth of the banking system allowed the non-bank public to hold progressively smaller and smaller proportions of their money in currency and then in demand deposits; and improved banking practices allowed banks to hold less cash reserves.

In order to analyse the stability or the predictability of these ratios let us examine them in relation to other economic variables.

First the currency to (total) deposits ratio, c. Over the long-run the <u>currency ratio</u> reflects the habits, institutions and preferences of the community with respect to the use of currency and deposits. In the short-run, however, variations in the ratio reflect the confidence of the public in the banks' ability to maintain convertibility of their deposits into currency.

This ratio has been investigated for a long time. In 1911, Fisher (1911) assigned it an important role in causing upper turning points in economic activity. In his model, an increase in economic activity fosters an increase in the demand for credit which is met through increased bank loans made in the form of demand deposits. The increased deposits lower the actual currency ratio below its equilibrium value and set in motion forces to restore equilibrium. More recently theoretical developments attempted to explain how fluctuations in the currency ratio affect the money supply when the public change their cash balances from one to the other, the aggregate amount of money supply as well as its composition are altered. This effect can be offset by other factors (eg open-market operations of the Central Bank) and therefore forces the Central Bank to give considerable importance to the currency ratio when planning monetary control.

For the U.S. Cagan (1965) showed that for the period 1877-1953 the currency ratio was the chief contributor to specific cycles in the rate of change in the money stock. For the U.K., Crouch (1967) estimated that, during the monetary contraction of 1954-56, the currency ratio changed to such an extent that it lowered the money supply by 1.36 per cent when it would have increased by 6 per cent as a result of a (ceteris paribus) increase in the base. Similarly, he argued that for the period 1946-47, the fall in the currency ratio more than offset a fall in the base and consequently the money supply increased. In 1951-52, it had the opposite effect, that is, its own increase offset exactly the increase in the base and consequently the money supply stopped rising.

In order to examine the behaviour of the ratio, Cagan (1965) analysed the behaviour of the currency ratio in relation to two other ratios: the currency to expenditure ratio and the velocity of money. When the public switch from currency to deposits, its effect on the currency/money ratio is entirely reflected in the currency/expenditure ratio. Substitution between deposits and other earning assets does not involve currency. The velocity of money shows the entire effect. If both of the explanatory ratios decline, then it is clear that there is substitution from currency and other assets into deposits. If however, the currency/expenditure ratio rises and velocity of money falls then this would be an indicator for gains in currency holdings at the expense of assets other than deposits. Gibson and Thom

(1971) tried to predict the ratio from its own history, that is, they estimated relationships of the ratio relating it to its own past values by extending the lag six months back over the period 1955-1969. Only the first two lags were found to be significant. But the important question was whether the equation was useful at all since a more orthodox approach would be to study the ratio by specifying the factors that determine it and examining the direction of their influence.

The currency ratio is a behavioural variable. The assumption stating that it is constant is not very realistic although it simplifies the "orthodox view" (for details of this view see Newlyn, 1971) of the money supply process where it is argued that control of base money is a necessary and sufficient condition for the control of the money supply. This view would still hold if one could find a predictable relationship for the fluctuations in the ratio. An important question is therefore whether it bears a stable relationship with the economic factors that influence it. Among these factors, the level of real national income is likely to be important. As income grows the public's demand for both currency and bank deposits is likely to increase. The overall effect is likely to be a reduction in the ratio; since the income elasticity of deposits is expected to be greater than that of currency.

The expected cost of holding currency in lieu of deposits is another factor that will influence the ratio. A rise in the cost of holding currency leads people to substitute deposits for currency. The foregone cost of holding currency can be measured by the yield on deposits. The effect of the time deposits yield on the currency ratio is, however, not certain. A rise in the time deposit rate might induce a switch from demand deposits into time deposits, the result of which will not be shown in the currency ratio. It can also induce shifts from currency to deposits. This will reduce the currency to deposits ratio; but when all rates rise, the public may shift from deposits into other assets, and, depending upon yield differentials, this might raise or lower the currency to deposits ratio.

Another factor that would be of considerable influence on the ratio is the threat of widespread bank failures. This will increase the expected loss from holding deposits, thereby motivating a switch to safer assets.

Cagan (1965) found that the ratio of taxes to income was useful in explaining the demand for currency in the U.S. That is, the bigger the ratio of taxes to income, the greater the incentive to evade tax payments, the transactions of which are likely to be done in currency. Other factors that are likely to influence the currency ratio are: the extent to which bank and other credit cards are used and social attitudes towards such factors as the payment of wages and salaries by cheque. Uncertainties about general economic and political stability, and black-marketing can also be expected to create a demand for currency. Finally, the expected rate of inflation can also affect the currency ratio, since as individuals expectations of inflation rises, real assets will be substituted for currency and deposits, but perhaps at different rates.

The following equation summarizes the argument so far:

$$^{C}/_{D} = f(Y, i_d, F, T, \dot{p}^e, 0) \qquad (1.30)$$

where

Y = real income

i_d = interest on bank deposits

F = bank failure rate

T = taxes to income ratio

$\dot{p}^e$ = expected rate of inflation

0 = non-specified influences like social attitudes, uncertainties, etc.

The currency ratio can be examined more thoroughly when separated into two ratios: currency to demand deposits ratio, c', and time to demand deposits ratio, t.

First, we examine <u>the currency to demand deposits ratio</u>, c', which shows the public's decision as to its allocation of its money balances between currency and demand deposits. Following Burger (1971), the dependence of this ratio on the economic factors can be summarized in the following expression:

$$C' = f(\overset{+}{q}, (Y\overset{-}{/}Y^P), \overset{+}{TX}, \overset{+}{s}, \overset{-}{w}) \qquad (1.31)$$

where;

q = measure of net service charges on demand deposits

TX = public's tax liabilities

Y/Y^P = ratio of net national product to permanent net national product

s = mobility of the population and such factors as seasonal patters introduced by holidays.

w = nominal wealth of the non-bank public

The signs above the variables that influence c', in equation (1.31), are the expected signs of partial derivatives. The explanation of these signs follows from that of the currency ratio, c; they will not therefore be repeated here. The only difference between equations (1.30) and (1.31) is Y/Y^P. As the ratio of transitory income to permanent income rises, individuals are postulated to increase the portion of money held in demand deposits since the extent to which currency is a convenient or cost-efficient medium of exchange decreases with the size of any given transaction. It should be emphasized that the quantity of demand deposits the public desires to hold is partly dependent upon the yields available on time deposits and on other assets. That is, c', may be partly sensitive to interest rates. For example, as the time deposit rate rises, the public may be willing to hold a smaller amount of demand deposits relative to their holdings of currency. This implies that rates on time deposits and that on other assets might also provide an explanation for the behaviour of c'.

The second important ratio is the <u>time to demand deposits ratio,</u> t. This ratio is viewed as being determined by the portfolio decisions of the public. These decision are in turn influenced by the interest rate actions of the commercial banks. Again following Burger (1971) the relationship that expresses the dependence of the t-ratio an economic factors is as follows:

$$t = f(\overset{-}{i^{f}},\ \overset{+}{i^{t}},\ \overset{+}{W/P},\ {}^{Y}/Y^{P}) \qquad (1.32)$$

Where

i^f = index of yields on financial assets, other than time deposits traded on the credit market

i^t = the time deposit rate

W/P = real value of the stock nonhuman wealth held by the public

Y/Y^P = ratio of current income to permanent income.

The signs above the variables in equation (1.32) represent the expected signs of partial derivatives: as banks raise the time deposit rate, other factors constant, the public will be willing to increase the portion of the bank deposits they hold in time deposits. As yields on other assets rise, the t-ratio falls, the elasticity of time deposits with respect to the yields on their close substitutes being higher than the elasticity of demand deposits. When i^f rises relative to i^t, then the public switch from time deposits to other assets; the t-ratio falls as a result. In view of this, if banks are willing to induce the public to hold more time deposits, they must increase their offered yields on time deposits,

Finally, as real wealth (W/P) or the ratio of transitory income (Y) to permanent income (Y^P) rises, the public will restructure their holdings of bank deposits increasing the portion held in time deposits, since as for currency, the extent to which demand deposits are cost-efficient medium of exchange decreases with the size of any given transaction.

Having considered the behaviour of the currency ratio let us now

Where

i^f = index of yields on financial assets, other than time deposits traded on the credit market
i^t = the time deposit rate
W/P = real value of the stock of nonhuman wealth held by the public
Y/Y^p = ratio of current income to permanent income.

The signs above the variables in equation (1.32) represent the expected signs of partial derivatives: as banks raise the time deposit rate, other factors constant, the public will be willing to increase the portion of bank deposits they hold in time deposits. As yields on other assets rise, the t-ratio falls, the elasticity of time deposits with respect to the yields on their close substitutes being higher than the elasticity of demand deposits. When i^f rises relative to i^t, then the public switch from time deposits to other assets; the t-ratio falls as a result. In view of this, if banks are willing to induce the public to hold more time deposits, they must increase their offered yields on time deposits.

Finally, as real wealth ($W/_P$) or the ratio of transitory income (Y) to permanent income (Y^p) rises, the public will restructure their holdings of bank deposits increasing the portion held in time deposits.

Having considered the behaviour of the currency ratio let us now examine the banks' reserve ratio, r. The behaviour of banks has been of considerable interest to economists in general. Most theorists tried to model the money supply process through the behaviour of banks. For example, Brunner (1962) obtains an aggregate relationship by summing over a set of microeconomic equations describing the supply behaviour of individual banks. Polak and White (1955), on the other hand, use a simple aggregative model where they postulate a negative relationship between the ratio of Federal Reserve member-banks net free reserves to their deposit liabilities and the Treasury Bill rate. Teigen (1964) expands Polak and White's model by using a broader coverage (broader money stock measure than demand deposits at member banks). He describes the money supply process of commercial banks by studying the interaction of money stock and short-term rate within the context of a structural model.

In general, theories which have tried to model the behaviour of the banking firm, have begun by considering the bank's reserve and liquidity management (e.g. models by Orr and Mellon, 1961, Porter, 1961; Poole, 1968; Baltensberger, 1972;and Pringle, 1974). In these models the basic problem that a bank faces is the choice of optimal allocation of given funds (e.g. deposits), among reserves and earning assets (loans). Such an optimization requires a tradeoff between the opportunity cost of holding reserves (usually assumed to be non-interest bearing cash reserves) and the portfolio adjustment costs associated with reserve deficiencies (i.e. liquidity cost). The resulting demand for reserves is a function of the net yield on loans, r^c, portfolio adjustment costs resulting from reserve deficiencies, g, and the variability of deposits, AD. Further, if the bank is required by law to hold some quantity of cash reserves then the function will be for bank's demand for 'surplus' reserves (i.e. reserves in excess of the required quantity). Alternative types of deposits could also be incorporated in these models if, for example, the bank sees some deposits (e.g. time deposits) requiring smaller reserves than others (e.g. demand deposits). These considerations then lead to the following demand for reserves function:

$$XR = f(r^{C}, AD, g, TD/_{D}) \qquad (1.33)$$

where

XR = excess reserves over required reserves

AD = variability of deposits, uncertainty about the outflow of deposits

g = portfolio adjustment cost resulting from expected liquidity cost

$TD/_{D}$ = the proportion of time deposits out of total deposits

r^{C} = opportunity cost of holding cash reserves.

These models can be extended further to incorporate uncertainty and information costs for a net selection and default risk on loans (Baltensperger, 1980).

All these theories assume that a bank accepts all the deposits offered to it by the public. That is, the volume and structure of deposits are viewed as exogenous to the bank's optimal asset choice. A bank however, can influence the public's demand for its liabilities. It can, for example, compete on the interest it pays on various types of its liabilities. Further, there is no reason for the bank to accept all deposits passively; it is possible that a certain volume or structure of liabilities may not be acceptable to the bank.

Theories of liability management have been developed by incorporating these possibilities. In these, the banking firm is modelled through the bank's optimal decision with regard to its liability structure. Deposits are now viewed as endogenous to the banking firm. In its most simplistic form the supply of deposits is now a function of the rate of interest the bank pays on these deposits, the opportunity cost of funds other than deposits (e.g. equity funds), and the distribution of the bank's income charges (which depend on volume and structure of the bank's asset portfolio).

These models, however, like the models of asset management, are not complete. That is, no explanation is given for the interaction between asset and liability choices or about the determination of the total size of the banking sector (or firm). There are more complete models which have tried to explain scale. Klein (1971), for example, tried to determine bank scale and portfolio structure via revenue maximization. In his model, the bank is a price taker in the market for government securities and a monopolistic price setter in the markets for bank loans and deposits. This model, however, seems to breakdown as soon as the bank starts to operate as a price-taker in competitive markets (see Baltensperger, 1980). The bank's demand for reserves, in this model, is derived in a similar fashion to 'optimal asset choice' models. The only difference is that reserves are now treated as being linearly homogeneous in total portfolio size and completely independent of the composition of deposits. Such a treatment is questionable, and should be tested.

As an alternative to these theories, several models exist which apply the general theory of portfolio behaviour to the financial firm under the assumption of risk aversion (e.g. models by Parkin, 1970; and Pyle, 1971). In these models the basic discussion is about the conditions under which a firm decides to sell liabilities (e.g. deposits) in order to obtain financial assets. The differences in the length of the maturities of the bank's assets are seen as the most important determinant during bank's decision period.

Finally, there are models (Pesek, 1970;and Saving, 1971) that analyse size and structure of bank assets and liabilities purely in terms of the real resource costs of generating and maintaining those stocks. The usual theory of the firm principles applies; that is, the bank has a production function for these stocks as a function of inputs. The bank then derives its optimal combinations of assets and liabilties by maximising its profits.

1.3.4 Empirical Evidence

Our discussion of the determinants of the money supply have this far been conducted entirely in theoretical terms. Although less intensely investigated than money demand, there are several empirical studies which do attempt to analyse precisely how the public's demand for cash and banks' demand for cash reserves are determined in practice.

We consider these studies in more detail. In particular we are interested in two questions. First, what are the most important determinants of the ratios and, second, are the functions relating these determinants to ratios stable over time.

Public's Behaviour

First, we examine the currency ratio. Most empirical studies have analysed the currency to demand deposits ratio. Those few which have examined the currency to total deposits ratio undertook simple numerical analysis without establishing any econometric relationships. The works by Cagan (1965), and by Friedman and Schwartz (1963) are the most important of these studies. Both studies looked at US data over the period 1867-1960 during which the cash ratio fluctuated around a falling trend. Reasons given for the trend fall in the ratio are: growth of banking institutions, the resulting importance and usefulness of deposits relative to currency, the fall in costs of bank services, the growth in real per capita income, the establishment of the Federal Reserve System, and that of Federal Insurance of bank deposits.

Reasons given for short-term rises are business contractions and panics associated with banking failures.

In his analysis of the interaction between the real and monetary sectors for the U.S., Aghevli (1975) estimated the deposits to currency ratio (the inverse of the c-ratio), as a log - linear function of real income per capita and the number of banks, both of which are shown to have significant effects in the function.

The importance of real income is also confirmed for the currency to demand deposits ratio. Garcia and Pak (1979), for example, examined this ratio for the U.S. by using separate demand equations for currency and for demand deposits. Using quarterly data over the period 1952(2) - 1967(4), they found deposits to have higher point estimates of the impact income elasticities than currency. This order, however, is reversed for the long term or equilibrium elasticities. Similar results, have been obtained by Hess (1971) for the U.S. over the period 1947 - 1969. Boughton and Wicker (1979), on the other hand, found both short and long run elasticities to be higher for deposits than for currency with monthly U.S. data, for the period January 1921 to June 1936.

The evidence from these studies is somewhat mixed. With the currency to total deposits ratio, real income has a negative impact. With the currency to demand deposits ratio, the influence of real income is negative for the inter-war period. For the post-war period, however, a positive effect is observed. This evidence is based on the results of a small number of studies; nothing can, therefore, be said conclusively. The elasticity of the currency ratio with respect to real income remains to be established by further research.

With respect to the interest rate the evidence is somewhat more conclusive.

Using an Almon distributed lag estimation procedure, Hess (1971) found the rate on commercial paper to be positively related to the currency to demand deposits ratio. Becker (1971) provided further evidence on the importance for the c-ratio of the rate of return on demand deposits, the time deposit rate and the rate paid on a market security (over the period 1953 - 1971 with U.S quarterly data). Using a reduced form distributed lag regression, he found that all three rates had a significant influence on the demand for currency relative to demand deposits at the 5 per cent significance level. The obtained interest elasticities are - 0.14, 0.04 and 0.02 respectively. Similarly Teigen (1964a), using quarterly U.S. data for the period 1953 (1) through 1964 (4), found a significant positive relationship between changes in the currency to demand deposits ratio and the yields on Treasury Bills. In his subsequent study, Teigen (1969) found an elasticity for the currency to demand deposits ratio varying between 0.74 and 0.85 with respect to the time deposit rate, and between 0.9 and 0.65 with respect to the Bill rate (the former elasticity refer to 2SLS and the latter to OLS estimates).

Further evidence on the significance of interest rates over the interwar period is presented by Boughton and Wicker (1979). The steady state elasticities with respect to yield on demand deposits and on commercial paper are found to be -0.5 and +0.5 respectively. Garcia and Pak (1979) on the other hand, found currency to be more elastic in the long run (-0.215) than demand deposits (-0.101), with respect to the time deposit rate. With respect to the yield on commercial paper, however, these elasticities are -0.063 and -0.068 respectively.

The evidence then seems to suggest that the currency to demand deposits ratio is negatively related to the rate of return on demand deposits and positively related to the rate on commercial paper. With respect to the time deposit rate most studies find this relationship to be positive except for Garcia and Pak (1979). In this study, however, separate demand equations have been estimated for currency and demand deposits, and the rate of return on demand deposits has not been included as a separate regressor. As a result the effect of this variable could be partially picked up by the time deposit rate. This could then explain the negative relationship obtained in the latter study.

Those studies which estimated the currency to demand deposits ratio directly imply a range for interest elasticities that can be shown in the following way

the variables	the range of elasticities
(a) $^{C}/_{DD} + r_{DD}$	-0.14 to -0.5
(b) $^{C}/_{DD} + r_{TD}$	0.04 to 0.9
(c) $^{C}/_{DD} + r_{s}$	0.02 to 0.9

where r_{DD} = rate of return on demand deposits

r_{TD} = rate of return on time deposits

r_s = yield on commercial paper or Treasury Bill rate

Boughton and Wicker (1979) analysed the behaviour of the currency to demand deposits ratio during the Great Depression period for the U.S. They presented evidence that declining interest rates played a major role in the rise of the c' -ratio and that over one-fourth of this rise was attributable to bank failures. They used the percentage of banks which failed as their 'bank failure' variable.

I now turn to the determinants of the time to demand deposits ratio, t. The importance of interest rates in the demand for time relative to demand deposits is confirmed by a small number of studies. Jordan (1969), for example, in a study of deposit-type financial assets using cross-section data for the period 1956-1966 found the elasticity of the t-ratio with respect to the time deposit rate to be positive and with respect to the rate on other assets to be negative. The estimated parameters were significant in both cases. Similar results were reported by Goldfeld (1966), de Leeuw (1965) and Teigen (1969).

The relationship between real income and the t - ratio is also investigated by Goldfeld (1966). He does not estimate the ratio directly but he presents the results separately for demand deposits and for time deposits equations. The long run income elasticities are 0.72 and 1.0 for demand deposits and time deposits respectively, implying a positive relationship between real income and the t - ratio.

Most of the foregoing evidence is based upon the results derived from a limited number of studies. They cannot, therefore, be regarded as conclusive. The question of stability of these ratios is also an unsettled issue. There are very few studies which have investigated this matter directly. Among these studies, there is that by Becker (1975), who investigated separate demand equations for currency and demand deposits and for their ratio. In order to perform the Chow stability test, the data were split into a 32 observation group (the 1953 through 1960 period), and a 40 observation group (the 1961 through 1971 period). In all three regressions the stability of the regression coefficients was acceptable at the 5 per cent significance level. The study by Trescott (1984) offers an extension of Boughton and Wicker's (1979) results on the currency ratio during the Great Depression by testing the stability of the demand for currency alone. He finds the equation to be unstable for shorter sub-periods within their 1921-1936 span. He also finds evidence for instability when he divides the 1921-33 data before and after June 1924.

The study by Trescott and all the others which investigated the stability issue analysed separate demand equations for M1 and M3. In our survey of empirical studies on the demand for money (section 1.2.4), a list was presented for studies that have found evidence of instability in conventional money demand estimates for the U.K. and U.S. Most of these studies showed the equation for M1 to break down for the U.S. after 1973, and for M3, as well as (to a lesser extent) M1 for the U.K. after 1971. The implications are that similar breakdowns could be expected in these years for estimates of the ratios. It is of course possible that such breakdowns could be observed earlier since there is almost no evidence on the matter. That is, the stability of the function determining these ratios is one of those interesting topics that remains to be investigated.

<u>Banks' Behaviour</u>

In an analogous way to the currency ratio, Cagan (1965), and Friedman and Schwartz (1971) investigated the reserve to deposits ratio, r, for the U.S. over the 1870-1960 period. They found a tendency for the r - ratio to increase in the downswings of the economic activity and to fall in the expansionary phases of the cycle. Their argument is that the slowdown in economic activity is accompanied by a slower growth or fall in bank deposits and banks are left with 'excess' reserves. The opposite move occurs in the expansionary phase of the cycle. Furthermore, a sharp downturn in economic activity might produce a sharp fall in the demand for loans and so in the rate of interest. As a result, banks might refuse to commit a large proportion of their portfolios to bonds at low returns and might prefer to hold some of their funds idle.

Panics, financial uncertainties, and bank failures are found to increase the reserve ratio. At first the public converts their deposits into safer assets (currency), reducing bank reserves.

In order to re-establish the public's confidence in deposits, banks will then raise their reserves which will increase the reserve ratio. Further, the reserve ratio is found to respond positively to lower legal requirements and to gold sterilization policies. The establishment of the Federal Reserve System, for example, lowered legal requirements and gave confidence to the banks that they had a ready 'lender of last resort' to fall back on. This produced a fall in the reserve - ratio. Similarly, the growth in the importance of time deposits relative to demand deposits is found to lead to a reduction in the reserve to deposits ratio since time deposits are less likely to be withdrawn at short notice.

There are very few empirical studies which have tried to estimate different models of banks' behaviour. Among those that exist for the U.S., most have used models of asset management to study banks' demand for reserves. Polak and White's (1955) empirical work on banks' demand for excess reserves is one of these early studies which showed a close relationship between the ratio of net excess reserves to total deposits and the natural log of the yield on short-term government securities. More recently, in his empirical analysis of bank adjustments to monetary policy, Bryan (1967) specified the banks' demand for excess reserves to be a function of opportunity costs, loan demand, cost of borrowing, bank size, trend, and reserve settlement period. His estimated equation for anticipated changes in excess reserves is specified as linear in its arguments. He does not present the results but claims that estimated parameters were acceptable in terms of signs (i.e. these confirmed the theoretical predictions derived from asset management models).

Similar demand functions for free reserves were estimated by De Leeuw (1965), and Goldfeld (1966).

Their results established the importance of short-term interest rates, deposits and prudential deposits in banks' demand equations for free reserves. Goldfeld's results revealed further the importance of monetary policy for banks' reserves. The introduction of a shift variable to reflect the transition to a flexible capital market after 1953(2), increased the explanatory power of the equation and showed the same behavioural relationship not to be appropriate over the entire period.

The equations estimated by De Leeuw (1961) and Goldfeld (1966) were, however, found to be inappropriate to explain the large accumulation of excess reserves after bank panics. Friedman and Schwartz's (1963) "shock effect" and Morrison's (1966) "inertia effect" hypotheses were both developed in order to find an explanation for such a behaviour. Both of these hypotheses argue that banks accumulated excess reserves in anticipation of large reserve outflows. The difference between these two models is that in the inertia effect model the banks do not accumulate excess reserves following a banking crisis when there is a corresponding inflow of reserves; in the shock effect model, however, banks increase their excess reserves after every banking crisis. Both of these studies provide empirical evidence supporting the importance of expectations in the banks demand functions for excess reserves. Frost (1971) provides an alternative explanation for the large accumulation of excess reserves during the 1930s. In his model, the profit maximising bank has a kinked demand curve. His empirical study shows that all of the parameters in the model increase in absolute value whenever the short-term rate falls below some critical level. He concludes that any regressions run during periods incorporating such low levels for interest rates, should allow for a shift in the coefficients. The more recent work by Tinsley et al (1982) also establishes the importance of monetary policy on banks demand for excess reserves. They use demand specification of the following form:

Excess Reserves = f (own yield, opportunity yield, scale) (1.34)

Most conventional analyses of reserves demand use net deposits as a scale variable (assuming that yields on these deposits are either fixed by regulation or sluggishly adjusted by banks). Furthermore, a unitary elasticity is generally assumed with respect to that scale variable. Tinsley et al (1982), however, assume a smaller scale elasticity (analogous to Baumol - Tobin square root formulae for transactions balances) in their demand for excess reserves. Running their basic equation (where they regress the log of excess reserves divided by the cube root of deposits, to the log of the federal funds rate) over two different periods (1963 (7) to 1968 (8) and 1968 (10) to 1979 (9)) reveals a drop in the funds rate elasticity (from -0.27 to - 0.06) and in the intercept (from 2.28 to 1.34). They attribute these results to changes in Regulation D* that were introduced in September 1968.

Similar asset management models incorporating functions like (1.34) have been used to examine empirically banks' behaviour in countries other than U.S. Knobel's (1977) work on Israel over the period 1961-1968, and Richter and Teigen's (1982) work on West Germany over the period 1960-1980 are two examples.

For the U.K., Crouch (1968) constructed two models of the monetary sector, one with total bank deposits and the other with demand deposits only for the post-war period. In these models bank reserves were determined by the public's currency holdings, open-market operations in securities, and special deposits placed with the Bank of England. There are, however, no empirical studies on banks' excess reserves to deposits ratio. In fact, it is only after 1946 that London clearing banks started to observe an eight per cent minimum cash ratio, and from 1957 onwards a liquid asset ratio of about 28-32 per cent of their deposit liabilities. Crouch (1968) argued that historically banks never did hold reserves over and above the required levels. Even when interest rates were at low levels banks kept their reserves at a minimum. One possible explanation for this behaviour is that banks liquid assets were almost riskless and the transactions costs for these assets were very low. Consequently, even when

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* The introduction of lagged reserve requirements and the liberalization of carry-over provisions being the most significant changes in Regulation D.

the asset 'yield' was very low, it still outweighed the cost of acquiring them.

The first substantial empirical work on U.K. excess reserve ratio was carried out by Howard (1982) for the period 1973-1978. In this study, the demand for the excess reserves-to-deposits ratio- in general form - was.

$$\frac{XR}{D} = f(\frac{D}{P}), \lambda, r_{TB}, r_{LB}, PBMLR, SSD, \frac{CTB}{D}) \qquad (1.35)$$

where

XR = excess reserves over and above required levels

D = total deposits

λ = ratio of demand to total deposits

P = price level

r_{TB} = interest rate on UK Treasury Bills

r_{LD} = the cost to the bank of raising additional funds by borrowing from the non-bank public.

$PBMLR$ = the expected cost to the bank of obtaining funds from the Bank of England

SSD = supplementary special deposits

CTB = liquid asset reserves

For estimation, two stage least squares (2SLS) technique was used. In order to compute the instruments needed for 2SLS regression two types of relationships were used: the demand for currency function and the monetary authorities' policy reaction function.

His results indicated that the reserve ratio is a well defined function of known and observable variables. The obtained estimates show that the demand for cash reserves is interest sensitive, that there are economies of scale in the holding of reserves as real deposits increase, and that U.K. Treasury Bills and certain other bills are substituted for cash reserves. Further, the influence of the ratio of demand deposits to total deposits is not observed directly but through its effects on the interest sensitivity of the banks' demand for excess cash reserves.

Among all these foregoing studies, there are very few which have investigated the stability of the reserve ratio. Richter and Teigen (1982), and Tinsley et al (1982), however, found it to be sensitive to structural changes and that it was necessary to allow for the modifications (arising mainly from monetary policy changes) in order to obtain robust specifications.

CHAPTER TWO

The Econometric Methodology

2.1 Selection of an Appropriate Estimator

2.2 Econometric Technique

In this chapter we discuss what might constitute a 'good approach' to the estimation of money demand and money supply functions. Our discussion will centre on the estimation of money demand, it should be understood, however, that it will also apply to the estimation of cash and reserve ratios.

The chapter is in two sections. The first section deals with the question of what type of estimation will be appropriate. That is, whether or not the application of Ordinary Least Squares, OLS, is valid. The answer depends on whether or not money can be treated as an exogenous or endogenous variable. We have seen in the previous chapter (section 1.3.3) that this issue depends on the reaction function of the monetary authorities. We determine the exogeneity or endogeneity of money in the sample period by carrying out exogeneity tests.

The second section sets out a modelling strategy to be adopted for estimating the money demand function. We discuss the advantages and disadvantages of this approach - General to Specific - vis-a-vis the conventional approach adopted by most of the studies cited in chapter one. A key part of the modelling strategy is that we conduct a list of diagnostic tests on each of the estimated models in order to establish the robustness of the specification.

A further feature of the strategy is that a distinction is automatically made between long run and short run properties of the model. The section ends by a discussion of these properties.

2.1 Selection of an Appropriate Estimator

This section will discuss first the problems associated with and the validity of the 'single-equation' estimation framework in money demand equations. In the second place, a test will be derived in order to check whether the arguments appearing in the money demand functions are exogeneously determined and whether one can in fact use Ordinary Least Squares estimators.

The term exogeneity (of money) was previously defined in terms of the ability of the central bank to control the supply of money (see section 1.3). There, it was noted that if the central bank could control the supply, it was called exogenous; if not, it was called endogenous. If, on the other hand, the authorities peg the interest rate then it is usually asserted that under such control the demand for money determines the behaviour of the stock of money. An alternative view is that under interest rate control, the stock of money is determined in the short run by the demand for net bank credit and that any shock to the demand for bank credit would be accomodated by the banking system. The stock of money would change as a result. In econometrics, however, to say that a variable is exogenous is to say that it is regarded as independent of the influence of the variable whose value it seeks to explain. For example, for money demand functions to be estimated in a single equation framework it is necessary for the arguments appearing in the function to be exogenous with respect to the money supply.

If in fact money supply is endogenous and is dependent upon the variables entering the money demand function then it might not be possible to identify the demand function. For this reason the general relationship that we estimate between money, income, prices and interest rates will in the first instance, be termed 'the money adjustment process' rather than the demand for money. If an OLS regression technique is used to estimate the money adjustment equation in a single equation framework, then it is certainly necessary first to test the exogeneity of the arguments in the function with respect to money stock so that the consistency and efficiency of these estimates can be assessed.

Consider, for example, a dynamic money adjustment equation of the following form:

$$\sigma_1 (L)M_t = \sigma_2(L)\ Y_t + \sigma_3(L)\ r_t + \sigma_4(L)\ P_t + v_t \qquad (2.1)$$

where

$\sigma_i(L)$'s are polynomials in the lag operator L with $\sigma_{10} = 1$ and $L^n X_t = X_{t-n}$

Y = real income

M = nominal money balances

P = price level

r = nominal interest rate

There are two things to check. First, whether money is exogenous with respect to P, Y, and r. If it is, then there will be no reason to estimate a money adjustment equation. If it is not then we come to the next problem of testing whether Y, P, and r are exogenous with respect to M. Engle et al (1983) show that the important criterion for efficient estimation is 'weak exogeneity': "A variable Z_t is said to be weakly exogenous for estimating a set of parameters λ if inference on λ conditional on Z_t involves no loss of information".

They show that in the following over-identified two equation model

$$Y_t = Z_t\beta + \varepsilon_{1t} \qquad (2.1A)$$

$$Z_t = Z_{t-1}\,\delta_1 + Y_{t-1}\,\delta_2 + \varepsilon_{2t} \qquad (2.1B)$$

$$\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad \mathrm{IN}\ (0,\Sigma) \qquad \varepsilon = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{bmatrix}$$

Z_t is weakly exegenous for β if $\sigma_2 = 0$. If in addition to being weakly exogenous, Z_t is not Granger caused (ie $\delta_2 = 0$) then Z_t is defined to be strongly exogenous. They show that the conditional density of Y_t on Z_t can be written as the regression

$$Y_t = bZ_t + c_1 Z_{t-1} + c_2 Y_{t-1} + u_t \qquad (2.1C)$$

$$u_t \quad \mathrm{IN}\ (0,\sigma^2)$$

where $b = \beta + \frac{\sigma 12}{\sigma_{22}}$, $c = \delta i\,\frac{\sigma 12}{\sigma_{22}}$,

$$\sigma^2 = \sigma_{11} - \sigma_{12}{}^2/\,\sigma_{22}$$

If b is the parameter of interest and $\delta_2 \neq 0$ then for OLS to give efficient estimates, the parameters should satisfy the restriction $\delta_1 c_2 = \delta_2 c_1$

If, however, $\delta_2 = 0$ then Z_t will be weakly exogenous.

Following Geweke (1978) consider the following model:

$$H(L) Z_t = e_t \tag{2.2}$$

where Z_t is a vector of random variables arbitrarily partitioned into Y_t and X_t. That is (2.2) can be rewritten as:

$$\begin{pmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{pmatrix} \begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \begin{pmatrix} e_{1t} \\ e_{2t} \end{pmatrix} \tag{2.3}$$

Where $H_{ii} = H_{ii} (L)$

In the context of our model (2.1), Y_t refers to the money stock and X_t to the set of explanatory variables; income, prices and interest rates.

Solving (2.3) for X_t in terms of Y_t and e_t yields

$$X_t = -H_{22}^{-1} H_{21} Y_t + H_{22}^{-1} e_{2t} \tag{2.4}$$

Now if $H_{21} = 0$, then we say that X is determined independently of Y:

$$\left.\begin{aligned} X_t &= H_{22}^{-1} e_{2t} && (2.5) \\ Y_t &= -H_{11}^{-1} H_{12} X_t + H_{11}^{-1} e_{1t} && (2.6) \end{aligned}\right\} (2.7)$$

That is, no present or past values of Y should enter the regression (2.4). Furthermore, X_t is not correlated with e_{1t} but only with e_{2t}.

These results imply that in the dynamic multivariate regression

$$Y_t = M_1(L)X_t + M_2(L) v_t \tag{2.8}$$

if the error term is uncorrelated with every value of X_t then X_t is determined independently of Y.

In the late 1970s similar types of results have been obtained by Wallis (1977) and Granger and Newbold (1974) for autoregressive moving average (ARIMA) models.

Geweke (1978) points out that (2.7) incorporates two further implications of independent determination. Firstly there are no future values of the exogenous variables appearing in the equations. Secondly, no endogenous variables can appear in equation (2.6). Geweke shows that these two implications are equivalent. Furthermore, if, for example, the following equation is estimated directly

$$\varphi_1(L)X_1 = \varphi_2(L)Y_2 + u_t \tag{2.9}$$

the serial correlation can be avoided if the lag operator $\varphi_1(L)$ is kept large enough. For independent determination testing the null hypothesis Ho: $\varphi_2(L) = 0$ is sufficient.

The definitions of independent determination are directly linked to the causality test proposed by Granger (1969). Granger gives a definition of a testable kind of causal ordering based on the notion that if there is no correlation between past values of one variable, say Y, and that part of another variable X which cannot be predicted from X's own part, then this implies absence of causal influence from Y to X. To illustrate his definition of causality he gives an example in a two variable model. Let X_t and Y_t be two stationary time series with zero means. Then his simple causal model will be of the following form:

$$X_t = \sum_{J-1}^{m} a_j X_{t-j} + \sum_{J=1}^{m} b_j Y_{t-j} + e_t \qquad (2.10)$$

$$Y_t = \sum_{J=1}^{m} c_j X_{t-j} \sum_{J=1}^{m} d_j Y_{t-j} + u_t \qquad (2.11)$$

where e_t and u_t are uncorrelated white noise errors. Granger's definition of causality implies that Y_t is causing X_t provided some b_j is not zero. Similarly if some c_j is not zero then X_t is causing Y_t. If both causality events occur, then it is said that there is a feedback relationship between X_t and Y_t.

Pierce and Haugh's (1977) suggestion for testing causality follows directly from the Granger definition. That is, they simply regress a variable on its own past values and then add in past values of another variable. By using a standard F-test it is possible to test whether these past values of the second variable collectively have any significant effect or not. If it is found that the lagged values introduced do have significant effects then it follows that the second variable causes the first one.

Zellner (1978) criticised Pierce and Haugh's bivariate causality tests on the grounds that they restrict the analysis to the investigation of causal patterns existing between two varibles - the problem of omitted variables - hence creating the possibility of 'spurious' causation (i.e. both variables have a common cause). It is sometimes ascertained that this criticism is invalidated by the multivariate framework. This, of course, is not true since multivariate tests may not always be feasable and the possibility of omitted variables will always remain. Other criticisms put forward by Zellner, namely, that of mechanical prefiltering of the actual data series which inadequately renders the series white noise, has been invalidated by Geweke who has shown them to be unnecessary in the Granger tests.

Going back to equation (2.1) the Granger causality of M with respect to X = (Y,r,P) can be tested by using the technique just developed: assuming that no simultaneity exists between Y, P and r, this can be tested in the following regression

$$\begin{pmatrix} Y_t \\ r_t \\ P_t \end{pmatrix} = \begin{pmatrix} B_{11} & B_{12} & B_{13} \\ B_{12} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{pmatrix} \begin{pmatrix} Y_t \\ r_t \\ P_t \end{pmatrix} + \begin{pmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \end{pmatrix} M_t + u_t \qquad (2.12)$$

where $B_{ij} = \sum_{n=1}^{N_1} B_{ijn} L^n$ $\delta i = \sum_{s=0}^{N_2} \delta_{is} L^s$

by testing whether $\delta' = 0$. If one finds that M does not cause M then this would constitute the sufficient condition for

OLS to be used approporately in (2.1). A necessary condition for OLS to produce consistent and efficient estimates is that no simultaneous feedback exists.(*) This can be tested in (2.12) by testing the null hypothesis, H_0 , that

$$\delta_{10} = \delta_{20} = \delta_{30} = 0$$

The acceptance of this test, the absence of simultaneity will produce a recursive model where OLS would be the appropriate technique to use.

It should be emphasised that in the case where simultaneity exists, then Ordinary Least Squares can not be relied upon to yield unbiased estimates of the structural parameters. The ideal alternative, Instrumental Variable estimation has been used by Jonson (1976). But the problem, as usually suggested, is the lack of agreement on what constitutes the true structural model. For the Two-Stage Least Squares estimation technique, the problem is that, as raised by Cooley and Leroy (1981), there is no agreement on what constitutes an acceptable list of exogenous variables.(+)

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*If the off-diagonal elements of the error covariance matrix are non-zero then OLS will provide consistent but inefficient estimates.

+In this thesis we will test for Granger causality and for simultaneity. It should be stressed, however, that a more appropriate test would be the weak-exogeneity test.

2.2 Econometric Technique

In this section we first devise the conventional methodology in estimating demand for money function with its associated problems and advantages. Second, a rather more general approach, which we call 'the General to Specific Methodology' - incorporating the conventional modelling will be outlined. As an illustration of this approach the procedure used in a study by Hendry and Mizon (1978) will be summarized. Finally the implications for short and long-run will be analysed.

The studies we discussed in chapter one all start from a simple theory of individual equations relating current money to current income, price and interest rates. In these studies, lags usually appeared as a result of adjustment mechanism e.g. the partial - adjustment framework. These equations are then estimated and additional variables are added according to the significance of the variables. This procedure might be called 'Simple to Complex' modelling.

In the late 1970s, however, these approaches have been criticized for their uncritical acceptance of imposed a priori parameter restrictions. The problems associated with the conventional technique, paraphrasing Hendry (1980b), are that this method:

1) Commences from theories that are drastic abstractions of reality.

2) Formulates highly restricted models to represent these theories.

3) Estimates equations using techniques that are optimal only on the assumption that the highly restricted model is correctly specified.

4) Tests only few of the assumptions underlying the model.

5) Revises the specification in the light of the evidence acquired.

6) Reestimates accordingly.

Although it is possible to obtain a sensible model from this method, success obviously depends on the thoroughness with which diagnostic checking is pursued and the good fortune of the researchers in adding certain lagged variables rather than others. Accordingly the estimated parameters are highly sensitive to the specification of the error structure and a likely dynamic misspecification is often present in the final model.

There is, however, one advantage that such modelling offers and that is with respect to degrees of freedom. Since the number of observations in any estimation is limited but the number of explanatory variables can be unlimited, one might face problems with available degrees of freedom (for details, see Leamer, 1983). In the case of 'Simple to Complex' modelling, however, such a problem is not encountered at the beginning when the model is at its most restricted (in terms of regressors) stage. This problem can be faced at a later stage when the model is reestimated in the light of evidence acquired in which case the number of additional variables will have to be limited. These probems can be quite serious in a 'General to Specific' modelling which in contrast to the previous approach, starts from a model which is "general" in the sense that it includes lagged values of the variables up to some maximum lag and sequential testing procedures are then used to arrive at a specific, more parsimonous, final specifications. This approach, however, can be shown to be superior to the former when the sample size is large enough.

Based on Coghlan's (1978) demand for money function, Hendry (1980b) highlighted the problems of 'the Simple to Complex' modelling. He, in fact, showed how such a method could account for both superficially acceptable properties and serious dynamic misspecifications. He then went on to examine the properties of the alternative approach 'the General to Specific' modelling.

As an illustration of the superiority of the 'General to Specific' over 'Simple to Complex' let us take Haache's (1974) money demand function:

$$LnM_t{}^* = a_0 + a_1 LnY_t + a_2 LnP_t + a_3 Ln(1 + r_t) + e_{1t} \qquad (2.13)$$

where M^* = desired demand for money

Y = real output

P = price level

r = long term rate of interest

He then assumed a partial adjustment process of actual demand to desired demand. That is:

$$\mathrm{LnM}_t = (1 - \delta)\ (\mathrm{LnM}_t^* - \mathrm{LnM}_{t-1}) + e_{2t} \qquad (2.14)$$

Writing m = LnM, y = LnY, p = LnP, and (1+r) = Ln(1+r); taking first differences and imposing $a_2 = 1$ as Haache did, we obtain;

$$\Delta\ (m-p)_t = b_1\Delta y_t + b_2\Delta(1+r_t) + b_3\Delta(m-p)_{t-1} + v_t \qquad (2.15)$$

Furthermore Haache thought v_t to be autocorrelated. Thus he transformed (2.15):

$$\begin{aligned}(1-\ \rho L)\Delta(m\ -\ p)_t &= b_1(1-\ \rho L)\Delta y_t + b_2(1-\ \rho L)\Delta(1+r_t)\\ &\quad + b_3(1-\ \rho L)\Delta(m-p)_{t-1} + e_t \qquad (2.16)\end{aligned}$$

$$\text{where } (1-\rho L)v_t = e_t \qquad (2.17)$$

Assuming that first differencing and evidence of autocorrelation in the residuals are not due to misspecification, estimation of the equation by OLS with a search procedure for ρ will lead to the optimal estimates for the parameters. Hendry and Mizon (1978) subjected Haache's specification to a test of the autoregressive restrictions where the object of the exercise was to differentiate the systematic dynamics due to the partial adjustment process in (2.14) from the error dynamics as in (2.17), since in (2.16) we do not observe these various dynamics neatly separated out.

To perform this test they generalised (2.13) to a dynamic equation in y and x as:

$$\beta(L)y_t = \delta(L)x_t + \gamma(L)u_t \tag{2.18}$$

$$\rho(L)\ u_t = e_t \tag{2.19}$$

where $\beta(L)$ represent the systematic dynamics derived from prior theory and $\delta(L)$ represent the dynamics of the way in which the exogenous variables affect y_t.

The polynominals are:

$$\beta(L) = \sum_{i=0}^{I} \beta_i L^i, \quad \gamma(L) = \sum_{i=0}^{Q} \gamma_i L^i$$

$$\delta(L) = \sum_{i=0}^{D} \delta_i L^i \quad \rho(L) = \sum_{i=0}^{P} \rho_i L^i$$

(2.18) and (2.19) can then be transformed to an unrestricted equation as:

$$\Psi(L)y_t = \varphi(L)x_t + \gamma(L)e_t \tag{2.20}$$

Take J to be the order of the polynominal $\Psi(L)$ which is allocated in such a way that $P + I = J$. Haache, however, restricted (2.20) to:

$$\rho(L)\ \beta\ (L)\ y_t = \rho(L)\ \delta(L)\ x_t + \gamma(L)\ e_t \tag{2.21}$$

That is, he restricted I = 0 and P = J, i.e. the estimated $\beta(L)$ and $\delta(L)$ polynominals are restricted to have common characteristic roots due to common $\rho(L)$ component on both sides.

Hendry and Mizon point out that if Haache's specification was in fact due to error dynamics rather than systematic dynamics, the $\Psi(L)$ and $\varphi(L)$ polynominals should have common characteristic roots due to the common $\rho(L)$ element on each side. When equation (2.20) was tested for common roots, Hendry and Mizon found they could not reject P = 3 when they tried up to 4th order for the polynominal $\Psi(L)$. Once these common factors were extracted only the systematic dynamics would remain.

Furthermore, they noted that an equation like (2.15) has no long-run solution when we set all the growth rates equal to zero. In view of these observations, they considered a general unrestricted model of the following form:

$$\beta o(L)LnM_t = \beta_1(L)LnY_t + \beta_2(L)Ln(1+r_t) + \beta_3(L)LnP_t + w_t \qquad (2.22)$$

where the $\beta_i(L) = \beta_{i0} + \beta_{i1}(L) + \ldots..+\beta_{im_i}L^{m_i}$ are polynominals in the lag operator L of order m_i respectively with β_{oo} normalised to unity. Such a general structure is capable of modelling many forms of short-run disequilibrium behaviour since any testing is nested within that specification. If the model

(2.13) is denoted as autoregressive distributed lag, ADL(M0, M1, M2, M3) then the conventional short-run dynamics, the partial adjustment of money in the reduced form is in fact a special case of (2.13) with ADL (1,0,0,0). An adaptive expectations of income formulation is another special case of (2.13) with ADL (1,0,1,1).

The model (2.22) can be written as:

$$\psi(L)\ \underline{X}_t = w_t \qquad (2.23)$$

where $\psi(L) = (B_0(L) - B_1(L) - B_2(L) - B_3(L))$ is a vector polynomial in L and $\underline{X}'_t = (M_t\ Y_t\ R_t\ P_t)$.

$R_t = (1 + r_t)$

Having decided (a priori) on the order of the lag operator in (2.23), Hendry and Mizon then went on to test whether (2.23) can be factorized in the following form (by using the COMFAC alogorithms):

$$\rho(L)\ \underline{\alpha}(L)\ X_t = e_t \qquad (2.25)$$

where $\rho(L)$ is a scalar polynominal in L of order n, $\underline{\alpha}(L)$ is a vector polynominal of L or orders $L_0, \ldots\ldots L_i$, such that $m_i = n + L_i$, and e_t in white noise. If, in fact, such a factorisation is valid then $\beta(L)$ in (2.22) is said to have a common factor $\rho(L)$. Once they determined the order of error dynamics $\hat{n}$ and the order of systematic dynamics $\hat{L}$ they then tested for zero roots among the $\hat{n}$ common roots extracted. With this framework they reached a final specification of the following form:

$$\Delta Ln(M/P)_t = \underset{(0.65)}{1.61} + \underset{(0.09)}{0.21} \Delta Ln\, Y_t - \underset{(0.15)}{0.40} \Delta Ln P_t + \underset{(0.31)}{0.81} \Delta Ln\, (1+r_t)$$

$$+ \underset{(0.12)}{0.26} \Delta Ln\, (M_{t-1}/P_t) - \underset{(0.05)}{0.23} Ln(M/PY)_{t-1} - \underset{(0.21)}{0.61}\, Ln\, (1+r)_{t-4}$$

$$+ \underset{(0.04)}{0.14}\, Ln\, Y_{t-4} \qquad (2.25)$$

The functional form of this is to be compared with Haache's specification (2.16). An important feature of (2.25) is that unlike (2.16) it is possible to derive a long-run steady state solution by setting growth rates equal to constants. Equation (2.26) gives the derived long-run demand for money from (2.25).

$$^{M}/_{PY} = k\ (1+r)^{-2.6}\ Y^{0.6}\ \dot{p}^{\,-\,1.7} \qquad (2.26)$$

(where $\dot{p}$ = inflation rate).

Hendry and Mizon conclude that it is possible to derive a stable demand for money function.

There are, of course, some problems associated with this 'General to Specific' modelling. The main ones are:

(1) The intention may not be realised. That is, because the maintained specification is quite general, it might be difficult to reduce it to the special case of the data

generation process which it comprises. Consequently diagnostic testing remains crucial.

(2) Data limitations: the sample size should be large enough so that the errors can be treated as white noise.

(3) There is no uniquely best sequence for simplifying the model (in fact, the COMFAC algorithm discussed above is one among many of these sequences).

(4) It is necessary to control the probability of a Type I error. That is, it is necessary to consider the appropriate choice of a significance level for the individual tests used for simplifying the model.

The problems highlighted the importance of the three principles suggested by Davidson et al (1978) as basis for constructive research:

(1) Any new model should be related to existing models and it should account for previously understood results and also explain some new phenomena.

(2) To be empirically acceptable a model must account for the properties of the data.

(3) A theoretical framework is essential if wrong direction from research and uninterpretable measurements are to be avoided.

On balance and in view of the practical success of Hendry and Mizon's results on money demand, the framework that is used here also falls in the 'General to Specific' strategy. We will now look at this strategy.

As a starting point, the partial adjustment equation will be estimated to provide both a baseline for subsequent comparison and an example of the 'conventional' approach to modelling the demand for money balances. The results obtained will then be discussed and tests will be carried out to check the robustness of that regression. The residual correlogram will then be inspected to see whether it shows any signs of misspecification, (i.e. whether any higher order lags should have been allowed for in the equation).

I will then return to the specification search where a similar framework to the 'General to Specific' modelling is used. In the approach adopted here, a three stage procedure is employed in which:

Firstly, the general unrestricted model, equation (2.22) is estimated. Due to lack of hard evidence about the dynamic short-run behaviour of the economic relationship the order of the lag polynominal in (2.22) is chosen here to be 4, ($\overline{m} = 4$), if the series used are quarterly, and less or equal to 4 if they are annual; in certain cases in fact the sample size dictates this number. The residual correlogram will then be checked to see whether any further lags should have been allowed for in this general specification.

Second, the overall order of dynamics $\hat{m} = \min(m_i)$ is determined by separate t tests on the sequence of hypotheses

$$H_1 : \beta i\bar{m} = 0$$
$$H_2 : \beta_{i\bar{m}} = \beta_{im - 1} = 0$$
$$\vdots$$
$$H_{\bar{m} - m_i} : \beta_{i\bar{m}} = \beta_{im-1} = \ldots\ldots. = \beta_{im_{i+1}} = 0$$

For the F test not to loose power we want to keep the number of restrictions small at each stage. It might, therefore, be necessary to consider the significance level of each individual test. If, for example, X_i is the significance level of the ith test, then that of the jth test against the maintained hypothesis is:

$$1 - \overset{J}{\underset{i = 1}{\pi}} (1 - X_i)$$

Therefore, if X_i is chosen to be a constant level, X, for each of n tests, then the overall significance level of the sequence will be $1 - (1 - X)^n$.

e.g. if there are four test altogether (n = 4), and if each test is conducted at 0.05 significance level (X = 0.05), then this implies an overall significance level of almost 19 per cent:

$$1 - (1 -0.05)^4 = 0.1855$$

The specification of a fairly general maintained hypothesis (i.e. large m), however, may not require each hypothesis to be tested symmetrically. In these circumstances, it would be appropriate to set X_i small with subsequent X_i increasing with i.

As a general rule, we will try to keep the significance levels for individual tests low enough to be able to perform the final F-test at 0.05 significance level. If we encounter no problem at this stage we will carry on to the next stage.

The third stage in our modelling procedure is to test whether each variable should appear in level form or in differenced form.

e.g. if for example the specification obtained from the second stage is

$$Y_t = b_1 X_t + b_2 X_{t-1} + b_3 Y_{t-1} + u_t \qquad (2.27)$$

then, it can be shown that equation (2.27) has lots of restricted versions. One, therefore, needs to specify a search procedure in order to show how one specific form rather than another is derived at.

Two most commonly derived restricted versions of (2.27) are:

$$(2.28)$$

1. $\Delta Y_t = b_1 \Delta X_t + u_t$

2. $\Delta Y_t = b_1 \Delta X_t + (1-b_3)\ (X_{t-1} - Y_{t-1}) + u_t$

Two different restrictions on (2.26) are implied by these latter models. These are:

1. For (2.28) it is necessary to test whether $b_3 = 1$ and

$b_1 = - b_2$ in (2.27).

2. For (2.29) it is necessary to test whether $b_2 = 1-b_1-b_3$ in (2.27).

These tests can be performed with an appropriate F - test for linear restrictions and a likelihood ratio test for non-linear restrictions.

Finally, therefore, it is necessary to test for the possible models that can be derived from the final specification obtained in the second stage.

To implement the above stages, it is necessary to generate a set of test statistics.

Table (2.1) summarises this set of test statistics employed when analysing the robustness of the regression:

$$Y_t = \underline{X}_t \beta + e_t \qquad (2.30)$$

$$t = 1, 2 \ldots\ldots\ldots T$$

where $\underline{X}_t$ will typically contain not only current and lagged values of the regressors but also a constant and lagged values of Y.

TABLE (2.1)

Notation and test statistics

T	is the number of observations used for estimation.
k	is the length of the coefficient vector β.

Estimated standard errors are given in parentheses ( ).

$\hat{e}$	is the estimated residuals in time period t.
$\underset{\sim}{\alpha}$	refers to asymptotic distribution.
$USS = \sum_{t=1}^{T} \hat{e}_t^2$	is the sum of squared residuals
$s = (USS/T-k))$	is the standard error of the regression.
$\hat{r}_s = (\Sigma\hat{e}_t\ \hat{e}_{t-s})/\Sigma\hat{e}_t^2$	is the sth order residual autocorrelation.
ρ	= estimate of first order serial correlation parameter.
DW	is the Durbin and Watson statistics for testing for first order serial correlation in the residuals from a static regression.
h	is the Durbin's (1970) generalisation of DW to dynamic regression. Under H_o: no serial correlation $h \sim N(0, 1)$.
$Z_1(n)$	is the Lagrange Multiplier test statistic proposed by Godfrey (1978) for testing up to nth order serial correlation in the regression residuals, $Z_1(n)$ is calculated as TR^2 where R^2 is

the multiple correlation coefficient from the regression of

$\hat{e}_t$ on $(\hat{e}_{t-1}, \ldots., \hat{e}_{t-n}, \underset{\sim}{X}_t)$

Under H_0: no nth order serial correlation

$Z_1 (n) \underset{\alpha}{\sim} \chi^2_n$

An equivalent test for testing nth order serial correlation would be the F - statistics of the form.

$$\frac{R^2/n}{(1-R^2)/T-k-n} \sim F_{(n,\ T-k-n)}$$

where k is the number of variables in the original regression.

$Z_2(h)$ is the White (1980) test statistic for testing heteroskedasticity. It is calculated as

$Z_2(h) = TR^2_k$ where R^2_k is the multiple correlation coefficient from the regression of $\hat{e}_t{}^2$ on $(\Psi_{1t}, \Psi_{2t}, \ldots.,\Psi_{ht})$.

where

$\Psi st = X_{it}\ X_{jt}$; $s = 1, 2, \ldots, h$; $i, j = 1, 2 \ldots., k$;

$h = \frac{k(k+1)}{2}$

Sometimes a subset of X_t vector is used (e.g. if for example there are lagged values of the regressors, then the test is applied for testing heteroskedasiticity only among the current values.)

Under H_0: no heteroskedasticity, $Z_2\,(h) \underset{\alpha}{\sim} X_h^{\ 2}$

$Z_3(h)$ is the post-estimation diagnostic test for predictive failure over the last h observations. It is constructed as:

$$\frac{1}{S_1^2} \sum_{t=n}^{T} (\hat{Y}_t - Y_t)^2$$

where s_1 = standard error of the regression estimated over the first n observations.

$\hat{Y}_t$ are the predicted values of Y_t. $h = T - n$.

Under H_0 : good predictability, $Z_3\,(h) \underset{\alpha}{\sim} {}_h^{\ 2}$

$Z_4(k,T\text{-}2K)$ is the Chow (1960) test for stability of the β vector over two sub-periods of the sample period. It is constructed as:

$$Z_4(k,T\text{-}2K) = \left(\frac{S}{S_1 + S_2} - 1\right) \frac{(T - 2k)}{k}$$

where S_1 and S_2 are the sum of squared residuals from the two sub-period regressions. Under H_0 : no instability between the two sub-periods

$$Ƶ_4(k,T-2K) \sim F_{(k,T-2k)}$$

$Ƶ_5(r,T-k)$ is the test of the imposition of r linear restrictions on β. It is constructed as:

$$Ƶ_5(r,T-k) = \left(\frac{SR}{USS}-1\right)\left(\frac{T-k}{r}\right)$$

where S_R is the sum of squared residuals from the restricted regression.

Under H_0: restrictions are true,

$$Ƶ_5(r,T-k) \sim F_{(r,T-K)}.$$

$Ƶ_6(h1,h2)$ is the test statistic for testing whether the variances of the residuals are equal over two sub-periods $(n_1 - k)$ and $(n_2 - k)$ of the sample period.

It is constructed as

$$\frac{S_1^2}{S_2^2}$$

where S_1^2, S_2^2 are the residual variances of sub-periods 1 and 2 respectively

Under H_0: $S_1^1 = S_2^2$, $Ƶ_6(h_1,h_2) \sim F(n_1-k,\ n_2-k)$

$Ƶ_7(r)$ is the likelihood ratio test of the imposition of r non-linear restrictions on β. It is constructed as:

$Ƶ_7(r) = T \text{ Ln } \frac{SR}{USS}$ Under H_0 : restrictions are true

$$Ƶ_7(r) \underset{\alpha}{\sim} \chi_r^2$$

It is intended here, as suggested by Spanos (1983), that the temporal dependency information in the residuals - autoregressive or moving average type - will be modelled directly in terms of the observable random variables $\underline{X}_t$ in a way which leaves the errors white noise. In fact, this is tested with the above mentioned test statistics. Specifically, whether conditional on m, the factorisation $\rho(L)\ \alpha(L) = \Psi(L)$ is a possible route from the final specification obtained at the end of stage two, is tested with the test statistic Z_7. Once the parsimonious specification is reached and the above mentioned test statistics are employed to test its robustness, the resulting steady state solution is then obtained. This is done by noting that in such a state:

$X_t = X_{t-s}$ for all s.

Thus re-writing (2.22) as:

$$(\sum_{j=0}^{m_0} B_{0j}) \text{ Ln } M_t = (\sum_{j=0}^{m_1} B_{ij}) \text{ Ln} Y_t + (\sum_{j=0}^{m_2} B_{2j}) \text{Ln } (1+r_t)$$

$$+ (\sum_{j=0}^{m_3} B_{3j}) \text{ Ln } P_t \qquad (2.31)$$

(with $w_t = 0$)

or:

$$\text{Ln } M_t = \lambda_1 \text{ Ln } Y_t + \lambda_2 \text{ Ln } (1+r_t) + \lambda_3 \text{ Ln } P_t \qquad (2.32)$$

where the

$$\lambda_i = \frac{\sum_{j=0}^{M_i} d\ \beta_{ij}}{\sum_{j=0}^{M_0} \beta_{oj}}$$

are the long-run elasticities

of the demand for money with respect to Y, (1+r) and P respectively.

Currie (1981) refers to these steady-rate properties of such models as the 'static' long-run properties. He explains that the 'dynamic' long-run properties can be obtained if it is further assumed that a variable in period t-j is equal to the value of the variable in period t minus j times its trend rate of growth i.e.

$$X_{t-j} = X_t - j\,\pi_0 \quad \text{where } \pi_0 = \Delta X$$

and since all variables are in logarithms, the π's are interpreted as rates of growth.

He then argues that when dynamic long-run properties of these models do exist, it is not surprising to find that they are not typically sensible or well-determined as opposed to static long-run properties. He puts forward two reasons for this paradox. Firstly, the available time series could be too short for estimating relationships that are subject to periodic structural change. Secondly, he argues that if such properties are exploited by government policy, they may well then change as private sector behaviour adapts.

Currie shows the unreliability of the coefficients on the growth rates for two major money demand studies: the demand for money demand for money (M1) study by Coghlan (1978) and that by Hendry and Mizon (1978). For both of these models he shows the estimates for the growth rates to vary considerably as the estimation period is changed. In certain cases, Currie argues these results are due to dynamic misspecificiation from imposing the non-linear constraints (especially when Type II error is made).

He concludes however that if long-run dynamic effects are expected from the standard economic theory then these should be calculated even if these effects appear insignificant since these may be useful in a simulation exercise. If, however, the sign and magnitude of these long-run effects are inconsistent with the standard economic theory, he suggests that the model builder may constrain these effects to zero if the theoretical considerations do not provide any basis for dynamic effect.

As a result, following Currie, we will obtain the dynamic steady-state elasticities and then calculate how long (i.e. how many periods - years, quarters, months) it takes to reach the steady-state.

CHAPTER THREE

Data and Historical Survey

This chapter deals with the data used in the thesis. It is in three sections, each devoted to a description of the data for the major variables in each sub-period.

The first section analyses the main features of the data over the pre World War One period. First, the data and their sources are given. Second, the main features of the series are summarized. And finally, the behaviour of the major series is shown graphically and an outline of the main events of the period given.

The following two sections repeat the exercise for the other two sub-periods, the interwar and post World War Two periods.

3.1 The Pre World War One Period: 1871-1913

Table 3.1 presents a list of all the data series, along with their sources, used over the period 1871-1913. That is followed by descriptive statistics for these series. In the second section, an analyses is made of the major variables together with some illustrative figures. In doing so, the main events of the period will be outlined.

3.1.1 Choice of Data: 1871-1913

Table (3.1) presents the list of data series for this period, along with their sources. The series for money supply, currency and reserve ratios are derived from the Data Archive[a]. Some of the data used in this thesis for the period 1871-1913 do not correspond exactly with the published data (see Capie and Webber, 1985). This is because the published series have been updated with more archive material which became available more recently. The refinements are, however, marginal.

All the variables are annual averages. The money supply series, M2, consists of notes and coin in circulation with the non-bank public, plus sterling current accounts held by the private sector only (i.e. current accounts of all private sector residents denominated in sterling and excluding those held by the public overseas sectors), plus time deposit accounts of private sector

[a] At the Centre for the Study of Monetary History. This data base has been created as part of the Monetary History Project at the City University, Centre for Banking and International Finance. The project was made possible by a grant form the Economic Social Research Council.

TABLE (3.1)

Data Sources: 1871-1913

M = M2 series
Source: Centre for the Study of Monetary History Data Archive, 1983.

CD = Currency to Total Deposits Ratio
Source: Centre for the Study of Monetary History Data Archive, 1983.

RD = Reserves to Total Deposits Ratio
Source: Centre for the Study of Monetary History Data Archive, 1983.

Y = Gross National Product, GNP.
GNP at constant factor cost.
Source: Feinstein (1972), Table 7, T21 Column (7).

P = Gross National Product deflator.
This series is calculated by dividing GNP at factor cost by GNP at constant factor cost.
Source: for GNP at factor cost Feinstein (1972), Table 2, T8, column (10).

cr = The yield on $2\frac{1}{2}$ per cent Consols
Source: Capie and Webber (1985), Table III (10) Column (VIII).

bbr = Prime Bank Bill rate
Source: Capie and Webber (1985), Table III (10) Column (V).

tdr = Interest on Deposit Accounts
Source: Capie and Webber (1985), Table III (10) Column (VII).

br = Bank Rate
Source: Capie and Webber (1985), Table III (10) Column (I).

F = Bank failure rate = the proportion of total number of banks that failed during the year.
$F^* = (I-F)$ = bank safety index.
Source: Centre for the Study of Monetary History Data Archive 1983.

U.K. residents with deposit banks and with the discount houses. For this period it is not possible to separate current accounts from deposit accounts. We therefore work only with the broader definition of money. The current official definitions of money used by the Bank of England, M3, sterling M3, PSL1, PSL2, are still broader than our M2. M3 for example, includes time deposits with the accepting houses, overseas banks and other banks. It also includes residents' foreign currency deposits. Our definition then is the narrowest definition of money possible for this period. Only for years after World War One are data on a narrower definition of money available.

The currency to total deposits ratio refers to currency in the hands of the non-domestic bank public divided by banks' net deposits plus other deposits at the Bank of England (allowing for transit items).

The reserve to total deposits ratio refers to reserves of the commercial banks (including the notes and coin held in the Banking Department of the Bank of England) divided by banks' net deposits plus other deposits at the Bank of England (allowing for transit items).

The data on Gross National Product and its deflator are constructed from data on final expenditure at current market prices. The series in this case are chosen for conformity with other empirical studies (see Table (1.4), section 1.2) so that direct comparison of the results can be made.

The yield on 2½ per cent Consols is chosen to represent the long term rate. During the nineteenth century and until the outbreak of World War One, Consols comprised a very large part of the National Debt. These Consols had no maturity but were redeemable at par at the discretion of the government after some specified interval following their first issue. Between 1888 and 1913 these Consols refer to 2½ per cent Consolidated Bank Annuities. Between 1870 and 1888, however, Gladstone's 2½ per cent Consols did not comprise a significant proportion of National Debt; we, therefore, chose the rate on 3 per cent Consols as representative of the long term rate of interest for the period 1870-1888.

Prime Bank Bills are bills drawn on and accepted by a U.K. bank of unquestioned financial standing. These were readily saleable in the London Market. At the beginning of the period (1870s) bills of exchange would probably have been a better representation of the short rate, but since these were disappearing from the market over the course of these years we use the Bank Bill rate instead.

The deposit Rate refers to the rate on London clearing banks' deposit accounts (7-days notice) or the rate paid on ordinary deposit accounts.

The Bank Rate is the rate of interest at which the Bank of England would lend to the banking system - in effect, the Rate at which it discounted first class bills. From the 1890s, Bank Rate was regarded as a penalty rate, generally in excess of market rates.

Finally, the bank failure rate has been calculated as the proportion of banks that failed in each year. A failure refers to bankruptcy, suspension of payments or take-over since the reasons for the latter are not given explicitly in the 'Economist', the major source for the series.

Table (3.2) gives some descriptive statistics for the series. In later modelling work, most of these series are transformed logarithmically. However, this transformation imposes a constant elasticity which is unsuitable for interest rates. In this case we have taken the logarithm of (one+the rate) rather than the rate itself.

3.1.2 An examination of the variables in the period 1871-1913

For the world economy, the period 1871-1913 can be characterised as years of rapid growth. World trade as a whole grew rapidly over this period. The commanding position of Britain in the world economy was being threatened progressively by the industrialisation of other countries, especially by that of USA, and Germany. Another characteristic of the period is the financial instability experienced by the rapidly developing countries. The banking crises of 1873, 1884, 1890 and 1893 in the US, and the major banking collapse of the 1890's in Australia are just a few examples. There were also political troubles in Germany and the threat of war between Spain and the USA.

In spite of these difficulties in the outside world, a prominent feature of British economy is its stability often attibuted to

TABLE (3.2)

Descriptive Statistics of the Variables: 1871-1913

Variable	Mean	Standard Deviation	Coefficient of Variation
M	767361[(a)]	169251	0.22
CD	0.17	0.04	0.25
RD	0.10	0.01	0.10
Y	68.8[(b)]	16.28	0.24
P	93.4[(c)]	5.9	0.06
cr	2.94%	0.23	0.08
bbr	2.78%	0.88	0.31
tdr	2.72%	1.1	0.40
br	4.1%	1.2	0.29

(a) thousands of pounds

(b) Gross National Product at constant factor cost,1913 = 100

(c) Gross National Product deflator, 1913 - 100 the gold standard regime. The years from 1871 until the outbreak of World War I are often referred to as the 'Classical Gold Standard' period. By 1879 most industrial countries - Germany, the Netherlands, Switzerland and Belgium, Britain, the US, and, de facto, the British Empire - had effectively moved to the Gold Standard. The main exceptions were Japan, India, Russia and Austria-Hungary. These too, however, joined the rest of the economic world on gold by 1895. In fact, by 1900 this regime became worldwide and persisted until 1914 although Italy abandoned the gold standard during the final decade of the nineteenth century. During these years of 'Classical Gold Standard', the UK economy was free of any major financial uncertainty or crisis. The last major financial crisis was in 1866 when the major discound house Overend, Gurney and Company Ltd. failed. After this crisis, the economic stability of the period improved as the century neared its end. The liquidation of Baring Bros in 1890's did not result in any financial panic since they were saved by prompt action of the Bank of England. Thenceforth the lender of Last Resort facilities of the Bank of England provided greater protection against financial crises.

The classical analysis of the working of the gold standard was best outlined in the Cunliffe Committee Report (1918) where two essential conditions were emphasised - free convertibility of Bank of England notes into gold and vice versa, and free importation and exportation of gold across national borders:

> "When the exchanges were favourable, gold flowed freely into this country and an increase of legal tender money accompanied the development of trade. When the balance of trade was unfavourable, and the exchanges were adverse, it became profitable to export gold. The would be exporter bought his gold from the Bank of England and paid for it by

> cheque on his account. The Bank obtained the gold from the Issue Department in exchange for notes taken out of its banking reserve with the result that its liabilities to depositors and its banking reserve were reduced by an equal amount and the ratio of reserves to liabilities consequently fell. If the process were repeated sufficiently to reduce the ratio on a degree considerably dangerous, the Bank raised its rate of discount. The raising of the discount rate had the immediate effect of retaining money here". (Cunliffe Committee Report, 1918, para.4).

Three adjustment mechanisms are often given credit for the stability and smooth operations of the gold standard regime as an international standard.

First, there is the price-specie flow mechanism. Here changes in relative price levels or price differentials only occur as a result of changes in money supply which, in turn, are brought about by trade imbalances. Trade imbalances would lead to gold flows and would therefore change the money supply. These changes would then bring prices changes. The relative price changes would in return alter the international flow of goods and services in such a way that the orginal trade imbalances would be eliminated. The price-specie flow mechanism is based on the notion that arbitrage in one commodity - gold - ensured price level conformity.

The second mechanism is based on the role of short-term capital flows. In this case if there is a trade imbalance the resulting gold flows generate interest rate differentials. These then initiate capital flows in the opposite direction to the trade imbalance.

The third mechanism is based on the notion that gold has unique qualities both as a standard of value and medium of exchange. This means that gold standard was an ideal standard not just internationally but also domestically. This brings us to the stability provided by gold as a domestic standard. This stability was brought about on the one hand by the guarantee from the authorities of free convertibility of gold into non gold money and on the other, by the assurance that the new production would only add a small fraction to the accumulated stock (See for details Bordo, 1981; and Bordo, 1984).

In fact the classical gold standard provided a long-run price stability that was never to be experienced after World War I.

As Bordo (1981) pointed out:

> "The period since World War I has not been characterized by price stability except for the 1920s and early 1960s under the Bretton Woods System... Examining the deviations from trend suggests that real per capita income was less variable in the pre-World War One than subsequently...Moreover unemployment was on average lower in the pre-1914 period than in the post World War I period."

In term of its <u>output</u>, Britain's growth rate was lower after the 1873 peak than during the previous 20 years of the 'Great Victorian Boom' period. Figure (3.1) shows the behaviour of GNP in real terms. Over the period it grew by about 115 per cent or by 1.7 per cent in annual terms. Compared to the USA, France, Germany, Italy, Sweden and Japan, Britain's growth rate (GDP per capita) was on average about one per cent lower. (For a detailed discussion, see Matthews, et al, 1982.)

Analogous to the performance in the growth of its output, Britain's position in international trade was also weakened as a result of the growth of foreign competition. (For details, see harley and McCloskey, 1982.) Despite the relatively poor performance in world trade, Britain was still providing over 25 per cent of world trade in manufactured goods, its foreign investment was still the world's largest, and London remained as the world's major money market throughout this pre-World War One era.

What are the implications of the gold standard - fixed exchange rate regime - years for the money supply. It is sometimes argued that under fixed exchange rates, countries can have little influence over their money supply (i.e. base money is determined by the balance of payments). The supply of money adjusts to the demand for money which depends on the country's income, prices and interest rates determined in the world markets (see for example, McCloskey and Zecher, 1976). This implies that money is endogenous and tied to the world economy. The inability of the government to influence the money stock is further stressed in their more recent article (McCloskey and Zecher, 1984). "...And if purchasing-power parity does apply, then the central Bank can have only a neutral effect on the economy. The Bank would be free to push the general price level up or down, but could not alter relative prices, pegged by world markets..., if governments bind themselves to a fixed exchange rate, they can not even have a neutral influence on prices."

The implied endogeneity of the quantity of money in a world of fixed exchange rates in the long-run is not a subject of controversy. In the short-run, however, it is usually claimed that "there can be and is much leeway...before the external forces overwhelm the independent internal effects. And we have repeatedly been surprised in our studies by how much leeway there is and for how long - frequently a number of years..." (Friedman, 1984).

Another implication of fixed exchange rates is with respect to domestic policy. According to the "rules of the game" central banks had to reinforce the effects of payment imbalances on the domestic economy either by not offsetting the effects of reserve changes or by varying the money supply directly and the discount rate indirectly with reserve changes. Whether the Bank did follow these rules is a matter of controversy. According to Ford (1962) and Bloomfield (1959), for example, the Bank did not engage in countercyclical policy and refrain from accommodating changes in the level of domestic incomes. At the other end, there are those who believe that the Bank did violate some rules over time either due to profit motives (Pippenger, 1984) or due to the needs of the domestic economy (Dutton, 1984) or even to protect its own share of the London money market in the face of the growth of London clearing banks (Goodhart, 1984). As a result, there was an inherent conflict in the Bank's operations.

If it was acting as a profit-maximising commercial bank, it would maintain as low a gold reserve as possible. On the other hand, it would use the Bank rate in order to regulate gold flows. Under a fixed-exchange-rate system, the Bank Rate is tied to those in the rest of the world. In the short run however, some control or influence by the Bank of England on the Bank Rate can be exerted. (Goodhart, 1984).

Figure (3.4) depicts the movements in Bank rate. The representative long rate, the Consol rate, as shown in figure (3.5), has a similar pattern to that of Bank rate but with less fluctuation. There is a definite downward trend from 1877 to 1897, but from 1897 onwards the trend is upward, reaching by 1912 the same rate as it began with. The frequent fluctuations in Bank rate show how much the Bank of England must have operated on it in order to check runs on reserves. These movements in the Bank's rate of discount are thought to have repurcussions on prices in general. That is, to quote Ford (1962)

> "a drain of gold was corrected by a rise in interest rates which attracted short-term funds in the short-run, and which in the long-run checked domestic investment and thereby lowered prices causing equilibrating movements in the balance of trade".

Under the gold standard, Britain's output and prices are tied to world output and prices. Figure (3.2) shows the movement in the GNP deflator over the period as a whole. From 1873 until 1896 there is a clear downward turn, but from there onwards the trend is an upward one. Quantity theorists assert that the growth rate in money supply in relation to the course of economic activity provides the explanation of the movement in prices over the gold standard years. That is, monetary growth was deficient in relation to output between 1873 and 1896, and prices therefore fell by about 20 per cent. From 1892 to 1913, on the other hand, monetary growth was excessive in relation to output, prices therefore increased by about 18 per cent (See Capie and Rodrik - Bali, 1983, for a detailed discussion).

The behaviour of money supply - M2 - is shown in figure (3.3). Over the period on a whole, it grew by about 108 per cent - in annual terms by 1.7 per cent.

We noted above that under the gold standard the course of the monetary base and therefore that of the money supply, would depend on the balance of payments. That is, the changes in the base are not directly the result of decisions by the Central Bank. They are determined by the balance of payments, inflows of funds increasing the base and outflows decreasing it. The monetary authorities, nevertheless can influence in the short run the behaviour of the base by acting on gold and capital flows (for details, see chapter one, Section 1.3). The fact that the relationship between high-powered money and the cycle is not very strong over the period as a whole - especially after the 1880's might be an indication that the monetary authorities did influence the movement of funds. That is, under the gold standard it could be argued that in the downswing of the cycle with a surplus anticipated (as import growth slows) monetary base should grow. And the opposite should happen in the upswing of the cycle. We, however, could not find such a close relationship between the base and the cycle. (For details see Capie and Rodrik-Bali, 1983).

The fact that money was endogenous and tied to world money supply implies that there should be offsetting movements between the base and money multiplier components. If, for example, the currency ratio rises, this will reduce the money supply which will then reduce UK prices. Gold will flow into the country, increasing base money. This rise in monetary base will then increase the money supply bringing it back to its initial level.

Over the period as a whole, the base did not grow as rapidly as M2. From 1871 to 1913 it grew by 81 per cent leaving the multiplier to explain the rest of the 108 per cent growth in M2. Figures (3.6) and (3.7) depict the movement in the components of the money multiplier. Of these two components it is mainly the currency ratio that varied over the period. The behaviour of the currency ratio examined over the course of the business cycle shows that in the five downswings the ratio fell but in the upswings it fell by a greater amount (For details, see Capie and Rodrik-Bali, 1983).

The currency ratio was above 25 per cent at the beginning of the period and gradually declined to just over 10 per cent towards the end of the period. The spread of banking and the increasing proportion of the population that became familiar with the banking system are the main reasons behind this downward movement in the ratio.

The reserve ratio, on the other hand, after some initial erratic behaviour fluctuated about a gradually rising level. There were no legal requirements on this ratio and the variation from bank to bank could be quite considerable. Again an examination of its behaviour over the course of the business cycle found that the reserve ratio grew in every downswing and fell in every upswing. (For details, see Capie and Rodrik-Bali, 1983).

For the system as a whole, this ratio fluctuated on a rising trend between 9 and 13 per cent. One explanation for such behaviour is the increasing number of published bank accounts: that is, the need to publish bank accounts in itself provided an incentive for the banks to keep large reserves in relation to their deposits. There was also a widespread feeling that higher reserves should be held.

Over this period there was a large amalgamation movement going on. Most of the small banks were either going out of business or being taken over by others. There were also large mergers between big banks. These movements might have some effect on the components of the money multiplier. If individuals' confidence is threatened by a large number of banks failing, then this will induce them to switch from deposits to currency. Similarly if banks are trying to restore the public's confidence they will have to increase their reserves in order to do so. The 'bank failure 'variable is constructed so as to analyse these movements on the components of money multiplier. It should be emphasized that over this period this movement was not a smooth one in that there were years (e.g. 1873, 1906...) when there were actually no disappearances and there were years (e.g. 1878, 1894, 1901...) when almost five per cent of banks went bankrupt.

Figure (3.1)

GNP at constant prices, 1871 - 1913, annual (1913 = 100)

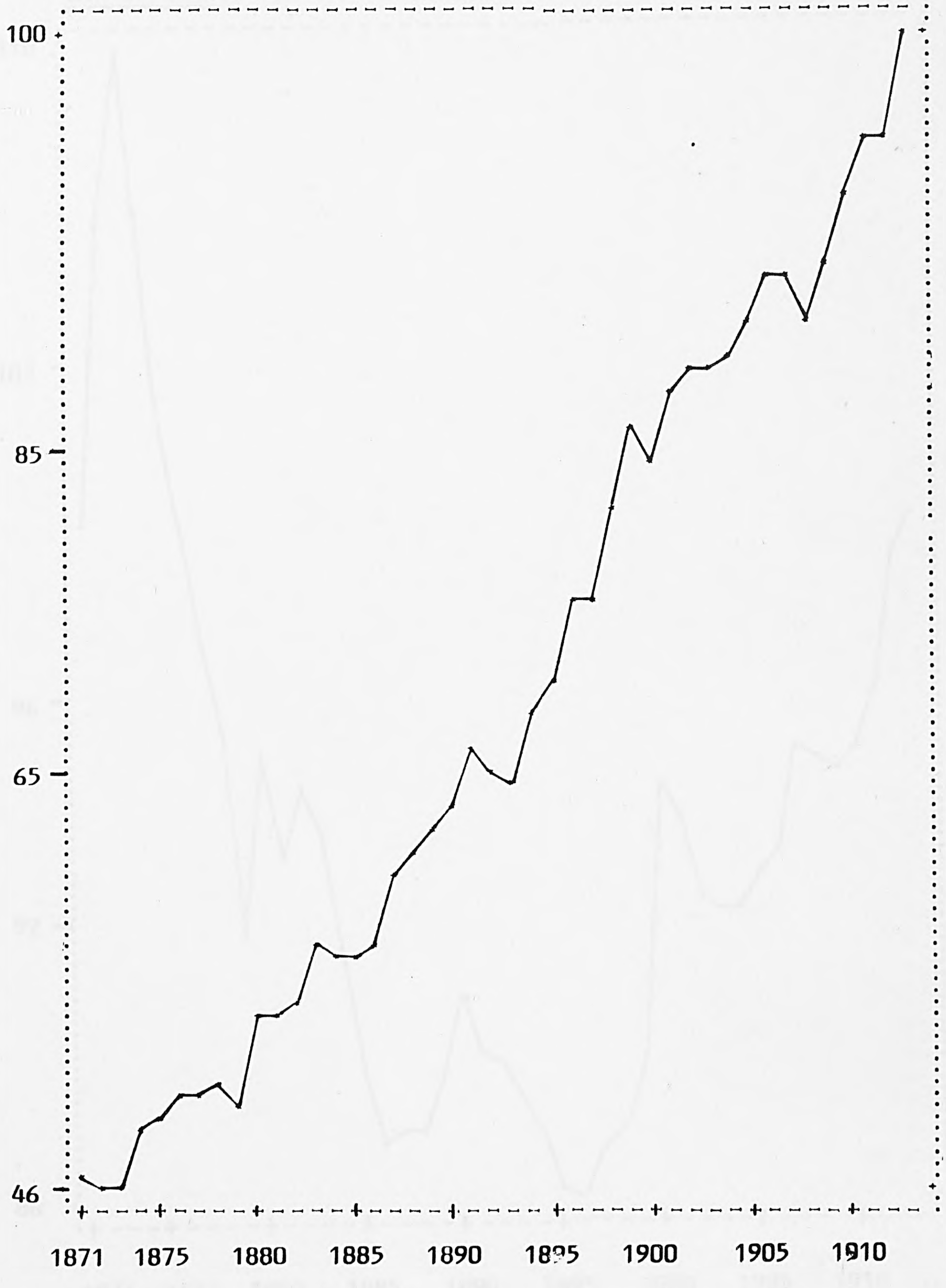


Figure (3.2)

GNP deflator, 1871 - 1913, annual (1913 = 100)

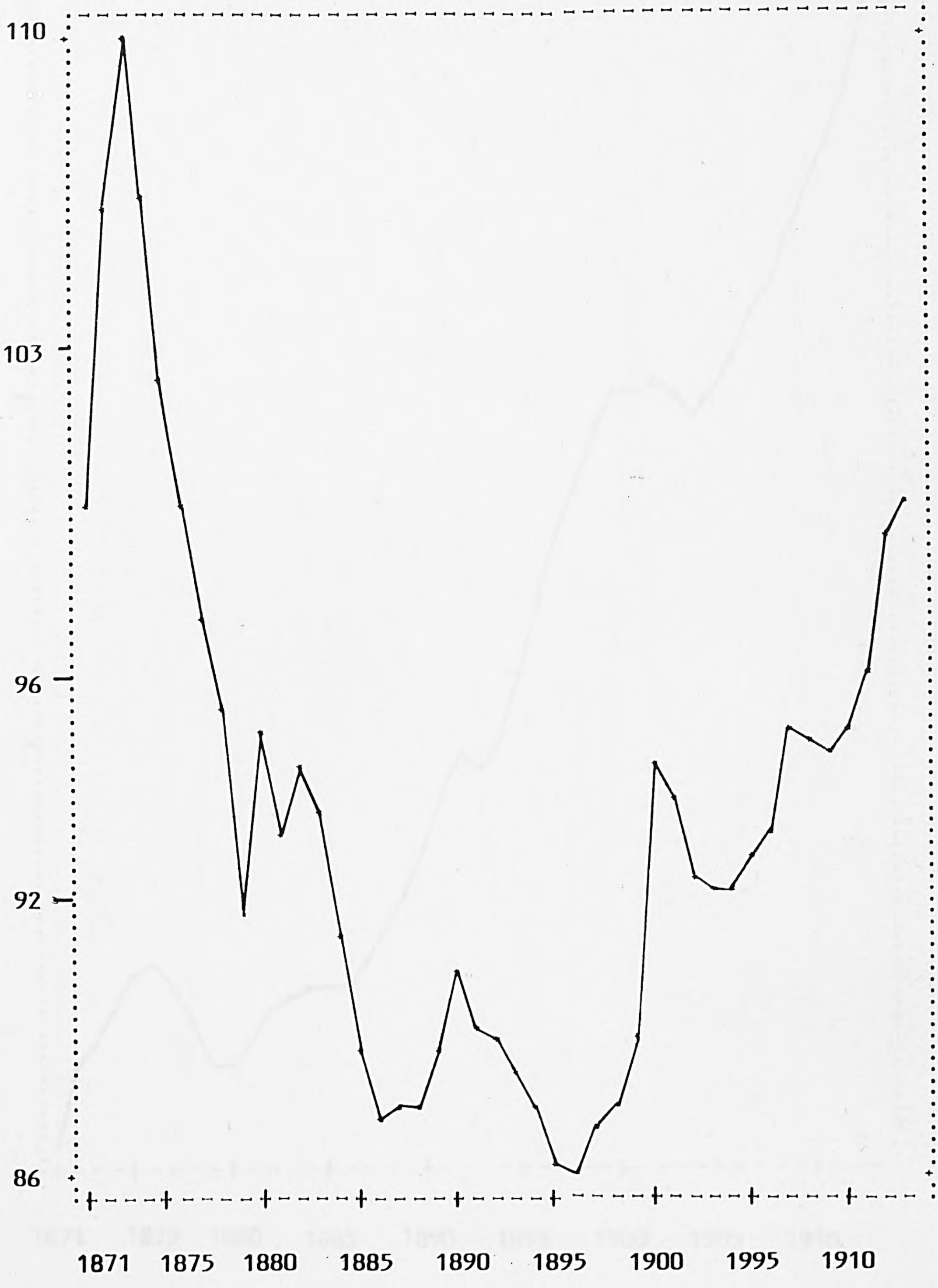


Figure (3.3)

Money Supply, M2, 1871 - 1913, annual , (£000,000's)

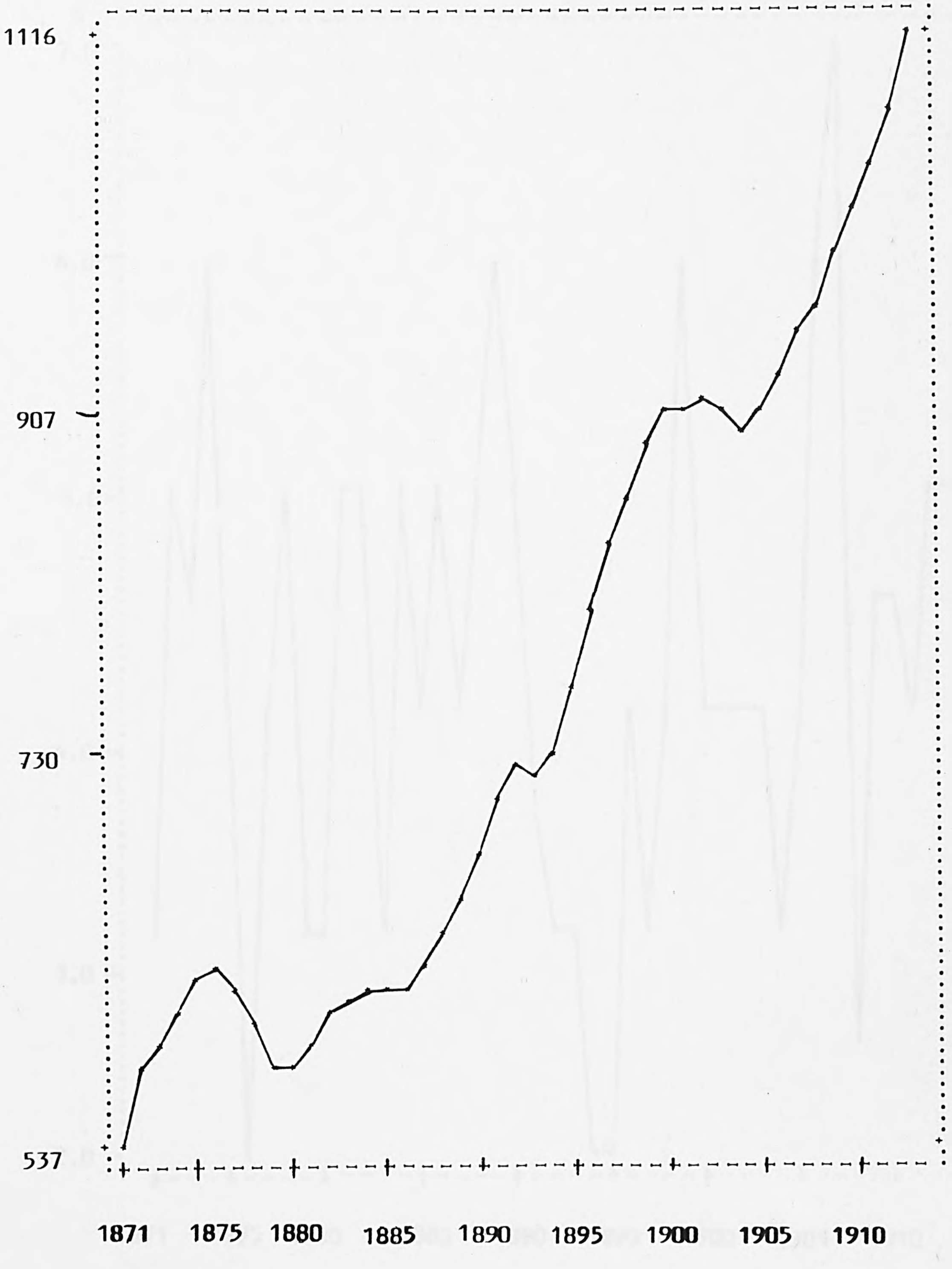


Figure (3.4)

Bank Rate, 1871 - 1913, annual

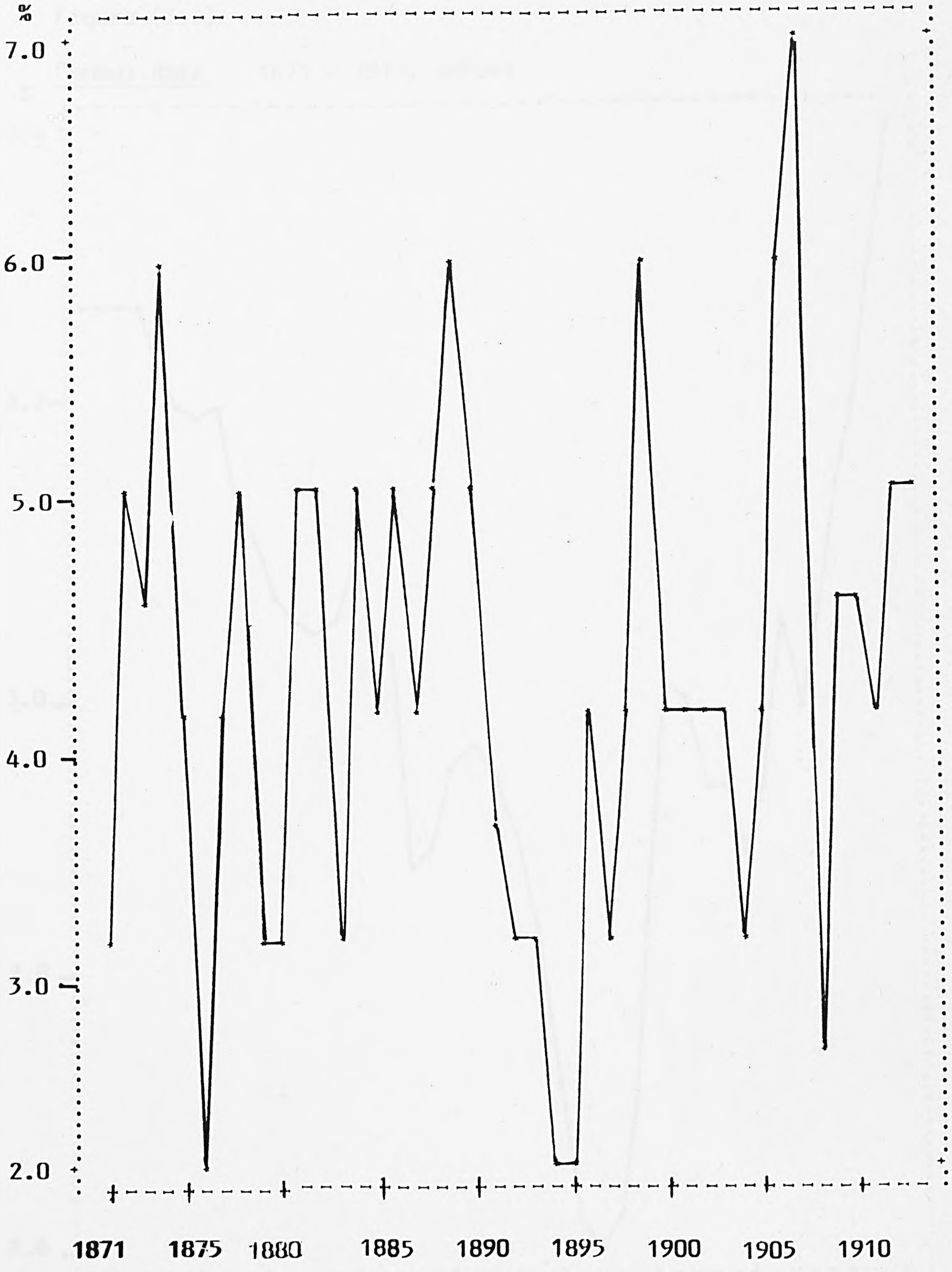


Figure (3.5)

Consol Rate 1871 - 1913, annual

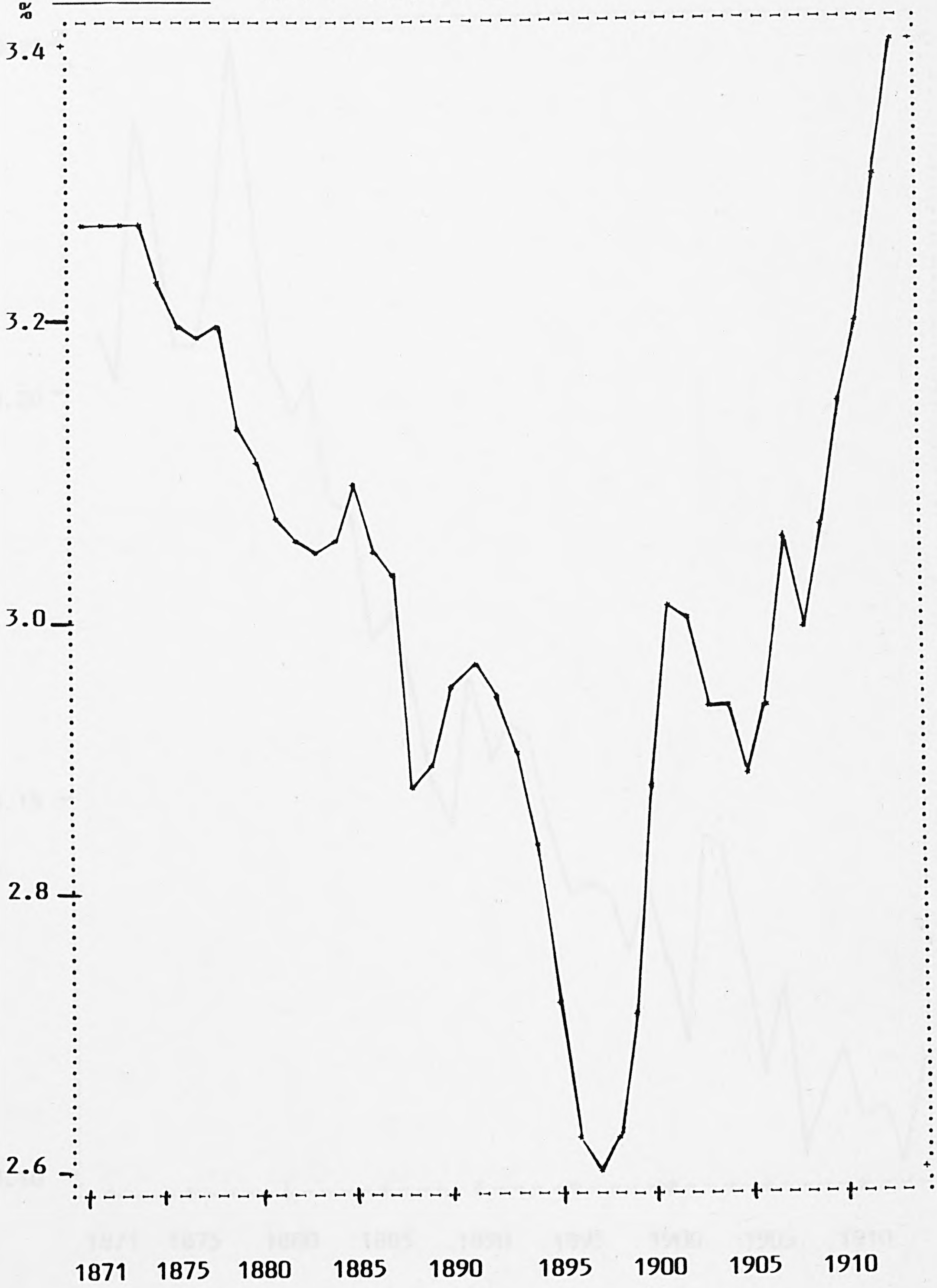


Figure (3.6)

Currency to Total Deposits Ratio, 1871 - 1913, annual

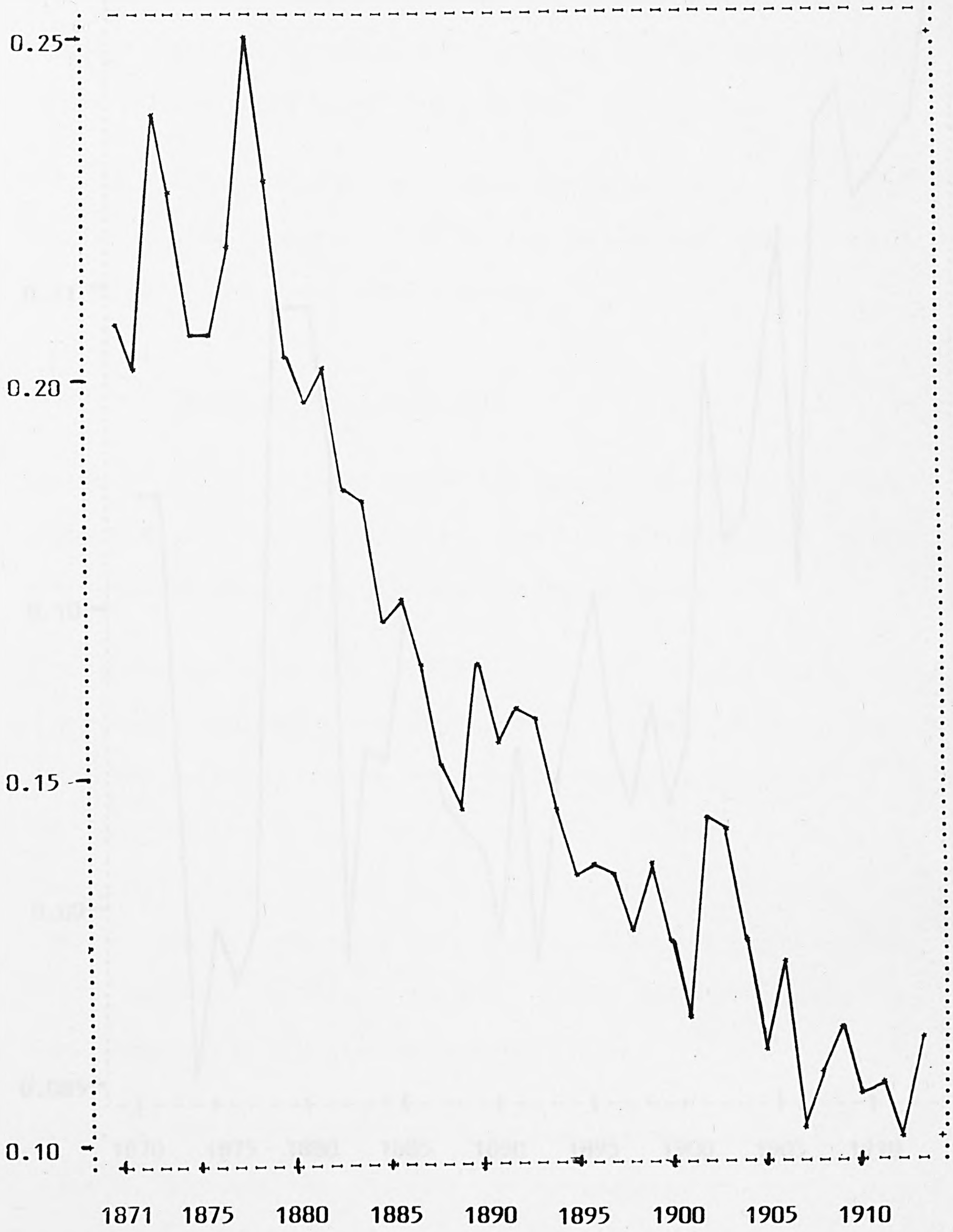
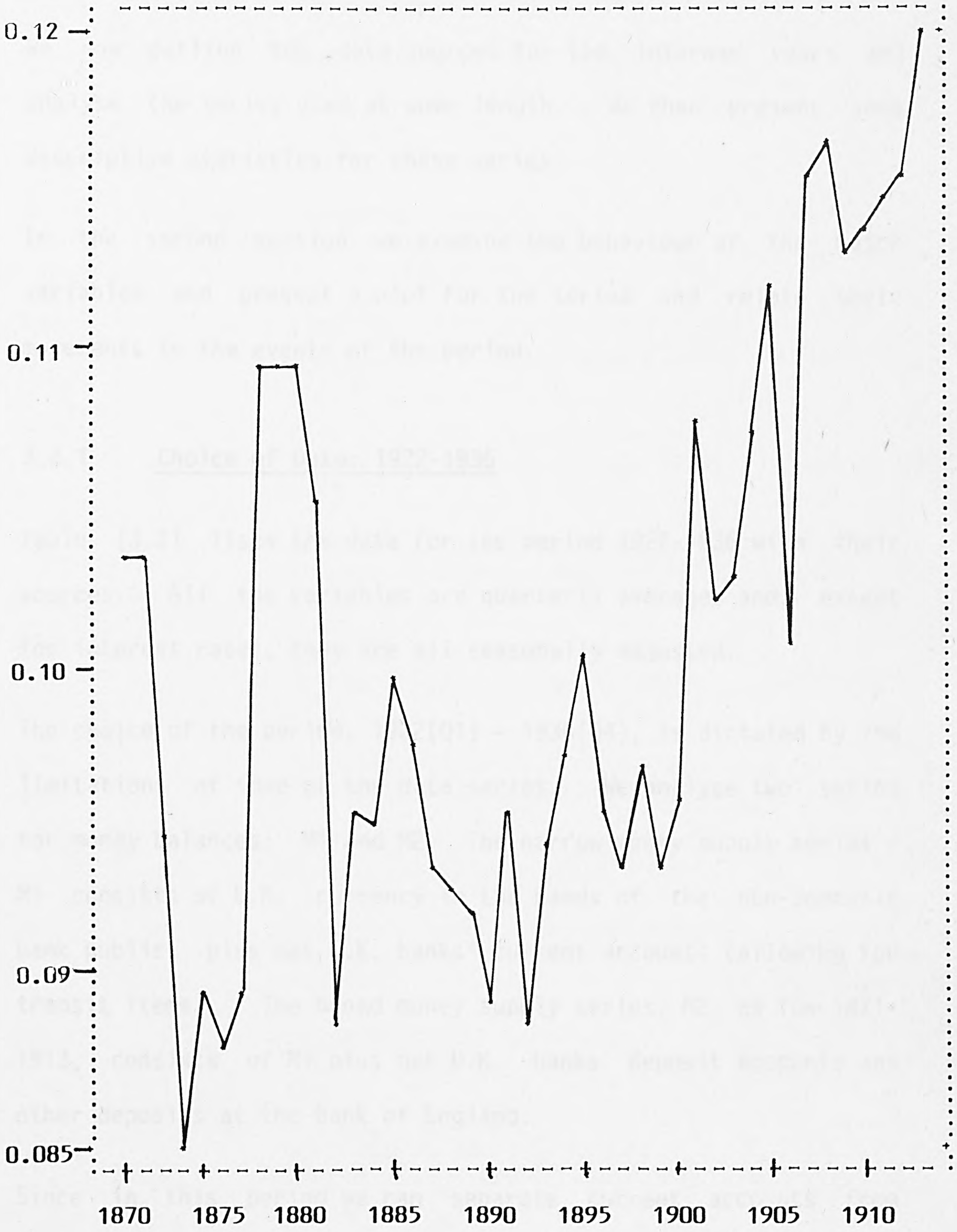


Figure (3.7)

Reserve to Total Deposits Ratio, 1871 - 1913, annual



3.2 The Interwar Years

We now outline the data sources for the interwar years and analyse the series used at some length. We then present some descriptive statistics for these series.

In the second section we examine the behaviour of the major variables and present a plot for the series and relate their movements to the events of the period.

3.2.1 Choice of Data: 1922-1936

Table (3.3) lists the data for the period 1922-1936 with their sources. All the variables are quarterly averages and, except for interest rates, they are all seasonally adjusted.

The choice of the period, 1922(Q1) - 1936(Q4), is dictated by the limitations of some of the data series. We analyse two series for money balances: M1 and M2. The narrow money supply series - M1 consists of U.K. currency in the hands of the non-domestic bank public, plus net U.K. banks' current accounts (allowing for transit items). The broad money supply series, M2, as for 1871-1913, consists of M1 plus net U.K. banks' deposit accounts and other deposits at the Bank of England.

Since in this period we can separate current accounts from deposit accounts we analyse the components of the money multipliers for the public with two ratios: currency to demand deposits ratio, and time to demand deposits ratio.

Table (3.3)

Data Sources 1922 - 1936

M = M1 and M2 series
Source: Capie and Webber (1985), Table 1 (2), Column (I) and Table 1 (3), Column (I)

CDD = Currency to Demand Deposits Ratio
Source: Capie and Webber (1985), Table 1 (2), Column (III)

TDDD = Time to Demand Deposits Ratio
Source: Capie and Webber (1985), Table 1 (2), Column (IV)

RD = Reserves to Total Deposits Ratio
Source: Capie and Webber (1985), Table 1 (3), Column (VII)

RTD = Ratio of Time Deposits to Total Deposits
Source: Capie and Webber (1985), Table 1 (3), Column (V)

Y = Composite Index of Economic Activity
Source: Capie and Collins (1979)

P = Ministry of Labour Retail Price Index: Cost of Living
Source: Capie and Webber (1985)

cr = The yield on $2\frac{1}{2}$ per cent Consols
Source: Capie and Webber (1985), Table III (10), Column (VIII)

bbr = Prime Bank Bill Rate
Source: Capie and Webber (1985), Table III (10), Column (V)

tdr = Interest on Deposit Accounts
Source: Capie and Webber (1985), Table III (10), Column (VII)

br = Bank Rate
Source: Capie and Webber (1985), Table III (10), Column (I)

The currency to demand deposits ratio refers to U.K. currency in the hands of the non-domestic bank public divided by U.K. banks' current accounts (allowing for transit items). The time to demand deposits ratio refer to U.K. banks' net deposit accounts (including Bank of England's banking department) plus other deposits at the Bank of England divided by U.K. banks' net current accounts.

The reserve to total deposits ratio refers to, as for 1871-1913, reserves of the commercial banks divided by the U.K. banks' net deposits plus other deposits at the Bank of England.

The ratio of time to total deposits refer to U.K. banks net deposit accounts divided by the U.K. banks' net total deposits.

The income series refer to the Composite Index of Economic Activity. From an examination of over 120 series 6 coincident indicators were finally selected; the principal ones of which were: industrial production, real turnover, and insured workers in employment.

The price series refer to Ministry of Labour cost of living index. This is biased to working class expenditure and not ideal in its representativeness.

The rates of interest: Consol rate, Bank rate, Bank Bill rate and time deposit rate, are the same as those of the previous section.

Table (3.4) gives some summary statistics for these variables. For modelling purposes, all these series are later transformed logarithmically. In the case of interest rates the logarithm of (one+ the rate) is taken rather than the rate itself.

Table (3.4)

Descriptive Statistics of the Variables: 1922-1936

Variable	Mean	Standard Deviation	Coefficient of Variation
M1	1457870[a]	106748	0.07
M2	2601790[a]	191917	0.07
CDD	0.28	0.014	0.05
TDD	0.97	0.097	0.10
RD	0.12	0.006	0.05
Y	98.5[b]	4.31	0.04
P	91.06[c]	8.27	0.09
br	0.036	0.013	0.36
bbr	0.028	0.017	0.59
tdr	0.018	0.011	0.63
RTD	0.48	0.025	0.05
cr	0.04	0.006	0.15

(a) In thousands of pounds

(b) Composite Index of Economic Activity, 1924 Average = 100

(c) Retail Price Index, 1924 Average = 100

3.2.2 An examination of the variables in the interwar period

Unlike the stability of the pre World War One 'era' the interwar period is generally characterised as having large fluctuations in economic activity and in world trade. The immediate problem in the post war boom years was the need to restore the steady expansion of world trade which had been disrupted by the war. All the efforts of the 1920's aimed at reducing the obstacles to trade and minimising the impact of the legacy of the wartime financial settlements ended in failure and disaster. The international depression which set in from around 1929 put an end to all these attempts at reviving the international economy. The volume of world trade which seemed to be on an upward trend (with the index of total volume of trade 1913 = 100, rising to 110 between 1926-30) fell by some 60 per cent between 1929 and 1932. (For details see Williams, 1971). From the early 1930's there were unfavourable trends in the world economy. Even for the U.S. economy which had been experiencing a wave of high prosperity for most of the 1920's, all ended in 1929. The stock market collapse in that year and the scramble for liquidity in the U.S. and in Europe, led the whole international system to near collapse. The depression lasted for a minimum of three years and the road to recovery began in 1932 or 1933.

Inside the U.K., immediately after the war a number of factors operated to produce a boom. This sharp upswing did not last long however and turned into a severe slump in 1921. Thereafter growth was quite strong. From 1922 until 1928, this annual average rate of growth in real GNP was about 2.6 per cent. There were some interruptions in this upswing, and a more serious depression began in late 1929 with a trough being reached in 1932. Over these depression years GNP in real terms fell by about 5.5 per cent. The revival which started in 1932 lasted until 1937. From there economic activity expanded a little, after a short recession until the outbreak of war in September 1939. The index of economic activity, figure (3.8) shows these movements in output.

Over the period 1922-1930 there were three exchange rate regimes. Britain suspended convertibility to gold in 1914 and resumed it in 1925. Until 1925, therefore, we have floating exchange rates and then from 1925 until 1931, a new gold exchange standard was established at the pre-war parity of $4.86. From 1932 until 1939 we have 'managed currency'.

The gold standard years of 1925-1931, was different from the previous gold standard era in that most countries held as reserves foreign exchange in addition to gold. This increased the importance of those financial centres, such as London, where most of the foreign exchange reserves were held. This meant that Britain now needed to hold reserves in excess of its own needs, as a cover for other countries' reserves.

Throughout the 1920's prices, especially in agriculture, were falling; the GNP deflator fell by about 14 per cent over the period 1922-1929 and by a further 7.5 per cent from 1929 to 1932. It was only in 1932 that prices started to rise. The GNP deflator rose by about 11 per cent from 1932 to 1938. (Figure

(3.9) depicts the movement in the cost of living index).

Throughout the second half of the 1920's some of the export industries remained depressed. To this problem were added a worsening trade balance and a scramble for liquidity throughout Europe, following the collapse of Credit Anstalt in Austria and, in Germany the temporary closure of the Danat Bank in 1931. The loss of confidence in London was intensified when the Macmillan Report revealed that Britain's short-term liabilities were much greater than had been thought. Gold was being withdrawn from London. As a result Britain was forced to abandon the gold standard. From 1932 to 1939 sterling was left to float but there was official intervention. This management of the currency was conducted through the Exchange Equalisation Account.

With respect to monetary policy, until 1931/32 the period can be characterised as one of 'dear money'. This restrictive policy was in response to the war and post war inflation of 1919/20, the problem of national debt, and finally to the struggle to maintain its gold and foreign exchange reserves. The principal instrument of policy was the Bank rate. At the same time, in order to minimise the deflationary impact on the economy where high levels of unemployment were being experienced, this restrictive policy was accompanied by offsetting open-market operations. The period after 1932 can be characterised as one of 'cheap money' when the Bank rate was reduced from its 7 per cent peak to 2 per cent and remained there until 1939. Figure (3.12) shows these movements in the Bank rate. Other short rates follow these movements in the Bank rate very closely. The Consol yield, (figure (3.13)), also follows these movements in the short rates, the fluctuation being less pronounced. From 1922 to 1931 the trend is relatively flat, around 4-5 per cent. From 1931 onwards it follows a gradually falling trend until 1936 when it remains around 2.8 - 2.9 per cent and then starts rising again until the outbreak of the Second World War.

What are the implications of these switches in government policy and the successions of various exchange rate regimes for the money supply?

Figures (3.10) and (3.11) show the movements in the monetary aggregates M1 and M2 respectively. Between 1922 and 1927 M1 fell by about 9 per cent (in annual terms by 2 per cent). For two years after that it rose by about 0.5 per cent in annual terms. M2, on the other hand, fell by about 9 per cent between 1922 and 1926 and then rose gradually until about 1929. Between their 1929 peak (quarter one) and 1932 through (quarter one) M1 fell by about 11 per cent and M2 by about 0.5 per cent. In the 1930's recovery, M1 rose by an overall of 27 per cent and M2 by 15 per cent between 1933 and 1939.

The discontinuities in government policy and in the exchange rate regimes meant that the monetary base and hence the money supply were determined domestically for some years and internationally for others.

Between 1922 and 1938 the base grew more than the monetary aggregates, by about 23 per cent (1.3 per cent in annual terms).

This means that the fall in the money multiplier held the growth of money back. Figures (3.14) - (3.16) show the movements in the money multiplier components. The currency to demand deposits ratio was on an upward trend until about 1926. The main explanation for the rise seems to lie in the behaviour of short-term interest rates which followed a similar pattern to that of the currency ratio. From about 1927, this ratio is relatively flat around 27-28 per cent until 1931 when there is a sharp rise to about 33 per cent. Given the fear about liquidity throughout Europe in 1931 it would be surprising if we did not find an increased demand for currency relative to deposits that year. But there was no banking crisis in Britain and fear was quickly dispelled, and the ratio reverted to its pre-crisis level of 28 per cent and stayed there for the years 1933-1936. From 1937 onwards the currency ratio rose steeply to new heights and this is probably attributable to the political situation which was rapidly deteriorating as war was believed by many to be imminent. The time to demand deposits ratio on the other hand, climbed steadily in the 1920s from around 80 to around 110 per cent in 1930. There was then a sharp rise in 1931 and then the trend is clear and firmly downwards. The main explanation for these movements lies, of course in the behaviour of interest rates which followed a similar pattern to that of the time to demand deposits ratio.

The reseve ratio is fairly flat with a value of 11.5 per cent between 1922 and 1932 except that is for two relatively sharp rises in 1925 and 1928; and one fall in 1929. The ratio then rises sharply until 1935 to about 13 per cent and then falls back to 10/11 per cent in 1936. Two explanations for these movements are found in the growth rates of income and in that of time to total deposits ratio. The reserve ratio seems to have followed these in an inverse fashion, falling first and then rising sharply. This is because banks possibly regard time deposits as requiring smaller reserves than demand deposits. When time deposits rise as a proportion of total deposits, therefore, banks would lower the reserves they hold against these deposits.

Figure (3.8)

<u>Index of Economic Activity</u>, 1922 - 1936, quarterly

(1924 average = 100)

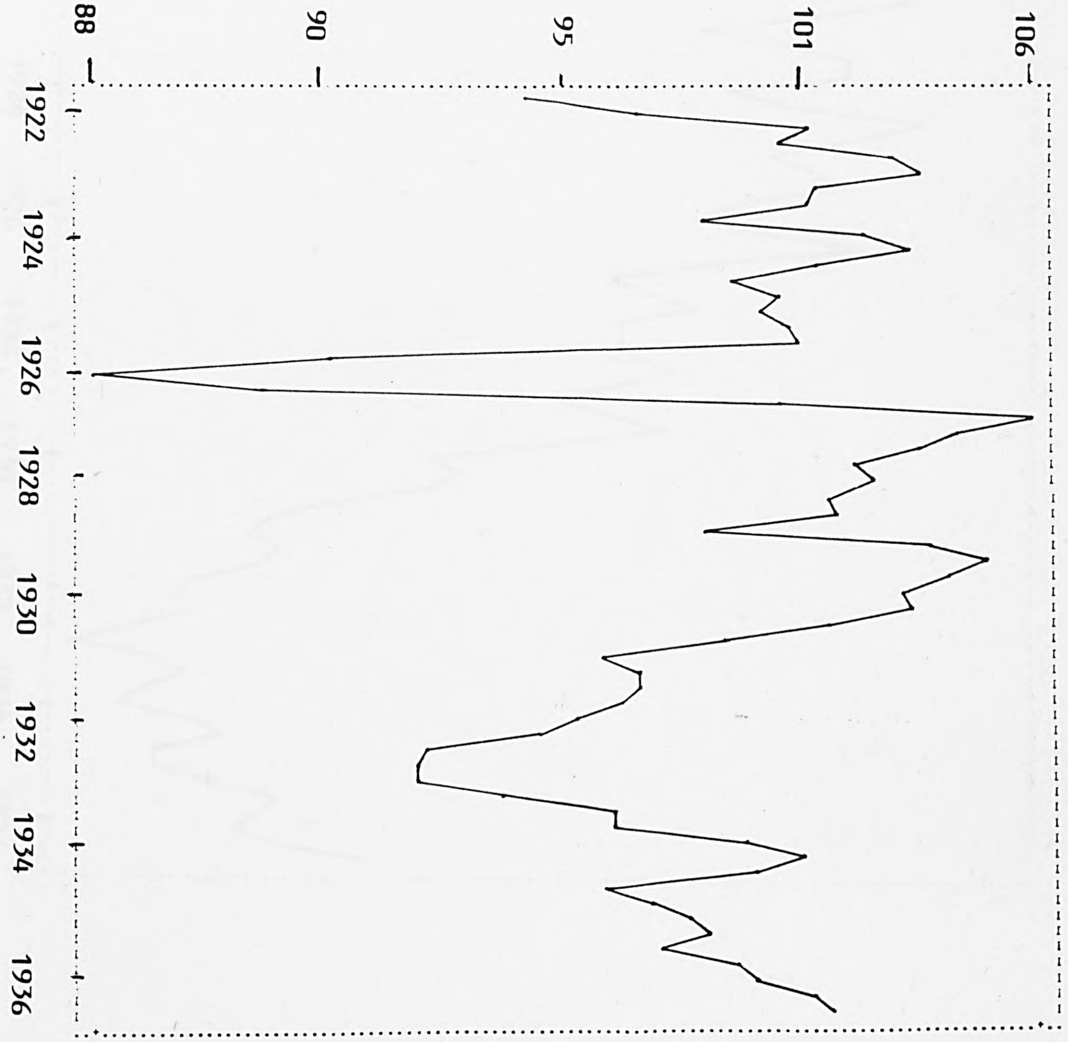


Figure (3.9)

Cost of Living Index, 1922 - 1936, quarterly

(1924 average = 100)

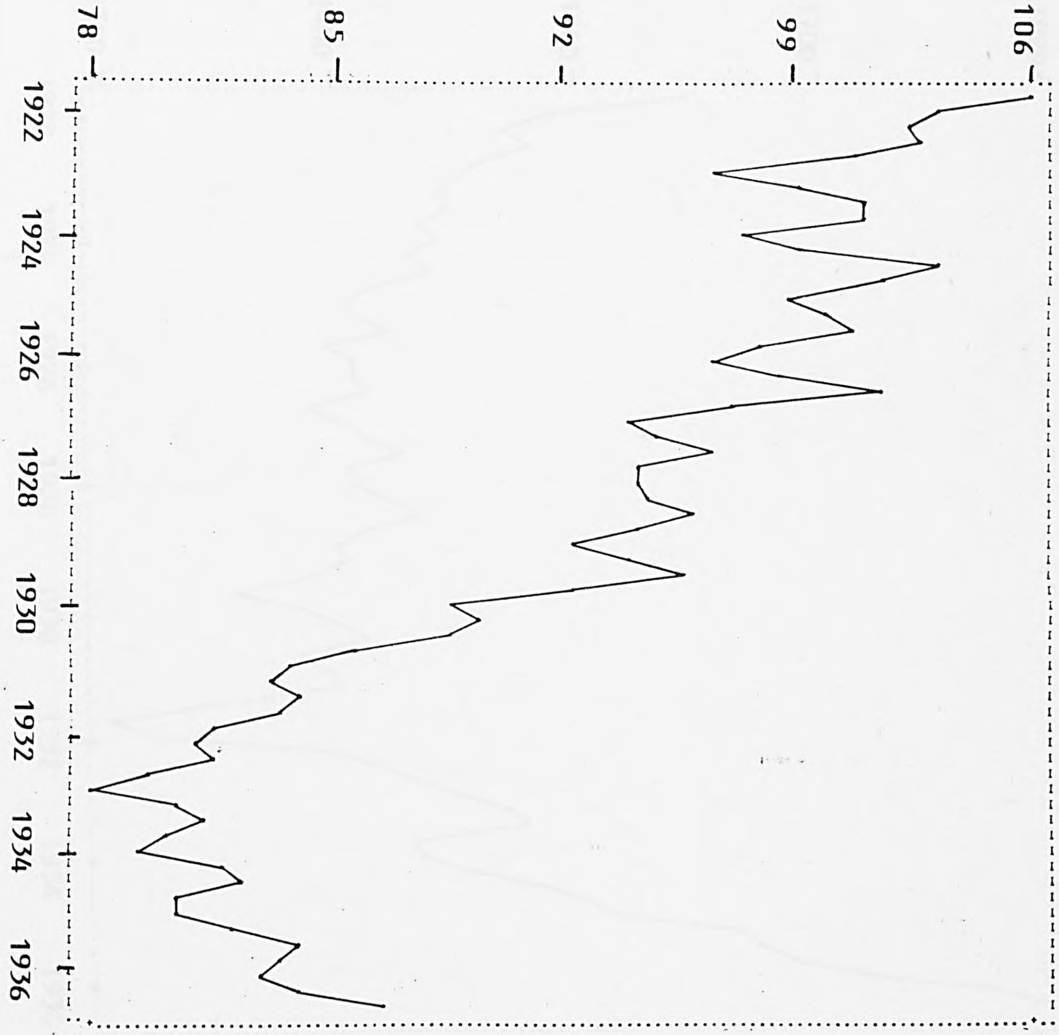


Figure (3.10)

Money Supply, M1, 1922 - 1936, quarterly

(£000,000's)

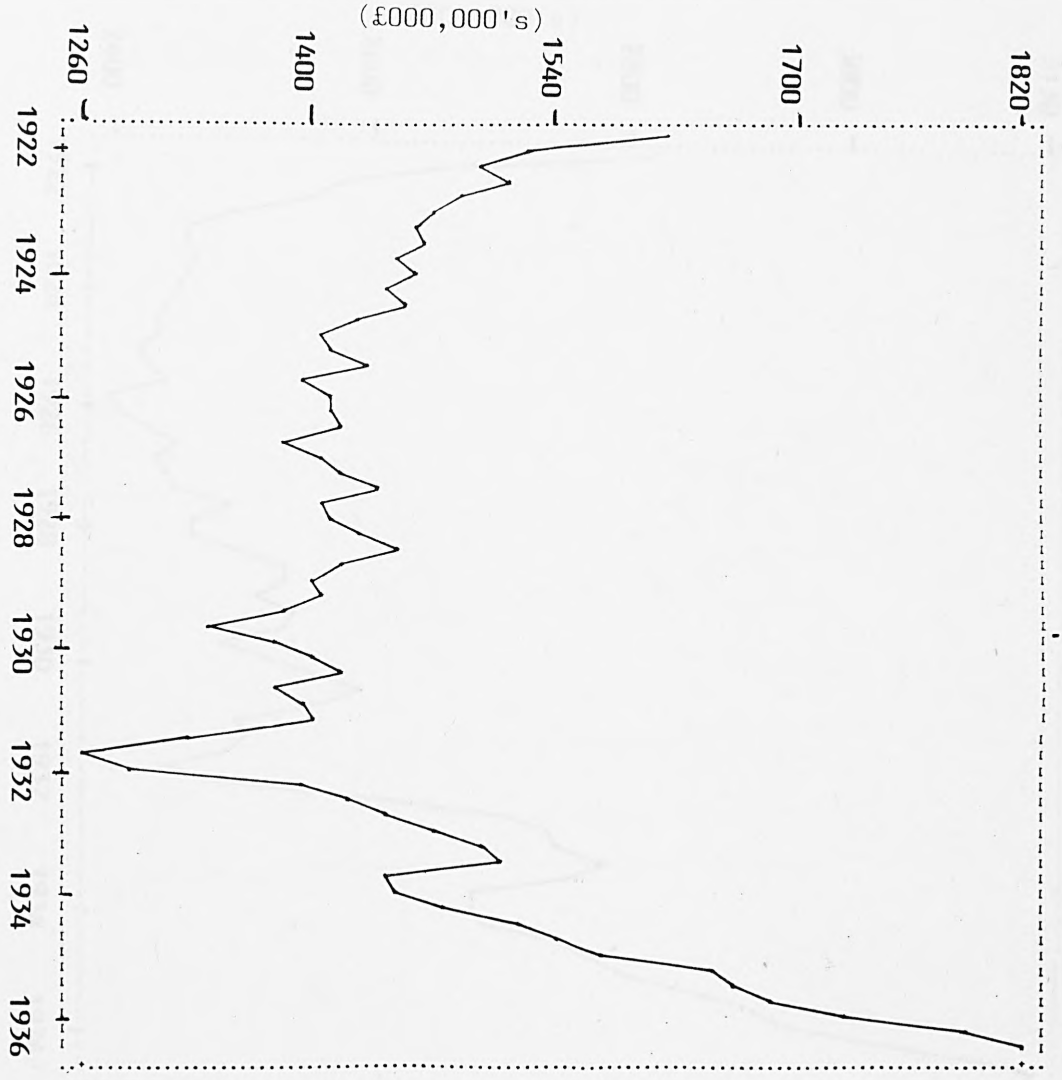


Figure (3.11)

<u>Money Supply, M2,</u> 1922 - 1936, quarterly

(£000,000's)

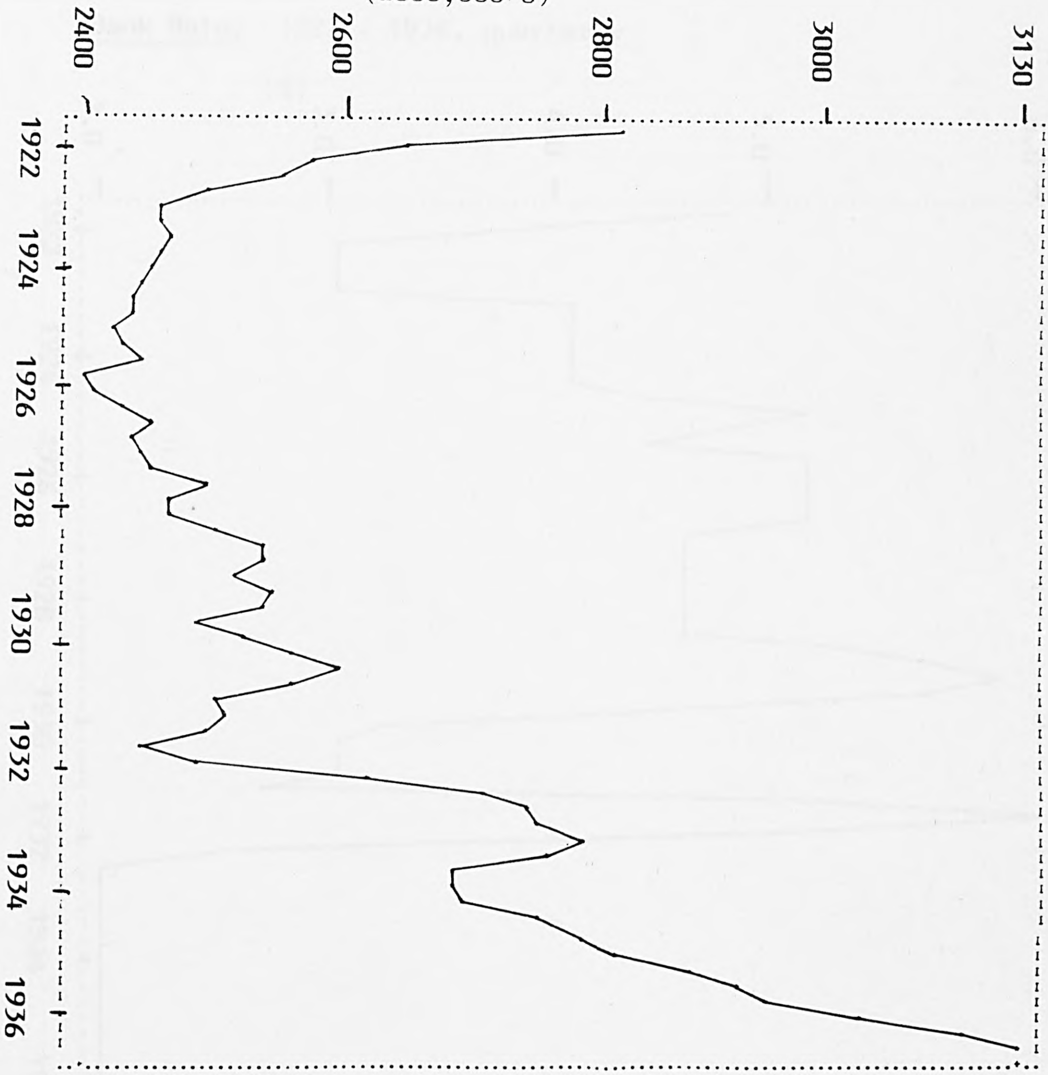


Figure (3.12)

<u>Bank Rate</u>, 1922 - 1936, quarterly

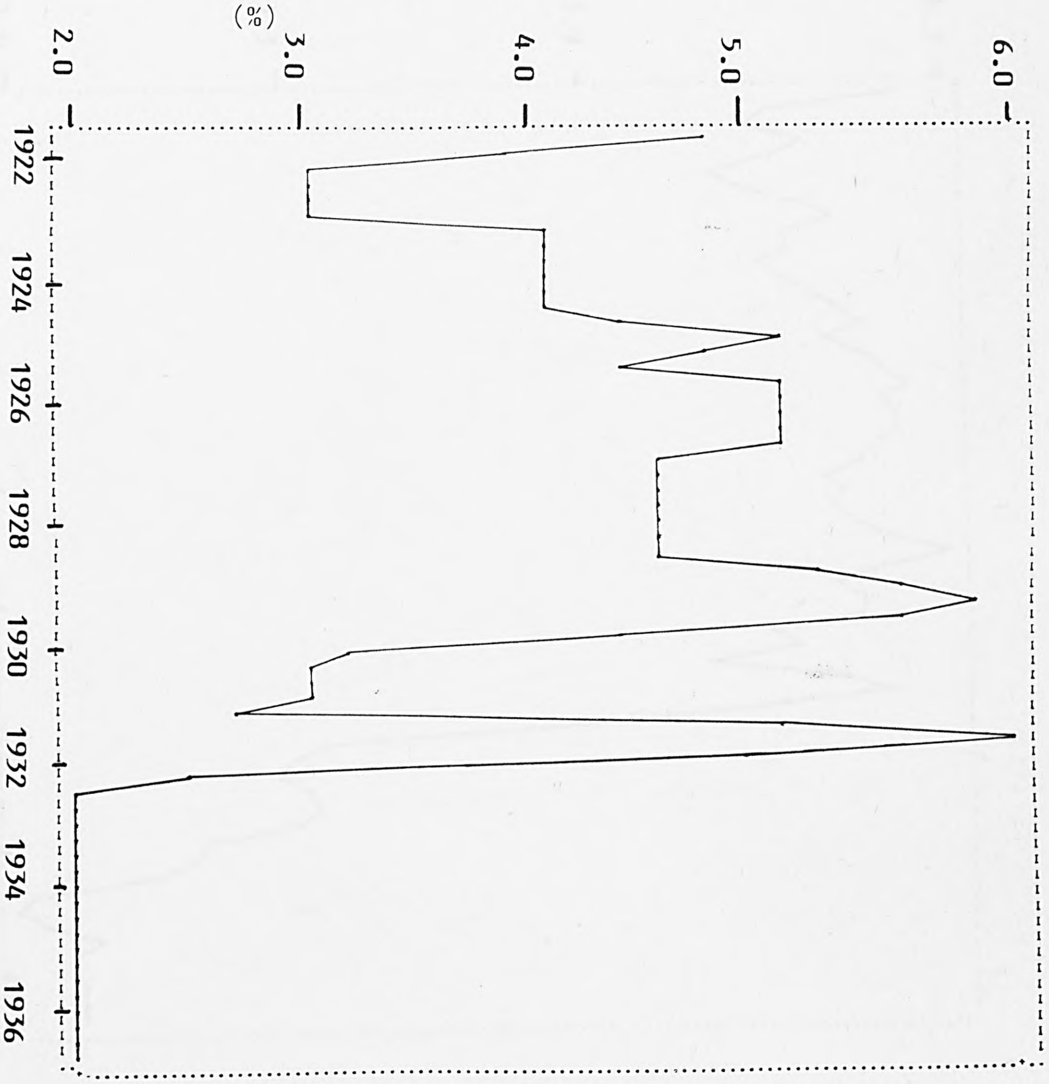


Figure (3.13)

Consol Rate, 1922 - 1936, quarterly

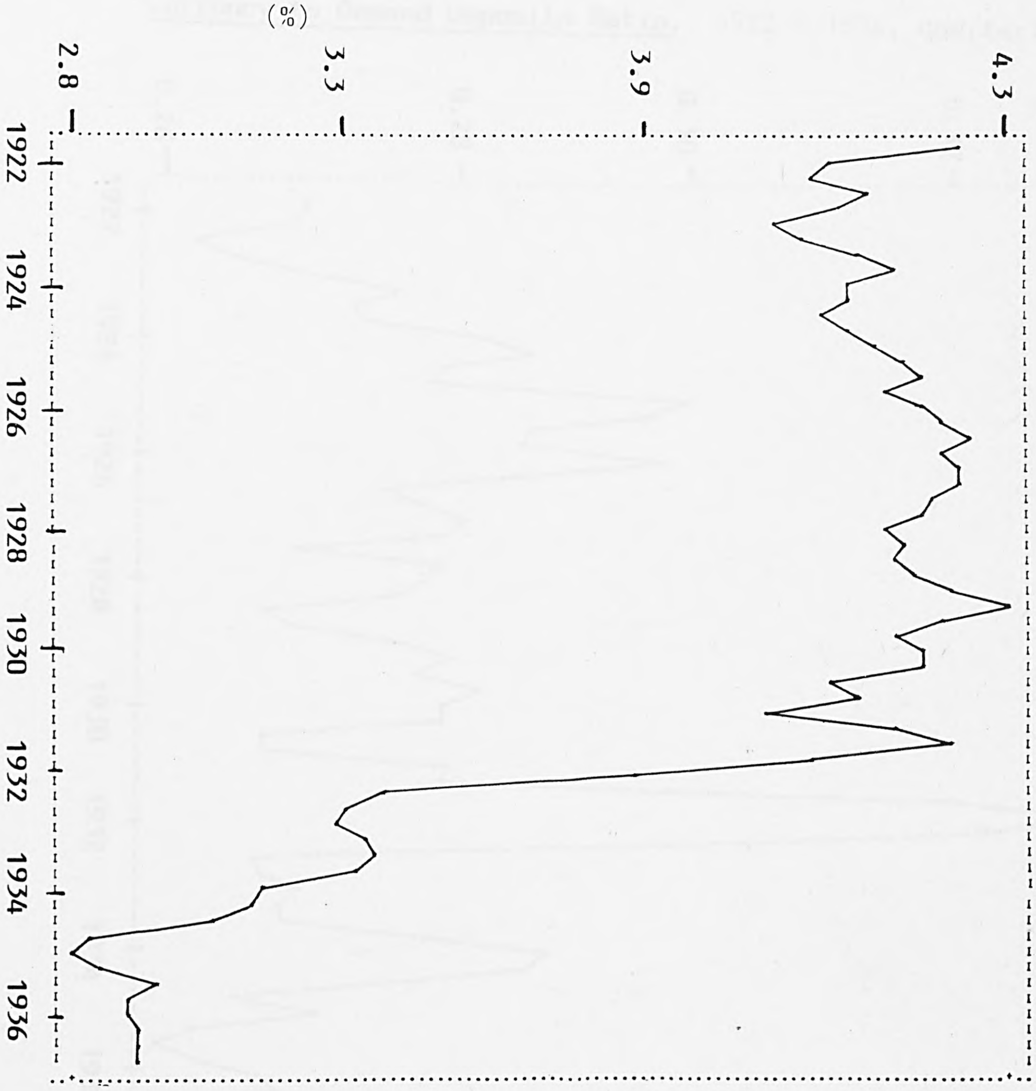


Figure (3.14)

Currency to Demand Deposits Ratio, 1922 - 1936, quarterly

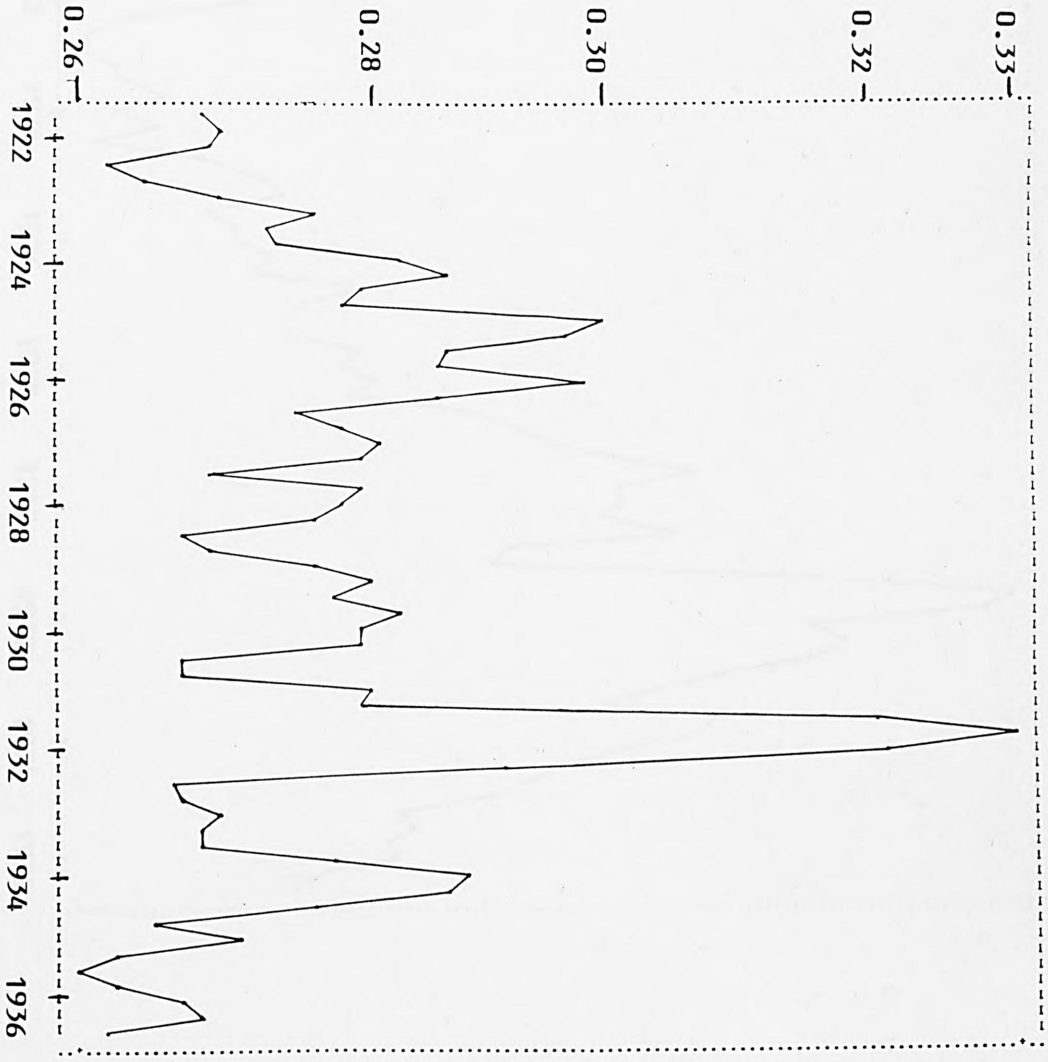


Figure (3.15)

Time to Demand Deposits Ratio, 1922 - 1936, quarterly

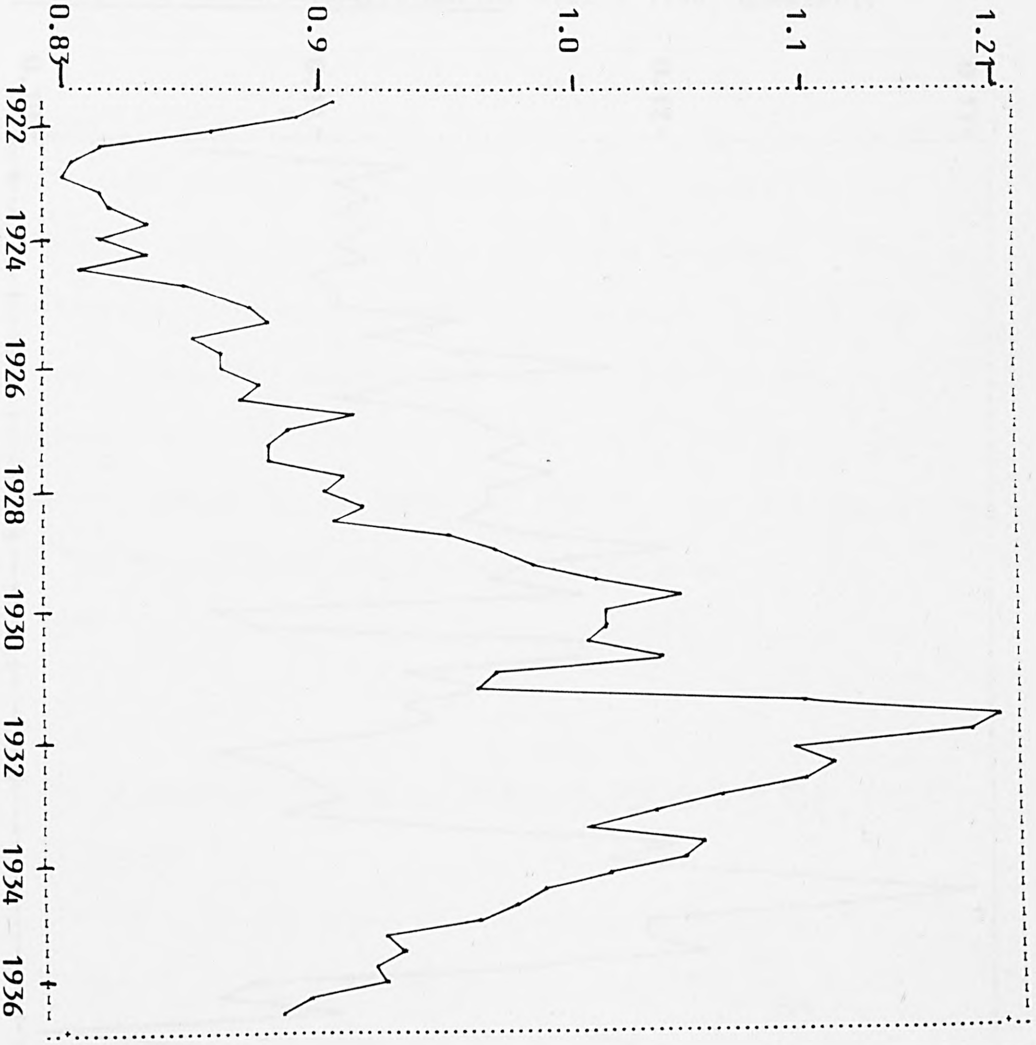
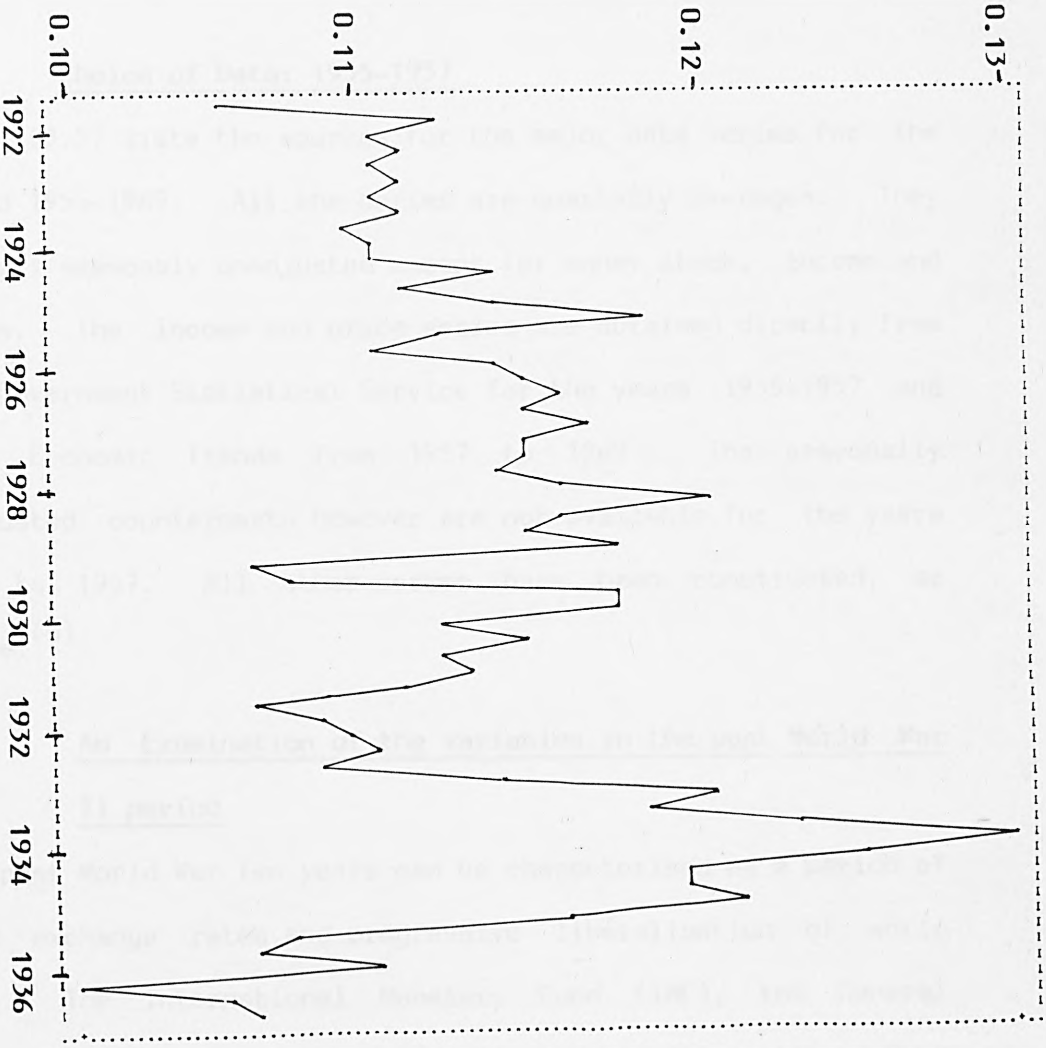


Figure (3.16)

Reserve to Total Deposits Ratio, 1922 - 1936, quarterly



3.3 The Post World War Two Period

As for the previous two periods we discuss the data series along with their sources for the post World War Two period. We will then examine the major variables in relation to the important events of the period.

3.3.1 Choice of Data: 1955-1957

Table (3.5) lists the sources for the major data series for the period 1955-1969. All the series are quarterly averages. They are all seasonaly unadjusted except for money stock, income and prices. The income and price series are obtained directly from the Government Statistical Service for the years 1955-1957 and rom Economic Trends from 1957 to 1969. The seasonally unadjusted counterparts however are not available for the years 1955 to 1957. All other series have been constructed, as before.(b)

3.3.2 An Examination of the variables in the post World War II period

The post World War Two years can be characterised as a period of fixed exchange rates and progressive liberalisation of world trade. The International Monetary Fund (IMF), the General Agreement on Tariffs and Trade (GATT), and the International Bank for Reconstruction and Development (the World Bank), set up at Bretton Woods in 1944 were essentially designed for these purposes.

(b) Most of the series are constructed as part of the Monetary History Project and are available in Capie and Webber (1985)

Table (3.5)

Data Sources: 1955 - 1969

M = M1 and M2 series
Source: Capie and Webber (1985), Table 1 (2), Column (2) and Table 1 (3), Column (I)

CDD = Currency to Demand Deposits Ratio
Source: Capie and Webber (1985), Table 1 (2), Column (III)

TDDD = Time to Demand Deposits Ratio
Source: Capie and Webber (1985), Table 1 (2), Column (IV)

RD = Reserve to Total Deposits Ratio
Source: Capie and Webber (1985), Table 1 (3), Column (VII)

Y = Gross Domestic Product at market prices, 1980 = 100, deflated by GDP deflator.
Source: Economic Trends, Annual Supplement, 1984 Edition No.9

P = Gross Domestic Product deflator, 1980 = 100
Source: Economic Trends, Annual Supplement, 1984 Edition No.9

cr = The yield on 2½ per cent Consols
Source: Capie and Webber (1985), Table III (10), Column (VIII)

tbr = Treasury Bills Allotment Rate
Source: Capie and Webber (1985), Table III (10), Column (II)

tdr = Interest on Deposit Accounts
Source: Capie and Webber (1985), Table III (10), Column (VII)

br = Bank Rate
Source: Capie and Webber (1985), Table III (10), Column (I)

All the series are transformed logarithmically. In the case of interest rate the logarithm of (one + the rate) is taken rather than the rate itself. Table (3.6) given some summary statistics for the untransformed variables.

Table (3.6)

Descriptive Statistics of the variables: 1955-1969

Variable	Mean	Standard Deviation	Coefficient of Variation
M1	7017[(a)]	856	0.012
M2	11310[(a)]	1953	0.17
CDD	0.45	0.04	0.09
TDD	0.86	0.14	0.17
RD	0.08	0.002	0.02
Y	38.3[(b)]	4.96	0.13
P	19.7[(c)]	2.90	0.15
br	0.06	0.012	0.22
tbr	0.051	0.013	0.26
tdr	0.036	0.012	0.34
cr	0.059	0.012	0.20

(a) In millions of pounds

(b) Gross Domestic Product in constant prices, 1980 = 100

(c) Gross Domestic Product Deflator, 1980 = 100

The I.M.F. was an attempt to re-establish stable relations between the currencies of different nations. The World Bank, on the other hand, was designed to provide long-term international loans for productive purposes. The import restrictions imposed up to the end of the Second World War were gradually lifted, and by 1950, most quotas on trade had virtually disappeared. The General Agreement on Tariffs and Trade, (GATT), established in 1947, and the successive conferences in the fifties and sixties (The Geneva Round 1956, The Dillon Round 1960, the Kennedy Round 1966-7) together with regional agreements, such as the European Free trade, were all movements towards the liberation of world trade. All these movements plus other factors such as reductions in freight costs, continual innovation of new products, the rapid diffusion of technology and most important the rapid growth of the world economy, prompted the expansion in world trade. In fact, from 1940 until the oil crisis in 1973 world trade increased more rapidly than ever before (Wright, 1978).

With the Bretton Woods regime the exchange rates were to be pegged within narrow margins to the dollar. This system seemed to work well until about 1960s when balance of payments problems led individual countries to adopt trade restrictions. Furthermore, they needed to adjust their rates of monetary growth and inflation to the needs of their domestic economy and not to the requirements of a fixed exchange rate regime (for details see Schwartz, 1983). As a result of these conflicting requirements the system broke down in the early 1970s.

Over the post World War Two period one can cite three other characteristics for the U.K. economy: (1) Economic growth faster than ever before (see figure (3.17)); (2) Balance of payments problems and creeping inflation; (3) Full employment and the use of demand management techniques.

Over the post World War Two period, as in other industrial countries, Britain was experiencing a much smoother growth than ever before (see Figure (3.17)). In fact the 2.8 per cent per annum growth rate in GDP (per capita) from the peak in 1953 until 1973, was considerably faster than either the 1.7 per cent per annum between the peaks of 1937 and 1951 or that of any other period after 1870 (see Wright, 1979).

If, however, Britain was doing well, other industrial economies were doing better. In fact, in the EEC the growth rate was about twice as high as in the U.K. (see Cairncross, 1981). Four principal reasons are usually advanced to explain this slower (relative to the EEC average) growth rate in Britain. First, a low investment ratio which was chiefly due to wrong investment decisions at management levels. Second, poor industrial relations possibly attributable to a relatively large number of unions in the U.K. Third, over this period the financial and legal aspects of business seemed to attract more entrants than did production and marketing. The government's 'stop-go' policies constitute the fourth exlanation. The governments' restictive policies however were partly made in response to the external deficits.

U.K balance of payments problems, in a world where trade was expanding rapidly, were mainly the result of unfavourable swings in the terms of trade which were some 16 per cent worse in 1955 than in 1938 (for details, see Dow, 1976). On the other hand, the higher proportion of imports into the U.K. from 1958, the year when almost all import restrictions were lifted, is a sign of the U.K.s failure to compete.

Britain's share of world growth was also falling. Between 1957 and 1967 the rate of growth of U.K. manufacturing exports was 2.4 per cent per annum (compared to 3 per cent per annum growth rate in manfacturing output).

The government's first attempt to assist exports came in 1949. In September of that year the exchange rate which had remained fixed at $4.03 since 1939, was devalued to $2.80. But this did not help greatly since most of Britain's trading partners followed suit. This in fact was an attempt to eliminate the so called dollar shortage. The sharp rise in import prices due to the Korean War (1950-1) led to further worsening of U.K. balance of payments.

The government's first concern was to promote full employment in the economy after the experience in the twenties and thirties when unemployment was never below one million. The early establishment of full employment after the war was achieved on the one hand by desires to have free trade, replacement of capital equipment and American aid to countries that suffered war damage, and on the other hand by the governments' cheap money policies. In the fifties and sixties the efforts of the government were concentrated on keeping inflation in check and in reducing the unemployment level. Prices, on the other hand, rose quite fast during and immediately after the war. Consumer prices rose by 10 per cent between 1945 and 1947 and by a further 10 per cent in the following two years. Devaluation and the outbreak of the Korean war introduced further inflationary impulses (prices rose by almost 20 per cent in the following two years). From there onwards inflation became a world wide phenomenon. In the U.K. prices rose at about 2.5 per cent per annum between 1952 and 1972. (Figure (3.18) shows the movements in the GDP deflator).

The government, then, was on the one hand trying to ensure internal harmony (full employment and inflation under control) and on the other to improve the balance of payments. The demand management policies of the 1948-1967 period were by and large based on Keynesian ideas. But too many conflicting objectives of the government culminated in another devaluation in November 1967. The exchange rate which remained fixed until then at $2.80 was then reduced to £2.40. It was only in 1971 that the rate moved up to £2.60 under the Smithsonian agreement.

In terms of fiscal policy, government depended more heavily on changes in taxation rather than expenditure. These changes usually amounted to an increase in some indirect tax or taxes. Some hire purchase restrictions were imposed in order to limit consumer credit. Monetary policy, on the other hand, played a secondary role. The "Cheap money" policies ended in 1951. But it was only in 1955 that the Chancellor emphasized the importance of monetary measures in his policies. Bank rate fluctuated between 4 and 7 per cent until 1967 and remained at 7 thereafter (see figure (3.21)). There were some direct restrictions on the banks as well. From 1946 onwards the London Clearing Banks had observed an 8 per cent minimum cash ratio and from 1951 they observed a liquid asset ratio (cash, call money, Treasury and Commercial Bills). This ratio was to be maintained at 28 to 32 per cent of their deposit liabilities. In 1957 this ratio had to be 30 per cent, and 28 per cent in 1963. Further, from 1960 onwards a scheme of special deposits became operative. Under this scheme part of the liquid assets of the London clearing banks could be rendered nonliquid by being blocked in special deposits at the Bank of England. This scheme was effective only from August 1961. In May 1969 the Bank of England halved the rate of interest paid on these deposits and in 1971 the scheme was abandoned. From the 1950's onwards there were some lending requests as well. These were designed to direct banks' money to sound institutions. In July 1955, banks were specifically asked to reduce the level of their advances by 10 per cent.

Finally, in the money market, from 1951 onwards, the Bank controlled the rates, especially the Treasury Bill rate by acting as the residual supplier of finance to the discount houses. The Consol rate, as shown in figure (3.22), followed these movements in short rates; and the fluctuations, of course, are less accentuated. There is a definite upward trend in this rate with three sharp and major peaks; 1957, 1961 and 1966.

The monetary aggregates M1 and M2 grew by about 65 per cent and 104 per cent respectively (2.1 and 3.0 per cent per annum) over the period 1946 to 1970. Figures (3.26 and (3.27) show the fluctuations in M1 and M2 respectively. Both M1 and M2 grew considerably faster over the cheap money phase (3.8 and 4.4 per cent per annum respectively between 1946 and 1951) than the dear money phase (2.4 and 3.8 per cent per annum respectively between 1955 and 1969) and it would seem that the monetary aggregate M1 followed the movements in the interest rates more closely in an inverse fashion than M2 (especially over the years 1957/8 and 1965/6). This is not surprising considering that M2 includes interest bearing assets, and M1 does not. The monetary base, on the other hand, grew much faster than either M1 or M2. This is a period of fixed exchange rates and hence any changes in the domestic component of the base will be offset by the foreign component. If, for example, there is a rise in the domestic component of the base, this will increase the money supply which will then increase prices. Foreign reserves will be lost as a result. This will then lower the base.

Between 1946 and 1970 the base increased by about 120 per cent (3.2 per cent per annum). It was the multiplier, especially that for M1, that held down the growth of money balances. Both M1 and M2 multipliers rose quite fast at first. From almost 2.5 and 3.8 respectively in 1946 they reach about 3.2 and 4.6 in 1949. After a relatively steady two years, they both fell rapidly until 1955 reaching about 2.4 and 2.8 respectively. From there onwards they follow a relatively flat trend until 1969.

Of the components of the money multiplier, the reserve ratio was by and large stable at 8 per cent. This is because from 1946 onwards the London Clearing Banks had observed an 8 per cent minimum cash ratio. And since these banks dominate the series the reserve ratio hardly moved away from that 8 per cent, suggesting that banks did not hold any excess reserves over the required level. In our examination of the money multiplier, we are therefore left with the components that explain the public's behaviour. The currency to demand deposits ratio firstly follows a gradually falling trend. It drops from about (see figure (3.23)) 35 per cent in 1946 to about 26 per cent in 1949, and then starts rising until 1958 when it stabilizes around 45 per cent with some variation around that. Looking at the movements in the short rates of interest we find that the currency ratio follows these very closely with a positive response. Similarly, the time to demand deposits ratio (figure 3.24)) is fairly flat until 1950 with a value of 55 per cent and very little fluctuation around that. The beginning of a smooth rising trend in 1951 coincides with the ending of "cheap money" policies and the sharper increase after 1955 can be attributed to the announcement by the Chancellor of his reliance on the monetary measures in his policies from 1955 onwards. As for the currency ratio, the time deposit ratio followed the movements in the short rates of interest in a positive fashion. From 1957 onwards this ratio increased gradually from about 70 per cent to around 110 per cent in 1969. The peaks in 1958 and 1961 can be compared with those in the interest rates.

Figure (3.17)

GDP at constant prices, 1955 - 1969, quarterly

(1980 = 100)

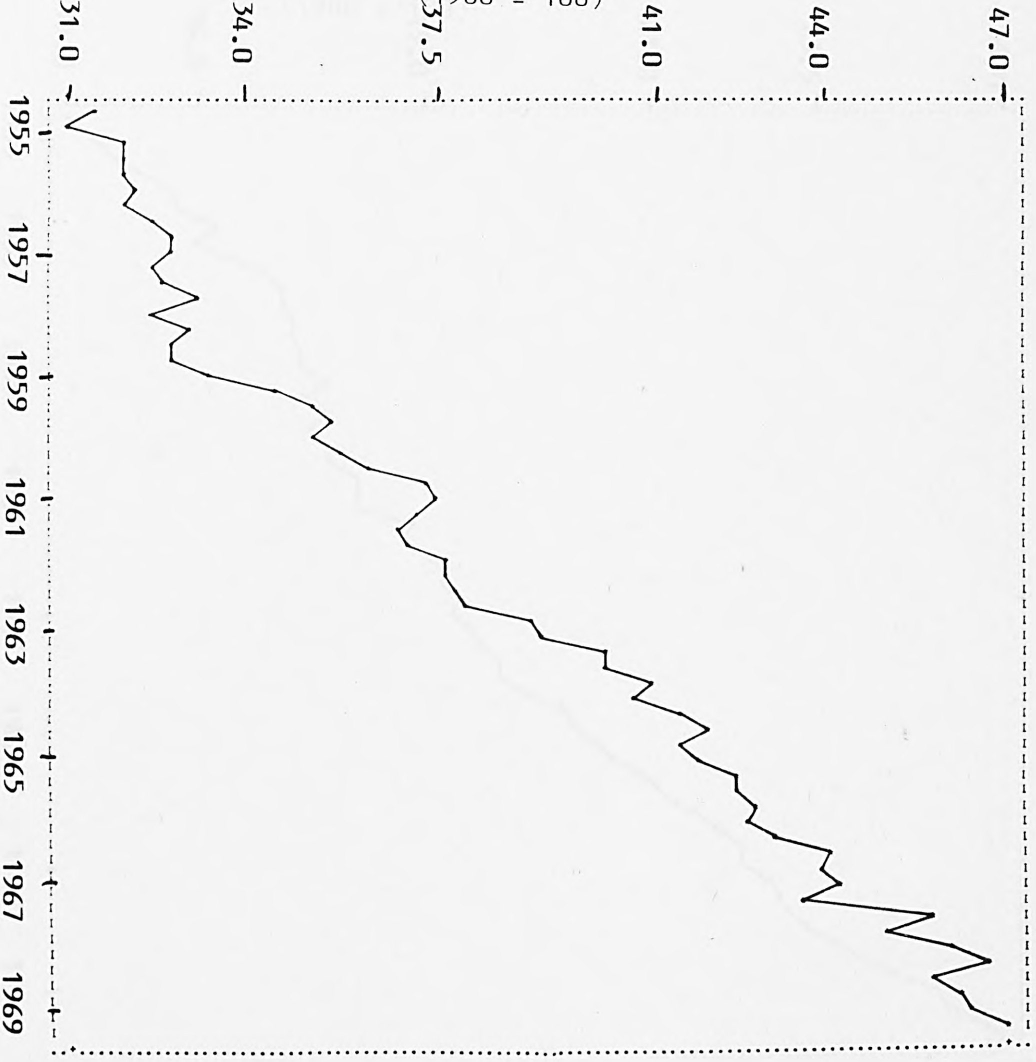


Figure (3.18)

GDP Deflator, 1955 - 1969, quarterly

(1980 = 100)

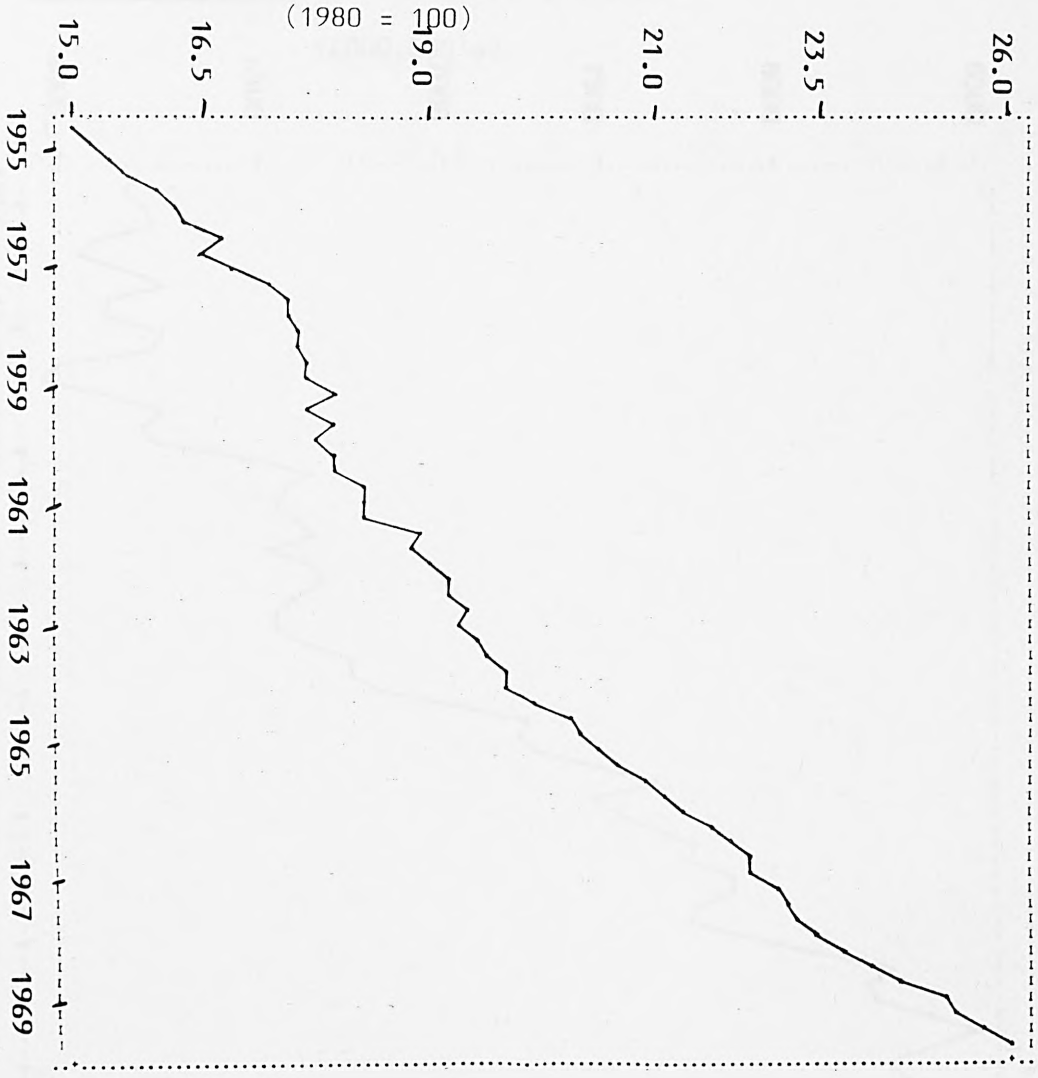


Figure (3.19)

Money Supply, M1, 1955 - 1979, quarterly

(£000,000's)

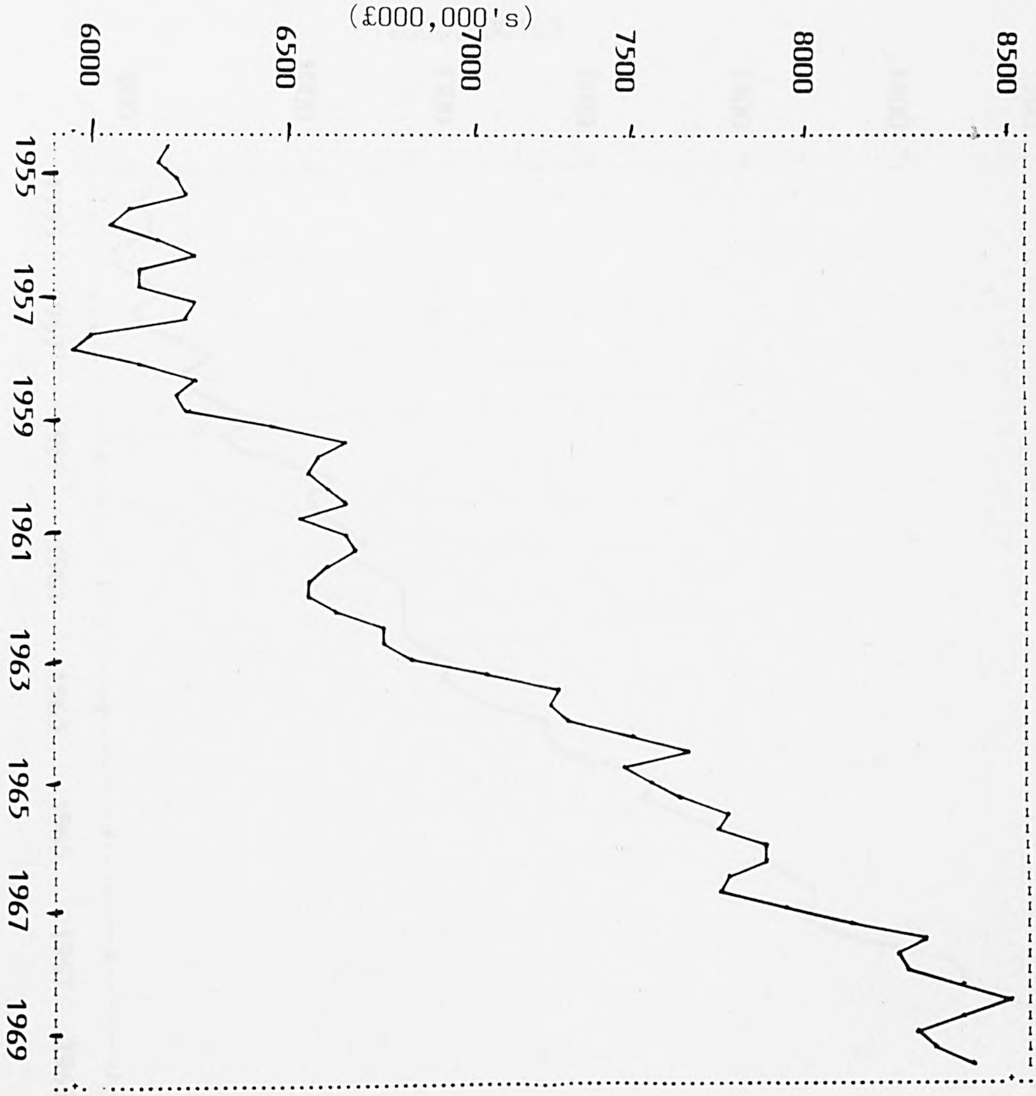


Figure (3.20)

Money Supply, M2, 1955 - 1969, quarterly

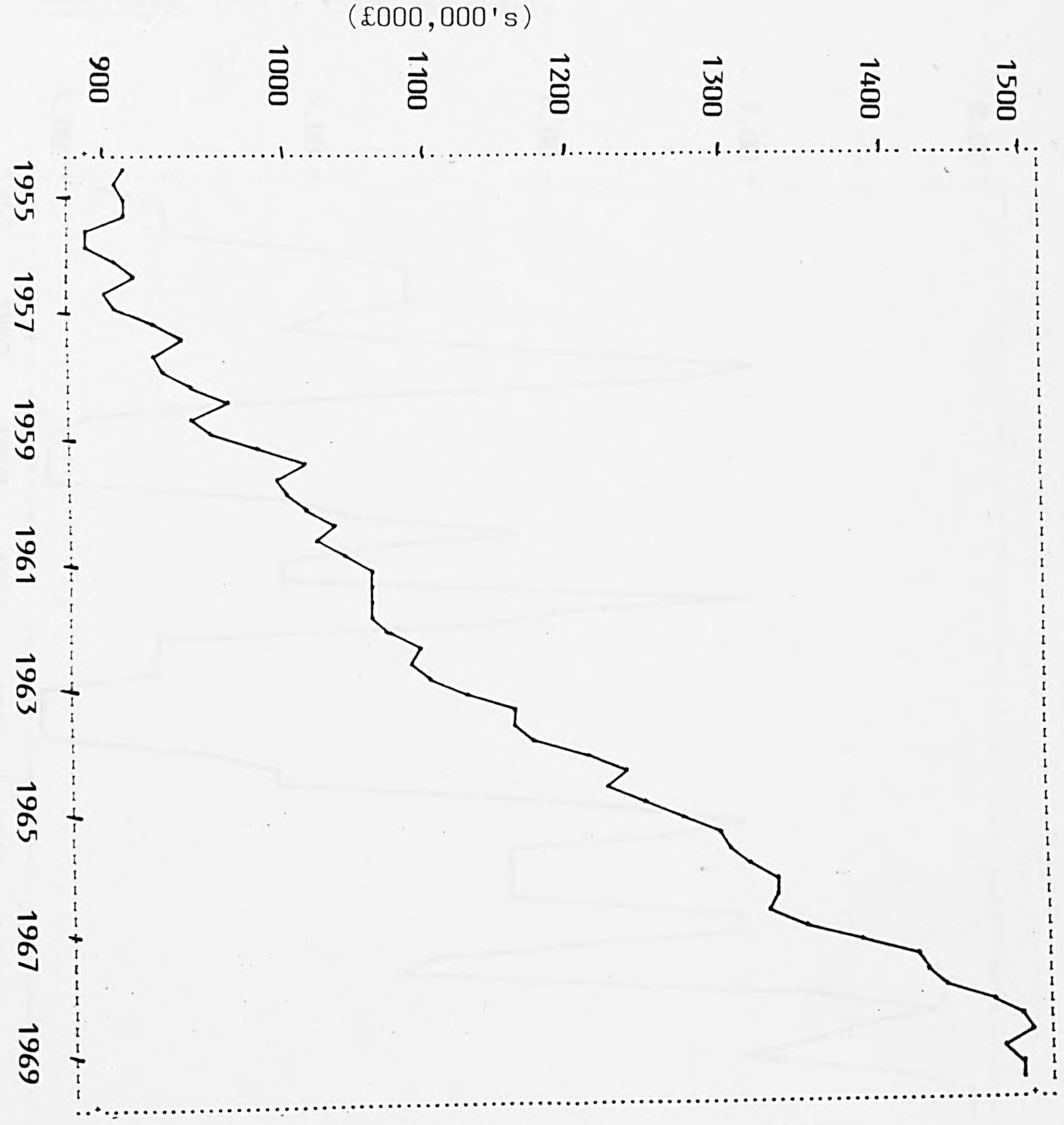


Figure (3.21)

Bank Rate, 1955 - 1969, quarterly

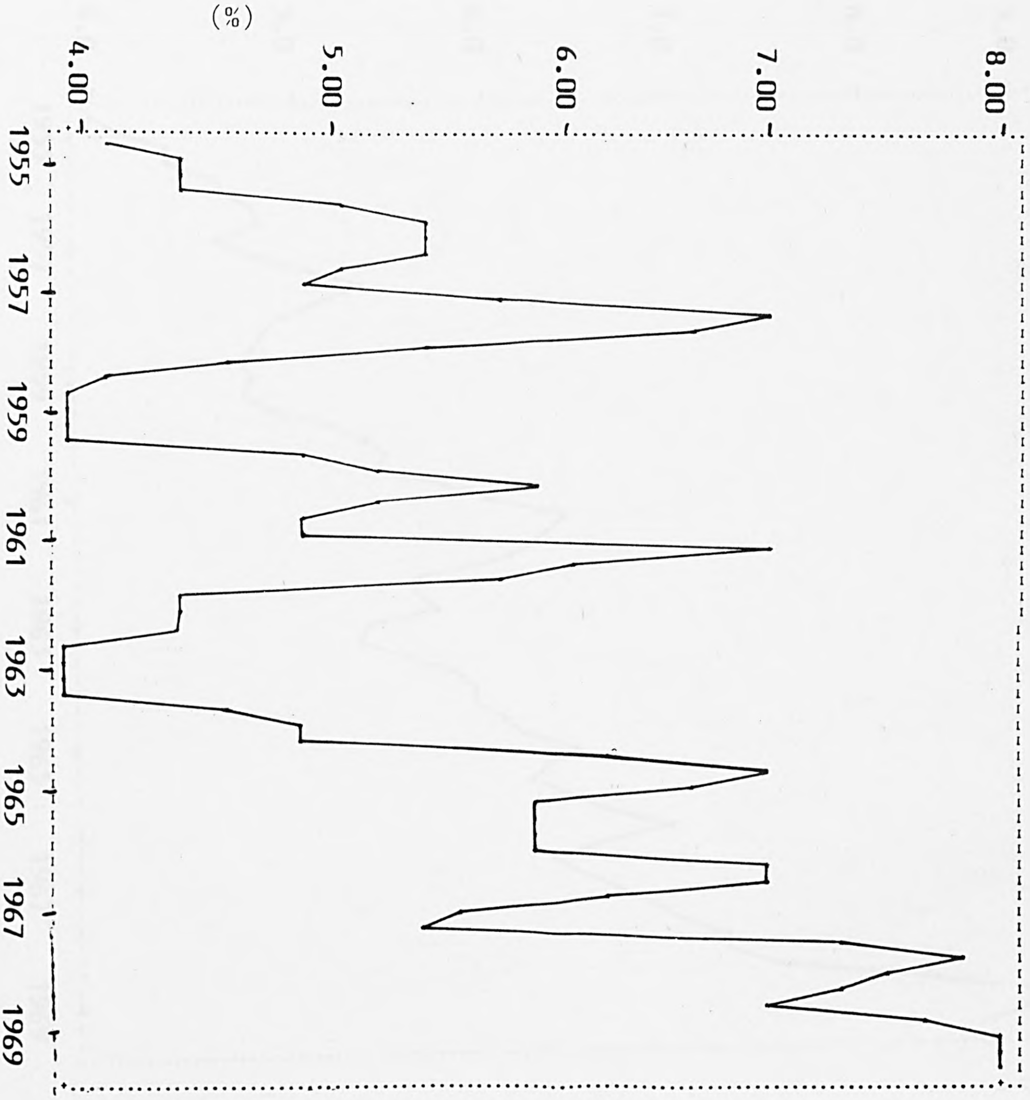


Figure (3.22)

Consol Rate, 1955 - 1969, quarterly

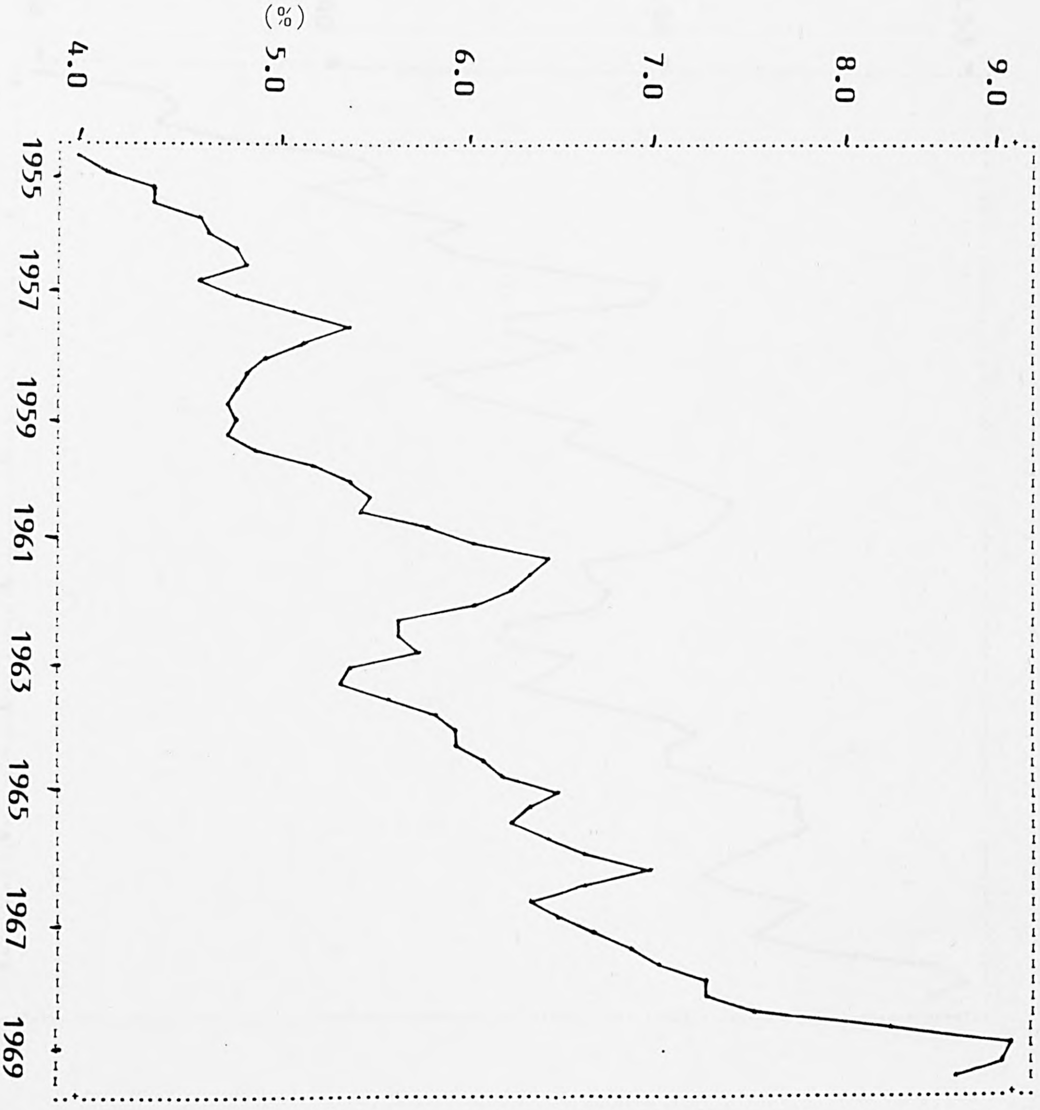


Figure (3.23)

Currency to Demand Deposits Ratio, 1955 - 1969, quarterly

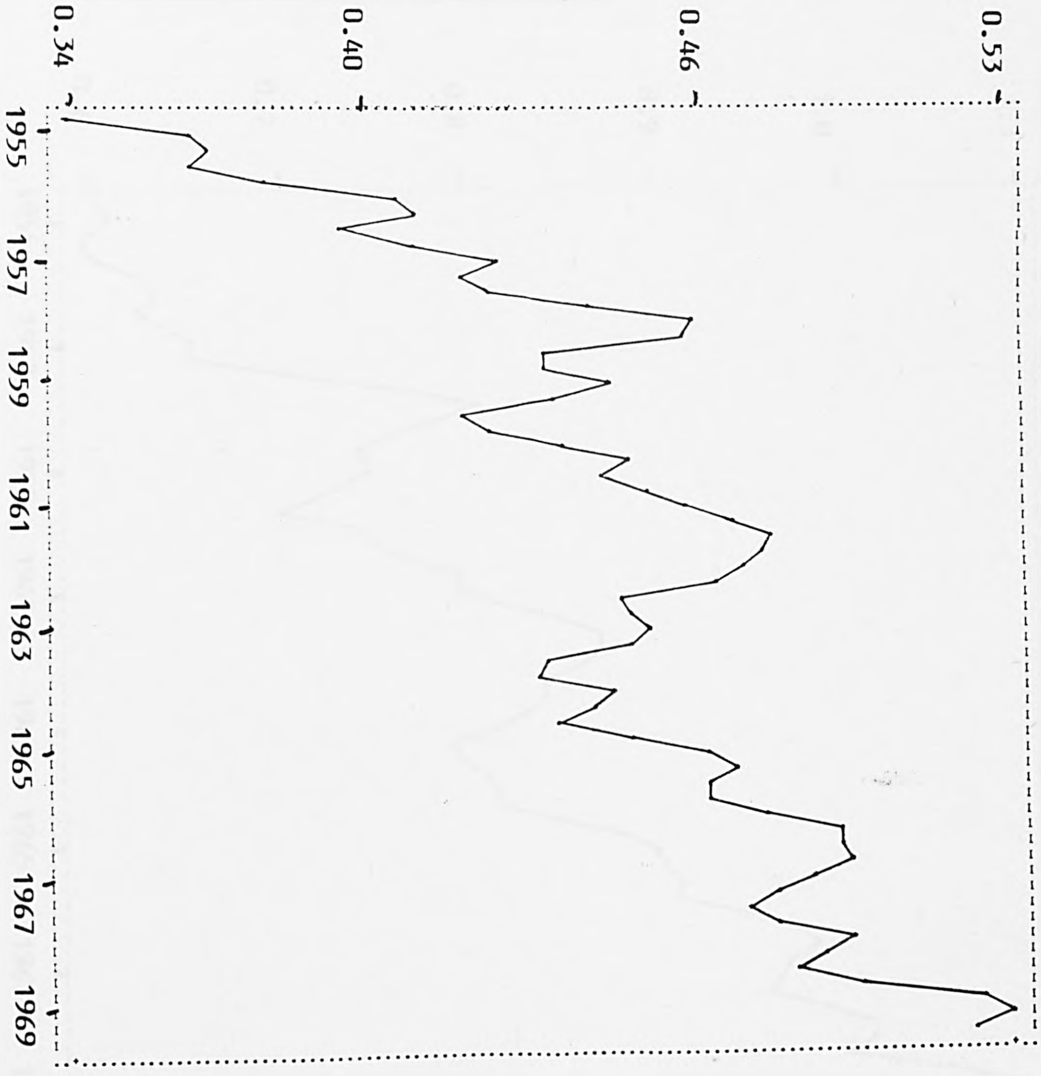
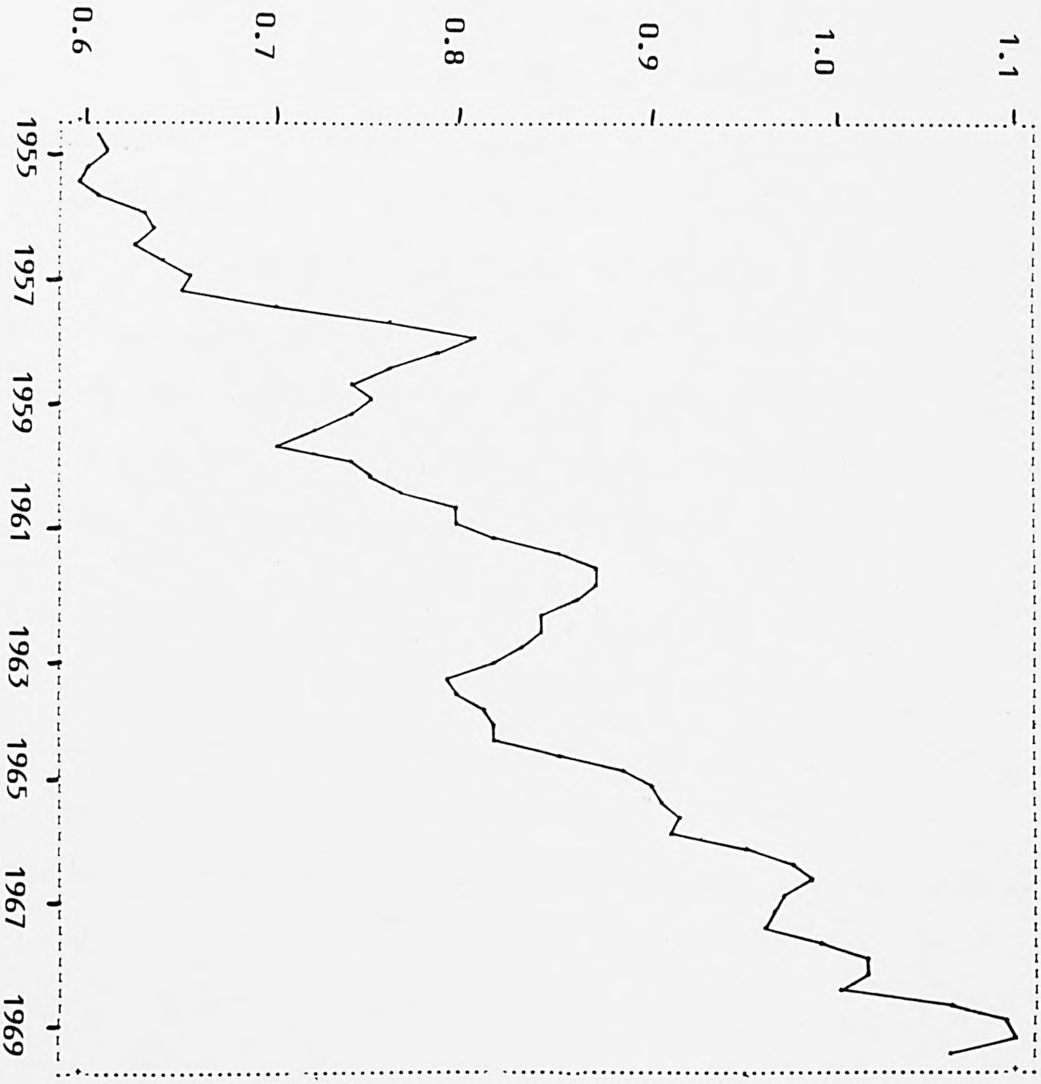


Figure (3.24)

Time to **Demand Deposits Ratio**, 1955 - 1969, quarterly



CHAPTER FOUR

Testing for Exogeneity

In chapter two (section 2.1), we argued that interest rate or exchange rate targeting policies of the monetary authorities might render the base and hence the money supply dependent upon the variables entering the money demand function. When this happens, then it might not be possible to identify the demand function. For this reason we then argued that it is the form of the resulting final specification that will decide whether the estimated general relationship between money, income, prices and interest rates should be interpreted as a demand or a supply function. We went on to note that, in econometric terms for Ordinary Least Squares, (OLS), to give consistent and efficient estimates it is necessary for the arguments appearing in the money adjustment equation to be exogenous with respect to the money stock. We then developed a formal test of exogeneity.

In this chapter we will use this test of exogeneity in order to determine two issues. First, we examine whether money, M, is exogenous with respect to income, prices, and interest rates (Y, P and r). If it is, then this implies that Y, P and r contain no information relevant to explaining the movements in money stock. There will therefore be no reason to estimate the money adjustment equation. Second we test whether Y, P and r are exogenous with respect to M. If they are, then OLS can be used to estimate the money adjustment equation. We perform these tests first with annual data for the period 1871-1913, and second with quarterly data for the sub-periods 1922-1936 and 1955-1969. In most cases this division of the sub-periods is dictated by the frequency and continuity of the data. These tests will be performed for M2 as well as for M1 for post 1922, the date when figures for M1 can be separated from M2 figures.

Testing for Exogeneity

It was explained in section (2.1) that if a dynamic regression model relating M to Y, P and r exists then M must be endogenous. This is equivalent to testing the hypothesis that in equation (2.1)

$$\sigma = [\sigma_2(L), \sigma_3(L), \sigma_4(L)] = 0$$

The test statistic is an F-statistic of the following form

$$\frac{F + (RRSS) - URSS)/r}{URSS/n-k}$$

where r = the number of restrictions

n = the number of observations

k = the number of variables

URSS is the sum of the squared residuals from estimation of (2.1) and RRSS is the sum of squared residuals from estimation under the restriction $\gamma = 0$.

Rejection of the null hypothesis, Ho (where Ho, $\gamma = 0$) would indicate that Y, P and r do in fact provide an explanation for M.*

If with this test it is established that money is in fact endogenous with respect to income, prices and interest rates we will then test whether OLS estimation is valid.

For OLS to be used appropriately, a sufficient condition is the exogeneity of the regressors, Y, P, and r and a necessary condition is the absence of simultaneous feedback. (See equation (2.12)).

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*This is a restricted F-test. A more symmetrical test would test the exogeneity of each regressor with respect to all other variables (not just M) in the system.

To perform these tests the orders of the lag polynominals are set a priori so that the individual equations can be estimated by OLS. In this case both N_1 and N_2 are set to 4 with constants being included in the regressions. Tests are performed on the regressors individually. That is, the exogeneity of the i^{th} variable in X in (2.3) is again tested with the F-statistic test set out in (4.1). In this case URSS is the unrestricted sum of squared residuals from the i^{th} equation in (2.12) and RRSS is the sum of squared residuals from the i^{th} equation obtained under the restriction $\delta_i = 0$.

In the cases where exogeneity is rejected, simultaneity is then tested by computing the t-statistic associated with the parameter δ_{io}.

Because we look at two definitions of M, we will be dealing with two alternative vectors of variables denoted:

$$Z_1 = (M1, Y, R^S, L^L, P)$$

$$Z_2 = (M2, Y, R^S, R^L, P)$$

where R^S and R^L refer to short and long interest rates respectively. The tests will be performed with annual and quarterly data.

Wherever the wage rate has been used as an additional regressor, the following two vectors are then used to perform exogeneity tests:

$$Z_3 = (M1, Y, R^S, R^L, P, W)$$

$$Z_4 = (M2, Y, R^S, R^L, P, W)$$

The F statistics and the appropriate t-statistics obtained for different periods with annual and quarterly data are given in Tables (4.1) to (4.6). The F statistics F_{M1} and F_{M2} refer to the test statistics for testing the endogeneity of M1 and M2 with respect to Y, P, R^S, R^L, (and W if it is included in the vector given at the top of the tables). F_1, F_2, F_3, F_4, F_5 refer to the F statistics for testing the exogeneity of Y, R^S, R^L, P and W respectively.

The following results emerge from these tables:

Table (4.1) gives the results for the vector Z_2 with annual data over the period 1871-1913. F_{M2} confirms the endogeneity of M2 with respect to Y, R^S, R^L and P. The F-statistics F_1 to F_4 show that the endogeneity is rejected for one regressor only, the income variable. Further, there is evidence, from the t-statistic, of simultaneity. OLS cannot be used to estimate the adjustment equation for M2 balances over this period.

Table (4.2) gives the results for the vector Z_1, with quarterly data for the period 1922-1936. F_{M1} confirms the endogeneity of M1 with respect to Y, R^S, R^L and P. The F-statistics, F_1 to F_4, show that the exogeneity is rejected for only one regressor, R^L. There is, however, no evidence of simultaneity, OLS can be used to estimate the adjustment equation for M1 balances.

Table (4.3) gives the results for the vector Z_2 with quarterly data over the period 1922-1936. F_{M2} rejects the endogeneity of M2 at the 0.05 significance level. This implies that Y, R^S, R^L and P provide no information for M2. There is, therefore, no reason to estimate the adjustment equation for M2 balances over this period. If, however, for completeness, we carry on and estimate this adjustment equation, then the F-statistics, F_1 to F_4, indicate that OLS will be appropriate since the exogeneity is rejected for only one regressor R^L, but there is no evidence of simultaneity (from the t-statistic) in this case.

Table (4.4) gives the results for the vector Z_1, with quarterly results over the period 1955-1969. F_{M1} confirms the endogeneity of M1 with respect to Y, R^S, R^L and P. The F-statistics, F_1 to F_4 show that the exogeneity is accepted for all the regressors, OLS therefore can be used to estimate the adjustment equation for M1 balances over this period.

Table (4.5) gives the results for the vector Z_3, with quarterly data over the period 1955-1969. F_{M1} confirms the endogeneity of M1 with respect to Y, R^S, R^L, P and W. The F-statistics, F_1 to F_5, confirm the exogeneity of the regressors and hence the usage of OLS for estimating the adjustment equation for M1 over this period.

Table (4.6) gives the results for the vector Z_2, with quarterly data, over the period 1955-1969. F_{M2} confirms the endogeneity of M2 with respect to Y, R^S, R^L and P. The F-statistics, F_1 to F_4 show that the exogeneity is rejected for one regressor, R^S. There is, however, no evidence of simultaneity (from the t-statistic) in this case. OLS can, therefore, be used to estimate the adjustment equation for M2 balances over the period.

TABLE (4.1)

Endogeneity/Exogeneity tests

1871-1913, Annual

$$Z_2 = (M2, Y, R^S, R^L, P)$$

The endogeneity of M2 with respect to Y, R^S, R^L and P:

$F_{M^2} = 4.69^*$

$r = 20$

$n\text{-}k = 14$

$F_{.95}(20,14) = 2.40$

The exogeneity of Y, R^S, R^L and P with respect to M2:

Y: $F_1 = 3.29^*$ $t_1 = 3.21^*$

R^S: $F_2 = 0.51$

R^L: $F_3 = 0.5$

P: $F_4 = 1.29$

$r = 5$

$n\text{-}k = 17$

$F_{.95}(5,17) = 2.81$ $t^{(17)}_{.975} = 2.10$

* (denotes significance at 0.05 level)

TABLE 4.2

Endogeneity/Exogeneity tests

1922-1936, Quarterly

$$Z_1 = (M1, Y, R^S, R^L, P)$$

The endogeneity of M1 with respect to Y, R^S, R^L and P:

$F_{M1} = 2.92$*

$r = 20$

$n-k = 31$

$F_{.95}(20,31) = 1.90$

The exogeneity of Y, R^S, R^L and P with respect to M1:

Y: $F_1 = 0.896$

R^S: $F_2 = 1.84$

R^L: $F_3 = 3.25$* $t_3^{(34)} = 1.08$

P: $F_4 = 0.36$

$r = 5$

$n-k = 34$

$F_{.95}(5,34) = 2.94$ $t_{.975} = 2.03$

* (denotes significance at 0.05 level)

TABLE (4.3)

Endogeneity/Exogeneity tests

1922-1936, Quarterly

$$Z_2 = (M2, Y, R^S, R^L, P)$$

The endogeneity of M2 with respect to Y, R^S, R^L and P

$F_{M2} = 1.84$

$r = 20$

$n-k = 31$

$F._{95}(20,31) = 1.90$

The exogeneity of Y, R^S, R^L and P with respect to M2

Y: $F_1 = 1.70$

R^S: $F_2 = 2.43$

R^L: $F_3 = 4.49$* $t_3 = 0.125$

P: $F_4 = 0.16$

$r = 5$

$n-k = 34$

$F_{.95}(5,34) = 2.49$ $t^{(34)}_{.975} = 2.03$

* (denotes significance at 0.05 level)

TABLE (4.4)

Endogeneity/Exogeneity tests

1955-1969, Quarterly

$$Z_1 = (M1, Y, R^S, R^L, P)$$

The endogeneity of M1 with respect to Y, R^S, R^L and P

F_{M1} = 2.52*

r = 20

n-k = 31

$F_{.95}(20,31)$ = 1.90

The exogeneity of Y, R^S, R^L, and P with respect to M1

Y: F_1 = 1.097

R^S: F_2 = 2.47

R^L: F_3 = 0.93

P: F_4 = 1.30

n-k = 34

r = 5

$F_{.95}(5,34)$ = 2.49

* (denotes significance at 0.05 level)

TABLE (4.5)

Endogeneity/Exogeneity tests

1955-1969, Quarterly

$$Z_3 = (M1,\ Y,\ R^S,\ R^L,\ P,\ W)$$

The endogeneity of M1 with respect to Y, R^S, R^L, P and W:

$F_{M1} = 4.40*$

$r = 25$

$n\text{-}k = 26$

$F_{.95}(25,26) = 1.95$

The exogeneity of Y, R^S, R^L, P and W with respect to M1

Y: $F_1 = 2.35$

R^S: $F_2 = 2.22$

R^L: $F_3 = 1.83$

P: $F_4 = 1.38$

W: $F_5 = 1.75$

$r = 5$

$n\text{-}k = 30$

$F_{.95}(5,30) = 2.53$

* (denotes significance at 0.05 level)

TABLE (4.6)

Endogeneity/Exogeneity tests

1955-1969, Quarterly

$$Z_2 = (M2, Y, R^S, R^L, P)$$

The endogeneity of M2 with respect to Y, R^S, R^L and P:

$F_{M2} = 2.95*$

$r = 20$

$n-k = 31$

$F_{.95}(20,31) = 1.90$

The endogeneity of Y, R^S, R^L and P with respect to M2

Y: $F_1 = 0.49$

R^S: $F_2 = 5.27*$ $t_2 = 0.23$

R^L: $F_3 = 2.42$

P: $F_4 = 1.98$

$r = 5$

$n-k = 34$

$F_{.95}(5,34) = 2.49$ $t^{(34)}_{.975} = 2.03$

* (denotes significance at 0.05 level)

Sensitivity to Serial Correlation

The foregoing results are based upon the F-statistics and the t-statistics relating to the equations of the form (2.10) and (2.11) in chapter two. One of the important conditions for these test statistics to produce reliable results is that the errors should be serially uncorrelated. When, however, we constructed the corresponding regressions for testing the exogeneity of Y, R^S, R^L and P with respect to money balances, some of these regressions showed serial correlation when tested with the Lagrange Multiplier test. In order to remove the observed autocorrelation the following procedures are applied.

(i) apply OLS to the regressions of the form (2.10) and (2.11) with four lags in the variables

(ii) investigate the autoregressive properties of the fitted residuals, u_t, by regressing u_t on u_{t-1}, ..., u_{t-4}

(iii) Check which of these coefficients were most significant and then apply a filter to the series of the form $(1 - a_1\ L - a_2\ L^2 - a_3\ L^3 - a_4\ L^4)$

(iv) Perform the necessary F-statistics and t-statistics to the prefiltered series.

After applying these filters to the series we then checked for any higher order serial correlation. In most cases we found no evidence of higher order autocorrelation. The F-statistics and the t-statistics obtained with the filtered series were not significantly different from those with the unfiltered series. That is, none of the conclusions reached were altered as a result.

Consider, for example, the F_1 statistic in Table (4.2). F_1 refers to the F-statistic for testing the exogeneity of Y with respect to M1. The unrestricted sum of squared residuals (URSS) in this case, was calculated from a regression which showed serial correlation (where the Lagrange Multiplier, $Z_1(4) = 15.54$) and the restricted residuals sum of squared, (RRSS), came from the regression which, again, showed serial correlation (where $Z_1(4) = 15.1$) When, however, we applied the above explained filter to the series, the Lagrange Multiplier tests ($Z_1(4)$) for serial correlation showed no indication of serial correlation, ($Z_1(4)$ was found to be 6.81 and 2.66 in the two regressions used to calculate the F-statistic). The F-statistic F_1 was increased substantially to 2.1 but the exogeneity of Y with respect to M1 could still be accepted at the 0.05 significance level.

Similarly, even when we observed higher order serial correlation with the filtered series, the F and t-statistics were not altered so much from those with unfiltered series that further investigations for removing higher order autocorrelation were worth pursing. In any case, in almost all these cases, it was observed that, although there was autocorrelations in the regressions including the money balances (past and present values), the regressions excluding these money balances showed no sign of autocorrelation. This result in itself provides further evidence of exogeneity of Y, R^S, R^L and P with respect to M in these regressions.

Consider, for example, the F_3 - statistic in Table (4.3). The URSS in this case, came from a regression which showed serial correlation ($Z_1(4) = 22.9$). Applying the filtering to the series reduced the serial correlation but the null hypothesis of no serial correlation could still be rejected at the 0.05 significance level ($Z_1(4) = 9.6$). The F_3 with filtered series was now 5.31 still indicating that the exogeneity of R^L with respect to M2 could not be accepted at the 0.05 significance level. As with unfiltered series, however, no evidence of simultaneity could be found (t-static = -0.4). Further, the regression excluding money balances showed no evidence of serial correlation ($Z_1(4) = 7.2$).

In this chapter we first tested whether the money adjustment equation relating money to income, prices and interest rates does in fact exist. The results showed that such a relationship can be established with annual and quarterly results for all subperiods except for the inter war period where the endogeneity of M with respect to Y, P and R is confirmed for M1 only and not for M2.

We then tested whether such a relationship can be estimated with OLS. Whenever the exogeneity of the regressors with respect to M1 and M2 has failed, a test is then performed to test whether a simultaneous feedback exists or not. The absence of simultaneity confirmed OLS to be the appropriate estimation technique for all subperiods except for the period 1871-1913 where we found evidence of simultaneity between M2 and income. For this period, an alternative method to OLS, like the Instrumental Variable, IV, estimation technique is required.

CHAPTER FIVE

Estimation: 1871-1913

In previous chapters we have discussed various theories and empirical studies surrounding demand for and supply of money. We will now check whether their implications are confirmed by our own empircial results from the period 1871-1913.

In the first section, a short summary will be given describing the behaviour of the main economic variables within this period.

The second section will deal with the money adjustment process for M2 balances. First a partial adjustment for modelling money balances will be estimated to provide both a baseline for subsequent comparison and an example of the 'conventional' approach used in most empirical studies. Second, the money adjustment process will be estimated using the three stage procedure explained in chapter two. The results obtained within this 'General to Specific' framework will then be compared with that of the conventional specification and with other empirical studies. The section will end with a discussion of the long and short run implications of the final specification.

In a similar fashion to the money adjustment process, the two money multiplier components will then be estimated in the third section. The results will then be compared to those of other empirical studies and a discussion of their implications for the money adjustment process will conclude the section.

5.1 The Period 1871-1913

We examined this period at some length in chapter three (section 3.1.2). In order to avoid repetition we will just outline the main features of the period.

This is a period of rapid growth in world economy. At the same time most fast developing countries outside Europe are experiencing financial instabilities. Most important are the various banking crises in the U.S. over the years 1879 and 1890. A major characteristic of the period for the UK is the stability created by the adjustment mechanism inherent in the workings of the Gold Standard. The implication of this fixed exchange rate regime for the economy as a whole is that key variables - money, output, prices - are tied to outputs in the world economy.

In terms of output, Britain was experiencing a slow but steady growth rate. An important feature of the period is the behaviour of prices - falling from 1873 until 1896 and then rising gradually until the end of the period. One explanation for such a behaviour in prices is found in the growth rates of money supply in relation to the course of economic activity. That is , up till 1986 the rate of growth of output was considerably faster than the monetary growth - hence prices fell. From 1896 onwards we find opposite movement in these growth rates - prices therefore rose. Overall the money supply grew at an annual rate of 1.12 per cent. There are four important peaks in the money supply series - 1876, 1884, 1892 and 1902 - all of which seem to follow the peaks in the business cycle (Burns and Mitchell, 1946). Domestic policy is constrained by the gold standard system and Bank rate is determined primarily by external considerations.

Under fixed exchange rate regime the base and ultimately the money supply are said to be endogenous and tied closely to the rest of the world's money supply. Further the operation of the gold standard mechanism implies simultaneity between base money and a broader money supply through the automatic adjustment between prices and gold flows. These conditions suggest that the simultaneity between the money supply and the arguments in its adjustment function is an important issue for this period.

This brings us to the next section where the money adjustment mechanism is examined in more detail. It should be remembered at this stage, however, that in chapter four we found simultaneity between M2 and income series.

5.2 Money Adjustment Process, 1871-1913

It was noted in chapter two that a three stage procedure will be used to estimate the money adjustment process. The general unrestricted model is of the form given in equation (2.1)

As a starting point, however, the conventional partial adjustment equation will be estimated for subsequent comparison.

It was found in chapter four that there was simultaneity between M2 and the income series, Y. OLS are therefore not appropriate. Consequently the conventional partial adjustment approach for modelling money balances has been estimated by instrumental variables, IV, with gross capital formation and the public expenditure on goods and services used as instruments for Y.

The result of the estimation is as follows.

$$M_t = \underset{(0.76)}{1.43} + \underset{(0.12)}{0.63}\, M_{t-1} + \underset{(0.11)}{0.35}\, Y_t + \underset{(0.14)}{0.51}\, P_t - \underset{(2.1)}{7.56}\, r^L - \underset{(0.51)}{0.68}\, r^S \qquad (5.1)$$

$s = 0.01669$ USS $= 0.010037$

D.W. $= 0.86$ $R^2 = 0.99$

$T = 42$

where Y = GNP at constant factor cost

$r^S = (1 + bbr)$, bbr = three month Bank Bill Rate

$r^L = (1 + cr)$, cr = the yield on $2\frac{1}{2}$ per cent Consols

M = M2 series

P = GNP deflator

All variables are in natural logarithms.

The conventional approach has been also estimated by OLS so that its results can then be compared to those obtained with Instrumental Variables method. Estimation by OLS gave:

$$M_t = \underset{(0.56)}{1.35} + \underset{(0.07)}{0.65}\,M_{t-1} + \underset{(0.07)}{0.34}\,Y_t + \underset{(0.11)}{0.05}\,P_t - \underset{(2.05)}{7.52}\,r^L - \underset{(0.45)}{0.65}\,r^S \qquad (5.2)$$

$s = 0.0166896$ $T = 42$ $\bar{R}^2 = 0.99387$

$DW = 0.85$ $R^2 = 0.99462$ $h = 4.18$

$USS = 0.010028$

The estimated coefficients and the implied long-run elasticities are not different than those obtained in (5.1). Further, Godfrey (1978) pointed out that the DW and some other statistics are invalid when the residuals of an instrumental variable approach are used. Moreover, the Wu-Hausman test(*) implies that there is a lack of correlation with respect to the instruments used.

(*) Wu-Hausman test, in this case, would involve first obtaining the residuals, v, from the following regression

$$Y_t = \alpha_o + \alpha_1 M_{t-1} + \alpha_2 P_t + \alpha_3 r_t^S + \alpha_4 r_t^L + \alpha_5 GE + \alpha_6 INV$$

where GE and INV are the instruments used for Y and then testing the hypothesis of $\beta_6 = 0$ in the following regression.

$$M_t = \beta_o + \beta_1 M_{t-1} + \beta_2 Y_t + \beta_3 P_t + \beta_4 r_t^S + \beta_5 r_t^L + \beta_6 v$$

In this case the estimated coefficient for v turns out to be -0.02 with a standard error of (0.15)
For details of this test, see Hausman (1978)
The sources of data are:

GE = Public Authorities' current expenditure on goods and services
Feinstein (1972), Table 7, T22, Column (2)

INV = Gross Domestic Fixed Capital Formation
Feinstein (1972), Table 7, T22, Column (3)

TABLE 5.1

Estimation results of the general specification for M2:
1871-1913, annual

j	0	1	2	3	4
Y_{t-j}	0.31 (0.09)	-0.03 (0.12)	-0.12 (0.13)	0.02 (0.11)	-0.01 (0.11)
P_{t-j}	0.25 (0.15)	-0.13 (0.15)	0.38 (0.14)	-0.36 (0.13)	0.05 (0.15)
r^S_{t-j}	-0.82 (0.33)	-0.12 (0.39)	-0.21 (0.50)	0.11 (0.39)	-0.20 (0.33)
r^L_{t-j}	1.71 (3.34)	-5.14 (4.66)	3.15 (4.96)	-0.47 (4.81)	3.47 (3.81)
M_{t-j-1}	1.53 (0.25)	-1.0 (0.44)	0.51 (0.38)	-0.19 (0.18)	

$R^2 = 0.999$ $a_0 = 0.95$ (0.64)

$\bar{R}^2 = 0.998$ $T = 39$

DW = 2.25 standard errors are in brackets

$s = 0.008171$ $Z_1(4) = 4.32$

The residual diagnostic test accompanying equation (5.2) shows the presence of serial correlation. Further, an inspection of residual correlogram shows $\hat{r}_1 = 0.49$, $\hat{r}_2 = 0.23$ and $\hat{r}_3 = 0.35$ suggesting the possibility of mis-specification.

In view of these results, the order of the lag polynominal in (2.1) is set to four. That is the general specification considered is of the following form.

$$M_t = a_o + \sum_{j=o}^{4} (\beta_j Y_{t-j} + \gamma_j P_{t-j} + \delta_j r^L_{t-j} + \alpha_j r^S_{t-j} + n_j M_{t-j-1}) \tag{5.3}$$

Due to the close similarity between OLS and IV estimators, (5.3) is estimated using OLS, the results of which are shown in table (5.1).

Performing the sequence of individual t-tests first on the interest rates, then on income, led to the following intermediate stage:

$$\begin{aligned} M_t = {} & \underset{(0.39)}{1.30} + \underset{(0.11)}{1.57}\, M_{t-1} - \underset{(0.21)}{1.13}\, M_{t-2} + \underset{(0.2)}{0.60}\, M_{t-3} - \underset{(0.11)}{0.27}\, M_{t-4} + \underset{(0.08)}{0.25}\, P_t \\ & - \underset{(0.09)}{0.09}\, P_{t-1} + \underset{(0.09)}{0.21}\, P_{t-2} - \underset{(0.09)}{0.35}\, P_{t-3} + \underset{(0.74)}{0.16}\, P_{t-4} - \underset{(2.19)}{5.35}\, r^L_{t-1} \\ & + \underset{(2.5)}{5.20}\, r^L_{t-2} - \underset{(0.21)}{0.71}\, r^S_t + \underset{(0.05)}{0.36}\, Y_t - \underset{(0.06)}{0.13}\, Y_{t-2} \end{aligned} \tag{5.4}$$

$DW = 2.11$ $\quad R^2 = 0.999$ $\quad Z_1(4,16) = 2.47$

$s = 0.006994$ $\quad \bar{R}^2 = 0.9989$

$T = 39$ $\quad Z_5 = (10,14) = 0.36$

The F-test Z_5 indicates that (5.4) can not be rejected against the maintained specification.

Progressing from (5.4) and testing whether each variable should appear in level or differenced form yielded:

$$\begin{aligned}\Delta(M-P)_t = & \underset{(0.02)}{0.01} + \underset{(0.04)}{0.48}\, \Delta^2(M-P)_{t-1} + \underset{(0.04)}{0.16}\, \Delta_2 Y_t \\ & - \underset{(0.05)}{0.72}\, \Delta^2 P_t - \underset{(0.03)}{0.21}\, (M-P)_{t-4} - \underset{(0.16)}{0.86}\, r^S_t \\ & + \underset{(0.03)}{0.21}\, Y_t - \underset{(1.84)}{6.21}\, \Delta r^L_{t-1} \qquad (5.5)\end{aligned}$$

$R^2 = 0.93$ $\bar{R}^2 = 0.911$

$DW = 2.04$ $s = 0.006934$

$Z_1(4) = 5.27$ $Z_3(6) = 3.84$ $Z_5(17,17) = 0.48$

$Z_2(28) = 24.42$ $Z_4(8,25) = 1.05$ $Z_6(17,22) = 1.696$

The tests following the final specification, equation (5.5) all pass with flying colours. The F-test Z_5 does not reject the restrictions implied by the specification against the maintained equation. The residual diagnostic tests show no evidence of mis-specification. The Chow test for parameter stability, Z_4, also confirms that the final specification is robust. The following specification gives the results of estimating specification (5.5) for two sub-periods. The period 1871 - 1896 in a period of falling prices and 1896 - 1913 in that of rising prices.

1871-1896

$$\Delta\ (M-P)_t = \underset{(0.06)}{-\ 0.06} + \underset{(0.05)}{0.47}\ \Delta^2(M-P)_{t-1} + \underset{(0.06)}{0.17}\ \Delta_2 Y_t - \underset{(0.07)}{0.70}\ \Delta^2 P_t$$

$$\underset{(0.05)}{-0.19}\ (M-P)_{t-4} \quad - \underset{(0.24)}{0.84}\ r_t^s + \underset{(0.05)}{0.21} Y_t - \underset{(3.5)}{2.13}\ \Delta\ r_{t-1}^L \qquad (5.6)$$

$R^2 = 0.94$

$\bar{R}^2 = 0.912$

DW = 2.05

1897-1913

$$\Delta\ (M-P)_t = \underset{(0.2)}{0.44} + \underset{(0.08)}{0.60}\ \Delta^2(M-P)_{t-1} + \underset{(0.83)}{0.01}\ \Delta_2 Y_t - \underset{(0.08)}{0.75}\ \Delta^2 P_t$$

$$\underset{(0.08)}{-0.38}\ (M-P)_{t-4} \quad - \underset{(0.3)}{0.17}\ r_t^s + \underset{(0.05)}{0.28}\ Y_t - \underset{(2.33)}{5.76}\ \Delta\ r_{t-1} \qquad (5.7)$$

$R^2 = 0.942$ DW = 2.36

$\bar{R}^2 = 0.897$ s = 0.00616

We should remark briefly on the short-run results before examining the steady state long-run results. The short-run dynamics are quite complex despite the relative simplicity of the final specification.

The following table gives the solved coefficients for the specification (5.5).

TABLE (5.2)

Solved Coefficients for M2

1871-1913, annual

j	0	1	2	3	4
M_{t-j-1}	1.48	-0.96	0.48	-0.21	-
P_{t-j}	0.28	-0.04	0.24	-0.48	0.21
r^{S}_{t-j}	-0.86	-	-	-	-
r^{L}_{t-j}	-	-6.21	+6.21	-	-
Y_{t-j}	0.37	-	-0.16	-	-

When we examine the response time paths of the series to shocks in the exogenous variables we find that in relation to income, the response is an initial overshoot with subsequent negative effects taking the total effect to unity. A similar response is observed in relation to the interest rates, and price level. Figures (5.1), (5.2) and (5.3) illustrate these short-run movements in money balances for one per cent increase in income, price level and interest rates respectively.

Figures (5.1), (5.2) and (5.3)

Short-run movements in M2 for 1% increase in income, prices and interest rates

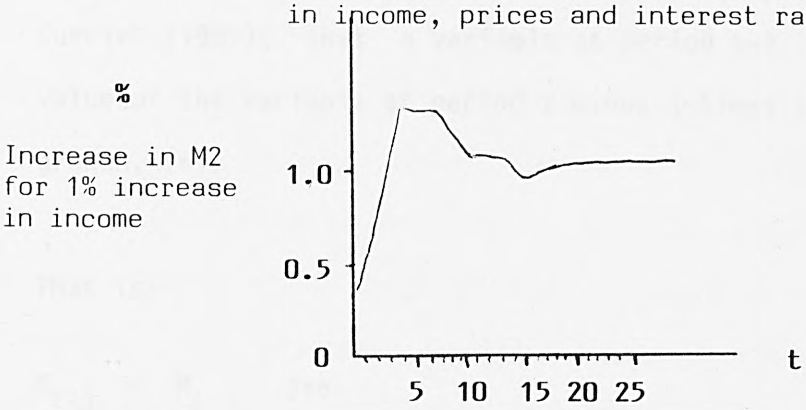

Figure (5.1)

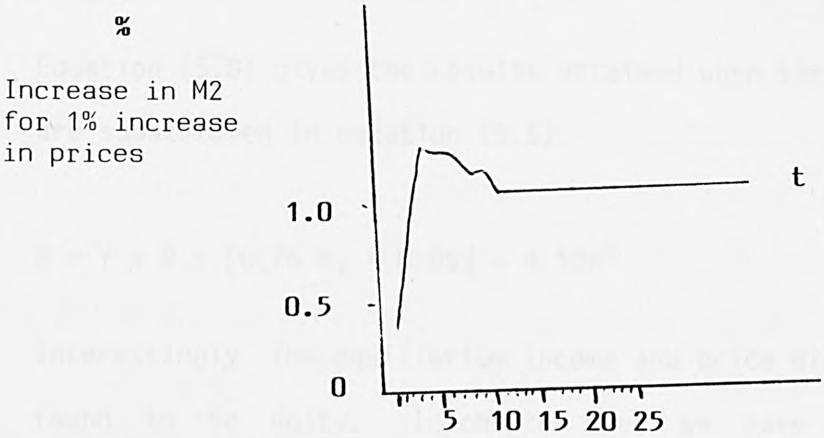

Figure (5.2)

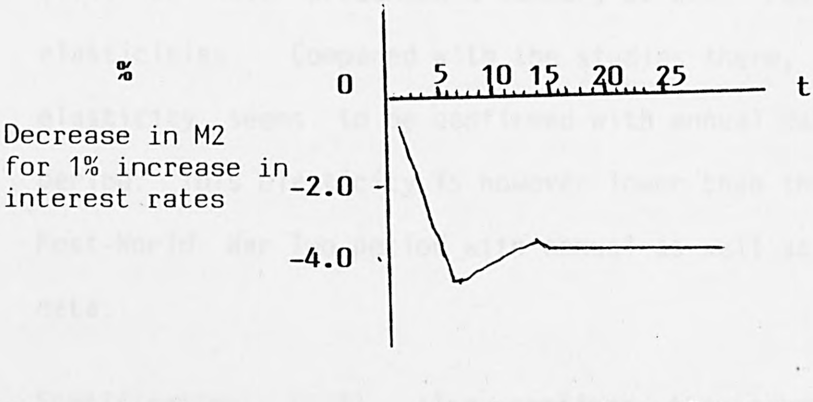

Figure (5.3)

The long-run relationship can be seen if we are in steady-state. In order to examine the long-run properties it is assumed with Currie (1981), that a variable at period t-j is equal to the value of the variable at period t minus j times its trend rate of growth, (π).

That is:

$$M_{t-j} = M_t - j\pi o$$
$$Y_{t-j} = Y_t - j\pi 1$$
$$P_{t-j} = P_t - j\pi 2$$

Equation (5.8) gives the results obtained when these assumptions are substituted in equation (5.5)

$$M = Y + P + [0.76\ \pi_1 + 0.05] - 4.10r^S \qquad (5.8)$$

Interestingly the equilibrium income and price elasticities are found to be unity. In chapter one, we have discussed the empirical results from major U.K. and U.S. studies. In Table (1.4) we have presented a summary of U.K. results on income elasticities. Compared with the studies there, a unity income elasticity seems to be confirmed with annual data for the same period. This elasticity is however lower than those reported for Post-World War Two period with annual as well as with quarterly data.

Specification (5.8) also confirms the common view that transactors are concerned with the real purchasing power of money balances; that is, M is found to be homogenous of degree one in prices which imiplies the absence of money illusion.

The long-run interest elasticity of M2 with respect to the Bank Bill rate, evaluated at the mean yields -0.11. The static equilibrium properties with respect to income, prices and interest rates are in conformity with most other studies. Among them, a good example would be the study by Klovland (1986) where the demand for money in the U.K. is examined for the period 1875-1914. The "preferred equation" in this study relates the real demand for money to income, the own rate of return on money and the yields on two substitute assets. There is, however, some difference between his results and ours. Klovlands's preferred equation is shown to be significantly affected by the rate of return on deposits and the Consol yield. Our final specification, however, is affected by the Consol rate in the short run only and the interest rate on time deposits is not included as a separate variable in our specification search.

The steady state results show money balances to have a positive real growth elasticity of the order 0.76 . In section (1.2) we argued with Gurley and Shaw (1967) that at relatively early stages of development a positive relationship between real growth and money balances should be expected; since money at those stages of development constitutes almost the only store of value. At higher stages of development, as in the post-war period, the relationship between money balances and real growth becomes negative since alternative financial assets grow faster than money balances as means of storing wealth. The empirical results that relate to the post 1963 period - e.g. Hendry and Mizon

(1978) - support such a negative relationship. It remains to be seen whether we will come to the same conclusion with our data.

5.3 Money Multiplier Components

In this section we analyse the components of the money multiplier. With the currency to total deposits ratio we examine the public's behaviour and with the reserve to total deposits ratio, that of the banking sector.

The currency ratio follows a downward trend from around 25 per cent at the beginning of the period to about 10 per cent towards the end. The increasing familiarity with the banking system and the spread of the banking are the two obvious explanations for this downward trend behaviour over this period.

The reserve ratio on the other hand, shows just the opposite movement, following a gradually rising trend from around 9 per cent to about 13 per cent. The main reason is thought to be the widespread feeling that larger reserves should be held in order to strengthen the public's confidence in banks.

5.3.1 Currency-Deposit Ratio

For the period 1871-1913 it is not possible to separate demand deposits from time-deposits. We can not therefore examine the currency to demand deposits ratio but only the currency to total deposits ratio to explain the public's behaviour. In chapter one, section (1.3), we have analysed the variables that are expected to affect this currency-ratio. Equation (1.30) gave these theoretical variables.

A dynamic specification for equation (1.30) in an unrestricted general form is given in equation (5.9).

$$({}^{C}/_{D})_t = a_o + \sum_{j=o}^{2} (a_{1+j}\, Y_{t-j} + a_{4+j}\, P_{t-j}$$

$$+ a_{t\div j}\, ({}^{r}TD)_{t-j} + a_{10+j}\, F^{*}{}_{t-j}$$

$$+ a_{13+j}\, (\frac{C}{D})_{t-j} + uc \qquad (5.9)$$

where

Y = GNP at constant prices

(r_{TD}) = (1+TDR), TDR = time-deposit rate

F^{*} = bank safety index = (1-F), F = bank failure rate

P = GNP deflator

In equation (5.9) the order of the lag polynominal is set at two. The residual correlogram and the diagnostic tests did not show any mis-specification, so that equation (5.9) can be treated as sufficiently general.

Initially, two representative rates of interest are chosen: the Bank-Bill rate and the rate on time-deposits. The former rate, however, turned out to be insignificant and was therefore dropped.

In our study, the bank failure rate, F, is represented by the proportion of the total number of banks that failed during the year. Another measure could be the ratio of deposits in failed banks to total deposits, but, for the period 1871-1913, data limitations prevent the usage of such a proxy.

It should be observed that in the UK over this period banks did not fail outright, with associated loss of depositors funds. Rather, they were taken over by, or amalgamated with, another bank. We treat these takeovers as equivalent to outright failure in the information they conveyed about the banking system; the reason for the takeover was usually well known.

The importance of the inflation rate in the UK money adjustment process is confirmed in the previous section for the period 1871-1913. We will let the data show us how this variable can be constructed for the currency-ratio, that is we include the prices in level form (current and lagged) as separate variables rather than in differenced form.

Finally, due to the lack of empirical evidence on the significance of the public's tax liabilities in the currency-ratio (see section 1.3.4) and data limitations over the construction of this variable over the period, this variable is ignored in the regression.

Table (5.3) shows the results of estimating equation (5.9)

Restrictions were then imposed on the maintained hypothesis and testing was continued down to a parsimonious model. The final specification finally reached is as follows:

$$({}^{C}/{}_{D})_t = \underset{(0.14)}{0.25}\ ({}^{C}/{}_{D})_{t-1} \underset{(0.15)}{-0.69}\ Y_t \underset{(0.4)}{-0.68}\ \Delta P_t$$

$$\underset{(0.95)}{+1.8}\ [1+(r_{TD})_t] \underset{(0.97)}{-2.00}\ F^*_{t-1} \underset{(0.9)}{+3.53} \qquad (5.10)$$

$R^2 = 0.94^{(*)}$ $Z_5(9,35) = 0.5$ $Z_4(6,29) = 0.55$

$R^2 = 0.93$ $Z_2(15) = 11.68$ $Z_3(10) = 19.37$

$s = 0.0619$ $Z_1(4) = 4.13$ $Z_6(14,17) = 1.06$

standard errors are given in brackets

The resulting specification shows that the level of the currency ratio is well explained by current real income, the time-deposit rate, the current inflation rate, and the previous year's performance of the banking system as suggested by the proxy, the bank failure-rate variable.

Paremeter estimates all have the expected signs. The interest rate is significant at the one per cent level. Its positive effect on the ratio can be explained by the switch from deposits to other assets since all interest rates might be expected to move together (the Bank Bill rate was tried as a representative yield on assets other than deposits but was dropped because it appeared insignificant).

The currency ratio appears rather elastic with respect to the time deposit rate, but this is due to the variable being (1+r) rather than just r. This elasticity evaluated at the mean yields 0.06.

TABLE (5.3)

Estimation Results of the general specification

for the currency-ratio: 1871-1913, annual

j	0	1	2
Y_{t-j}	-1.27 (0.49)	0.46 (0.70)	-0.04 (0.46)
P_{t-j}	-0.72 (0.65)	0.75 (0.9)	0.047 (0.6)
$(r_{TD})_{t-j}$	1.486 (1.23)	-0.23 (1.2)	-1.6 (1.3)
F^*_{t-j}	0.17 (1.27)	-1.99 (1.2)	-0.05 (1.20)
$(^C/_D)_{t-j}$	0.25 (0.20)	-0.177 (0.20)	

$R^2 = 0.948$ $s = 0.07$ $a_o = 4.48$ (1.47)

$\bar{R}^2 = 0.91$ $Z_1(4) = 3.29$ $T = 41$

Standard errors are given in brackets

The coefficient on the own rate of return (- the inflation rate) shows that as the expected inflation rate rises this reduces the currency ratio. This implies that real assets are substituted for currency as the inflation rate rises. The coefficient of the variable measuring bank safety is significant and has the right sign. It shows that as there is an increase in the banks' failure rate people switch from deposits to currency. The elasticity of the currency ratio with respect to the failure rate, F, evaluated at the mean yields 0.04. Similarly the coefficient on the real income variable is of the expected size and magnitude. Rising real income changes the mode of life, tending to reduce the relative demand for currency by converting the practice of holding wealth in currency to deposits since as a way of holding money balances, deposits are regarded as superior to currency. Another possible explanation is as follows: the spread of banking following urbanization provides familiarity with the advantages of deposit banking which in turn encourages the banking habit and reduces the relative use of currency. The effect of urbanization however can not be separated from that of real income, and the 'income effect' combines the two.

Before commenting further on the currency-deposit ratio, let us examine the reserve to total deposits, ratio, r.

5.3.2 Reserve - Deposit Ratio, (r-ratio)

Following the theoretical and empirical discussion on the reserve ratio (Sections 1.3.3 and 1.3.4) the following dynamic specification is chosen to represent the unrestricted general form in our specification search:

$$\left(\frac{R}{D}\right)_t = b_o + \sum_{j=o}^{2} (b_{1+j} \, (^rBB)_{t-j} + b_{4+j} \, (^rBR)_{t-j}$$
$$+ b_{7+j} \, Y_{t-j} + b_{10+j} \, F^*_{t-j}$$
$$+ b_{13+j} \left(\frac{R}{D}\right)_{t-j-1}) + ut \qquad (5.11)$$

where

Y = GNP at constant prices

r_{BR} = the Bank Rate

r_{BB} = the rate of interest on Bank Bills

F^* = bank safety index, $(1 - F)$, F = bank-failure rate

(All variables are transformed logarithmically)

Equation (5.11) represents a rather simplified version of equation (1.33). This is because, first the proportion of time-deposits out of total deposits, the variable $TD/_D$ in equation (1.33), cannot be constructed since time deposits cannot be separated from demand deposits over this period.

The second simplification is with respect to the variable representing the variability of deposits, AD. In order to proxy the uncertainty about the outflow of deposits, a series is constructed as the standard deviation of four-yearly moving average of deposits. This variable, however, appeared insignificant and was therefore dropped.

Two additional variables have been used in an attempt to capture the effect of the above omitted variables: the real income and the bank-failure rate. The importance of these variables in the reserve ratio is confirmed with the studies by Cagan (1961) and by Friedman and Schwartz (1971). (For details, see section 1.3.4). The further additional variable the Bank rate, r_{BR}, is included in order to capture the cost to the banks of last resort borrowing. An increase in the Bank rate increases the cost of obtaining funds from the Bank of England and thus leads banks to hold lower reserves.

Finally, there were no legal reserve requirements over this period and there was no agreement among 'all' banks as to the minimum level at which to hold their reserves. The dependent variable, therefore, is not excess reserves to deposits ratio (as suggested by equation (1.33)) but 'total' reserves to deposits ratio.

The following table gives the results of estimating equation (5.11).

TABLE (5.4)

Estimation results of the general specification

for the reserve-ratio: 1871-1913, annual

j	0	1	2
$(rBB)_{t-j}$	-2.31 (2.98)	0.05 (2.86)	2.09 (2.77)
$(rBR)_{t-j}$	2.20 (2.87)	1.05 (2.83)	-2.07 (2.64)
Y_{t-j}	0.20 (0.46)	0.41 (0.60)	0.69 (0.42)
F^*_{t-j}	-3.98 (1.03)	-1.91 (1.24)	-1.70 (1.17)
$(\frac{R}{D})_{t-j}$	0.40 (0.17)	0.15 (0.17)	-

$D.W = 2.115$ $\qquad Z_1(2) = 1.8$

$R^2 = 0.78$ $\qquad \bar{R}^2 = 0.68$

$s = 0.06196$ $\qquad a_o = -1.66\ (0.57)$

Restrictions are imposed on the maintained hypothesis which led to the following final specification:

$$\left(\frac{R}{D}\right)_t = \underset{(0.11)}{0.58}\left(\frac{R}{D}\right)_{t-1} \underset{(0.8)}{+1.49}(r_{BR})_{t-1}$$

$$\underset{(0.92)}{-3.96F^*}_t \quad \underset{(1.0)}{-1.74F^*}_{t-1} \quad \underset{(0.98)}{-2.03F^*}_{t-1}$$

$$\underset{(0.34)}{-0.64}\ \Delta Y_{t-1} \quad \underset{(0.29)}{-1.08} \qquad (5.12)$$

$R^2 = 0.74(*)$ $\qquad Z_5(8,34) = 0.57$ $\qquad Z_3(5) = 4.34$

$\bar{R}^2 = 0.70$ $\qquad Z_1(2) = 1.08$ $\qquad Z_6(15,13) = 1.37$

$s = 0.058$ $\qquad Z_4(7,27) = 0.99$ $\qquad Z_2(21) = 21.42$

standard errors are given in brackets.

The resulting specification shows that the level of the reserve-ratio is well explained by the level of the Bank rate lagged one year, the rate of growth of income, and the level of current and past values of the bank safety variable.

All the variables have the expected signs and are of the anticipated magnitude. The Bank Bill rate which represents the opportunity cost to the bank of holding non-interest bearing cash reserves was non-significant and hence was dropped. The elasticity of the reserve-ratio with respect to the Bank rate evaluated at the mean yields 0.14. (This variable is significant at the 1 per cent significance level and not at the 5 per cent). Its positive coefficient shows that as the cost of the last resort borrowing (that is the expected cost to the bank of obtaining funds from the Bank of England) increases, this encourages the banks to hold larger reserves. The elasticity with respect to the bank failure rate, again evaluated at the mean yields 0.2. Its sign shows that as financial crisis produce panics in the banking system, the banks feel the need to raise their safety margin.

Homogeneity

In the above estimation, following most empirical studies, e.g. Boughton and Wicker (1979), we proceeded without considering the importance of homogeneity. We turn briefly and finally to this issue now. The general specifications (5.9) and (5.11) assumed homogeneity with respect to deposits, and the question is, is such an assumption justified or more interestingly, what happens to the results when such an assumption is relaxed.

One way of testing this would be to include deposits (*) in current levels and lagged one period, as separate regressors in the final specifications (5.10) and (5.12) and then check their significance. Equations (5.13) and (5.14) give these results for (5.19) and (5.12) respectively.

(*) logarithm of deposits

$$\begin{aligned}(\tfrac{C}{D})_t = {} & \underset{(0.81)}{3.33} + \underset{(0.15)}{0.29}\,(\tfrac{C}{D})_{t-1} \underset{(0.21)}{-0.63}\,Y_t \\ & \underset{(0.46)}{-0.26}\,\Delta P_t + \underset{(0.91)}{1.39}\,(r_{TD})_t \underset{(0.91)}{-1.71}\,F^*_t \\ & \underset{(0.34)}{-0.84}\,D_t + \underset{(0.32)}{0.82}\,D_{t-1}\end{aligned} \tag{5.13}$$

$s = 0.05766$

$R^2 = 0.9526$ $D.W = 1.93$

$R^2 = 0.94$

$$\begin{aligned}(\tfrac{R}{D})_t = {} & \underset{(0.46)}{-1.71} + \underset{(0.12)}{0.52}\,(\tfrac{R}{D})_{t-1} + \underset{(0.84)}{1.33}\,(r_{BR})_{t-1} \\ & \underset{(0.92)}{-3.53}\,F^*_t - \underset{(1.05)}{1.30}\,F^*_{t-1} - \underset{(0.97)}{1.79}\,F^*_{t-2} \\ & \underset{(0.36)}{-0.51}\,Y_{t-1} \underset{(0.37)}{-0.30}\,D_t + \underset{(0.37)}{0.37}\,D_{t-1}\end{aligned} \tag{5.14}$$

$s = 0.0572936$ $\bar{R}^2 = 0.72$

$D.W = 2.27$

$R^2 = 0.77$

From equation (5.14) it can be seen that the assumption of homogeneity is not rejected for R/D ratio; in equation (5.13), however, deposits D_t and D_{t-1} both appear significant suggesting that they should have been allowed for in the general specification for C/D. Starting from such a maintained and then imposing restrictions resulted in the following specification:

$$\left(\frac{C}{D}\right)_t = \underset{(0.82)}{3.27} + \underset{(1.15)}{0.32}\left(\frac{C}{D}\right)_{t-1} \underset{(0.21)}{-0.60}\, Y_t$$

$$\underset{(0.86)}{1.27}\,(r_{TD})_t \underset{(0.92)}{- 1.73}\, F^*_{t-1} \underset{(0.37)}{-1.0}\, D_t$$

$$\underset{(0.33)}{0.96}\, D_{t-1} \qquad (5.15)$$

$s = 0.0577$ $\quad R^2 = 0.95$ $\quad Z_1(4) = 3.04$ $\quad Z_3(5) = 6.96$

$Z_5(11,24) = 0.31$ $\quad \bar{R}^2 = 0.94$ $\quad Z_2(6) = 11.42$ $\quad Z_4(7,28) = 0.95$

An important result that emerges from equation (5.15) is that the own rate of return, ΔP_t, appeared insignificant and had to be dropped. The final specification for $(\frac{C}{D})$ ratio suggests that D_t and D_{t-1} can be modelled together as ΔD_t implying that no long-run result can be obtained with respect to that variable: that is, when there is a shock to deposits, $(\frac{C}{D})$ adjusts temporarily but no permanent effect is observed.

The important results emerging from this section are:

Firstly, the currency and reserve ratios have been identified as being determined by robust and parsimonous functions. Secondly, in their examination, an important variable has been identified, the bank failure rate (proxying the conditions in the financial sector), the impact of which appears to have been important in both functions. Two additional variables, interest rates and the income term, both appear important in the functions.

Finally, in the case of currency-ratio only, the rate of growth of deposits seem to provide further explanation in the behaviour of the public over the period 1871-1913. Since the inflation term appeared insignificant when ΔD was included as an additional regressor, this implies collinearity between the two terms. Presumably, the explanation for the term ΔD in the function for C/D ratio could be that an increase in money supply would firstly induce individuals to accumulate it in the form of deposits which will reduce the C/D ratio. They will then gradually adjust their spending behaviour so that only the rate of growth of deposits and not the level of deposits affect the ratio.

CHAPTER SIX

Estimation: 1922-1936

In chapter five we analysed the money adjustment process and the money multiplier components over the period 1871-1913 with annual data. In this chapter we perform a similar exercise for the interwar period. First, we outline the major events in the period emphasizing the behaviour of the principal economic variables. We then go on to the money adjustment process over this period. From 1922 onwards, we can separate time deposits from demand deposits and will, therefore, analyse M1 balances and M2 balances separately. Further, it is also possible to obtain quarterly series for M1 and M2 balances. The quarterly series for income however is best used only until 1936. Due to these limitations the period that will be considered here starts in 1922 and ends in 1936.

The section will start by estimating M1 balances in a conventional framework, i.e. in a partial adjustment process. Then, using the three stage procedure described in chapter two, the money adjustment process for M1 will be examined. The results will then be discussed and compared with that of 1871-1913 and some other studies.

One of the important results of chapter four was that, over the interwar period, M2 balances appeared exogenous with respect to income, prices and interest rates, implying that these latter economic variables provided no information to explain changes in M2. However, for completeness and comparison with the results we have obtained for M1, we will still estimate M2 balances using the same 'General to Specific' methodology. A discussion on the results with their implications for the short and long run will end the section.

The third section will deal with the money multiplier components. The public's behaviour will be analysed with two ratios: the currency/demand deposit ratio, and the time demand/deposit ratio. Since we cannot separate the banks' reserves held against demand deposits from those held against time deposits the behaviour of the banking sector will be analysed as before, with the reserve to 'total' depsosits ratio. The section will end with a discussion of the results of these money multiplier components.

6.1 The Interwar Period

With respect to the world economy, the interwar years were characterised by instabilities in the volume of trade and in the income of Britain's trading partners. Various banking crises, the stock market collapse in the USA, the scramble for liquidity in the US and in Europe are the main features of the period.

This severe disruption in the world economy was not experienced in the UK. In fact the UK economy was free of any banking crisis or of any financial difficulties and Britain's output growth was on average over the period better than it had been for forty years. However, UK's output did fluctuate much more around its average than over the pre World War One era. High levels of unemployment were experienced and until 1933 there was a secular price deflation. There were two domestic recessions: 1926-28 associated with the mining strike and 1929-32 associated with the worldwide Great Depression.

The severe disruption in Britain's trading partners meant that open economies (such as Britain) were liable to suffer severe buffeting. This forced the authorities in Britain to use different exchange rate regimes - first floating exchange rates until 1925 and from then until 1931 a new gold exchange standard at the pre war parity of $4.86. From 1932 to 1939 sterling was left to float with some official intervention.

With respect to monetary policy, first a 'dear money' policy until 1931/32 and then from there onwards a 'cheap money' policy was followed.

Partly as a result of these policies, both M1 and M2 fell between

1922 and 1929 (by 9 and 5 per cent annually respectively), and continued to fall until the beginning of cheap money period (by 11 per cent and by 0.5 per cent respectively between 1929 and 1932). They then rose rapidly during the cheap money period (M1 by 27 per cent and M2 by 15 per cent between 1933 and 1939).

Let us then examine the effect of these discontinuities in the government policy and in the exchange rate regime, and of the disruption in the world economy on the UK's money balances.

6.2 Money Adjustment Process, 1922-1936

6.2.1 M1 balances

In chapter four, the endogeneity of M1 balances with respect to income, prices and interest rates (Y,P,r) has been confirmed with quarterly data for the interwar period. We then tested whether Y, P and r were exogenous with respect to M1. The test results showed that their exogeneity was rejected for only one regressor, the Consol rate. However, since there was no evidence of simultaneity between this rate and M1, Ordinary Least Squares can be used to estimate the adjustment equation for M1 balances.

Before, however, we apply the three - stage procedure to estimate the adjustment equation for M1 balances we will start, as in the case of 1871-1913, by estimating the conventional partial adjustment equation over the period 1922-1936 with quarterly data.

The result of the estimation is as follows

$$M_t = \underset{(0.07)}{2.25} + \underset{(0.06)}{0.81} M_{t-1} + \underset{(0.05)}{0.09} P_t + \underset{(0.054)}{0.032} Y_t$$

$$- \underset{(0.30)}{0.27} r^S_t - \underset{(1.22)}{3.27} r^L_t \qquad (6.1)$$

$R^2 = 0.946$ $s = 0.0166$ $T = 59$

$\bar{R}^2 = 0.94$ D.W. $= 1.21$ $h = 3.42$

where

P = Ministry of Labour Retail Price Index

Y = Composite Index of Economic Activity

r^S = (1+bbr), bbr = three month Bank Bill Rate

r^L = (1+cr), cr = the yield on 2½ per cent Consols

M = M1 balances

P, Y, M series are seasonally adjusted series. All variables are in natural logarithms.

The results shown in equation (6.1) show the income term and the short-term interest rates to be significant. The price elasticity is about 0.5. Durbin h-test shows the presence of autocorrelation. In the conventional approach these results would have been sufficient to mean that there is 'error' autocorrelation. To 'cure' this problem, a Cochrane-Orcutt method would have been employed; the results of which yield:

$$M_t = \underset{(0.93)}{3.49} + \underset{(0.07)}{0.71M_{t-1}} + \underset{(0.73)}{0.12P_t}$$

$$\underset{(0.07)}{0.04Y_t} \; \underset{(0.39)}{-0.40r^s_t} \; \underset{(1.7)}{-4.12r^L_t} \tag{6.2}$$

R^2 = 0.999 D.W = 2.00 ρ = 0.47(0.13)

$\bar{R}^2$ = 0.999 s = 0.01538 $Z_7(1)$ = 6.5 T = 59

At first glance, equation (6.2), it seems that the error-autocorrelation is in fact cured. D.W is now 2.0 and ρ appears significant. A likelihood ratio test, however, given by Z_7 reveals that the 'common-factor restriction' implied by equation (6.2) is rejected, (see Hendry and Mizon, 1978). This means that the results of (6.1) showed 'residual' autocorrelation and not 'error'-autocorrelation. Inspection of the residual correlogram for (6.1) shows $\hat{r}_1 = 0.32$, suggesting the possibility of mis-specification.

On testing dynamic specification more generally, estimation of the maintained hypothesis, as given by equation (2.1) in chapter two with fourth order lag polynomials for the variables, gives the following results:

TABLE (6.1)

Estimation results of the general specification
for M1
1922 Q1 - 1936 Q4

j	0	1	2	3	4
Y_{t-j}	-0.025 (0.09)	0.018 (0.141)	-0.011 (0.14)	-0.05 (0.12)	0.045 (0.08)
P_{t-j}	0.013 (0.21)	0.19 (0.26)	-0.25 (0.26)	0.03 (0.26)	0.07 (0.21)
r^S_{t-j}	0.29 (0.52)	-2.03 (0.81)	1.90 (0.94)	-0.076 (0.95)	0.50 (0.59)
r^L_{t-j}	-3.52 (3.05)	3.72 (4.02)	-6.65 (4.13)	2.09 (4.10)	1.34 (2.98)
M_{t-j-1}	0.87 (0.18)	0.28 (0.24)	-0.21 (0.24)	0.08 (0.15)	-

a_0	= -0.51 (1.26)	T	= 56
R^2	= 0.98	s	= 0.0134
$\bar{R}^2$	= 0.96	$Z_1(4,23)$	= 3.56

The Lagrange Multiplier test for serial correlation fails at conventional significance level. Increasing the number of lags in each variable does not remove the observed autocorrelation. In fact, the result of the Lagrange Multiplier test on this ($Z_1(4,17) = 4.17$), shows further that this is the wrong direction to take. Reducing the number of variables, however, seems to help. At this stage, it seems that the presence of serial correlation is due to over-parameterisation.

Performing the sequence of t tests to eliminate the insignificant variables one by one led to the intermediate specification as shown in the following equation:

$$\begin{aligned}(M-P)_t = {} & \underset{(1.0)}{-0.29} \; \underset{(0.12)}{+0.96}(M-P)_{t-1} \; \underset{(0.13)}{+0.06}(M-P)_{t-2} \\ & \underset{(0.16)}{-0.18}P_{t-1} \; \underset{(0.18)}{+0.87}P_{t-2} \; \underset{(0.06)}{-0.03}Y_{t-3} \; \underset{(0.06)}{+0.02}Y_{t-4} \\ & \underset{(0.38)}{-1.57}r^s_{t-1} \; \underset{(0.41)}{+1.46}r^s_{t-2} \; \underset{(0.28)}{+0.48}r^s_{t-4} \; \underset{(1.71)}{-2.84}r^L_t \\ & \underset{(2.61)}{+2.93}r^L_{t-1} \; \underset{(2.36)}{-5.04}r^L_{t-2} \; \underset{(1.62)}{+2.52}r^L_{t-4} \qquad (6.3)\end{aligned}$$

$DW = 20$ $\quad R^2 = 0.99$ $\quad s = 0.012$

$T = 56$ $\quad R^2 = 0.99$ $\quad Z_5(11,32) = 0.14$

$Z_1(4) = 9.00$

The serial correlation is removed and the evidence of mis-specified dynamics in the partial-adjustment specification (equation (6.1)) has been modelled in (6.3) by first and second order lag polynomial on prices and by lagged and current interest rates. Since this intermediate stage has not yielded any evidence of misspecification from here it has been progressed further by dropping the remaining three insignificant variables, namely $(M-P)_{t-2}$, Y_{t-3} and Y_{t-4}.

The resulting components were then modelled to give the final specification as:

$$\Delta(M-P)_t = \underset{(0.017)}{0.078} \underset{(0.14)}{-0.81} \Delta P_{t-1} \underset{(0.31)}{-1.5} \Delta r^S_{t-1}$$

$$\underset{(0.20)}{0.49} r^S_{t-4} \underset{(0.88)}{-1.93} \Delta_4 r^L_t \underset{(2.17)}{+2.6} r^L_{t-1} \underset{(2.13)}{-4.89} r^L_{t-2} \qquad (6.4)$$

$R^2 = 0.73$ $\qquad Z_1(4) = 6.24$ $\qquad Z_2(21) = 17.92$

$\bar{R}^2 = 0.70$ $\qquad Z_3(4) = 12.68*$ $\qquad Z_6(10,32) = 1.57$

$s = 0.0115$ $\qquad Z_4(7,42) = 1.26$

$DW = 2.09$ $\qquad Z_5(18,49) = 0.28$

The test results following equation (6.4) all check out well except for the predictive-failure test where the null hypothesis, Ho, of good predictability is rejected at the five cent significance level but not at the one per cent level.

The period was split into two subperiods, the final specification was then estimated for each of these subperiods separately.

(*) Denotes significance at the 5 per cent significance level.

1922 Q1 - 1932 Q3

$$\Delta\left(\frac{M}{P}\right)_t = \underset{(0.10)}{0.15} \underset{(0.14)}{-0.85}\,\Delta P_{t-1} \underset{(0.38)}{-1.33}\,\Delta r^{s}_{t-1}$$

$$\underset{(0.26)}{0.56}\,r^{s}_{t-1} \underset{(1.31)}{-2.87}\,\Delta_4 r^{L}_{t} \underset{(2.95)}{+1.35}\,r^{L}_{t-1} \underset{(2.98)}{-5.3}\,r^{L}_{t-2} \qquad (6.5)$$

$R^2 = 0.79$ DW = 1.73

$\bar{R}^2 = 0.75$ s = 0.0106

1932 Q4 - 1936 Q4

$$\Delta\left(\frac{M}{P}\right)_t = \underset{(0.05)}{0.17} \underset{(0.41)}{-0.64}\,\Delta P_{t-1} \underset{(1.56)}{-0.7}\,\Delta r^{s}_{t-1}$$

$$\underset{(0.58)}{0.66}\,r^{s}_{t-1} \underset{(2.06)}{-2.13}\,\Delta_4 r^{L}_{t} \underset{(4.41)}{-1.13}\,r^{L}_{t-1} \underset{(4.35)}{-4.38}\,r^{L}_{t-2} \qquad (6.6)$$

$R^2 = 0.69$

$\bar{R}^2 = 0.50$

s = 0.0133

DW = 2.49

The Chow test for parameter stability Z_4 and the residual variances test Z_6 following equation (6.4) both pass with flying colours, implying significant differences between these two subperiods. The interesting results in (6.4) are that first it does not allow for a steady-state solution, and hence no long-run elasticity with respect to the interest rates can be obtained. Second, the estimated parameters show the growth in real balances to be a positive function of the short-interest rate and negative function of the long-interest rate.

The third puzzling result is with respect to the price elasticity which turns out to be 0.2 for M1 balances. This is considerably lower than the unitary elasticity obtained for the period 1871-1913.

Fourth, there is no income term in the adjustment for M1 balances.

Various explanations can be put forward to provide an answer for some of these puzzles.

First, the data is seasonally adjusted and it is thought that this might create some problems in the dynamics of the function (See Davidson et al, 1978). It is therefore necessary to check whether seasonally unadjusted data could make any difference to the results. When, however, we applied our three stage procedure to seasonally unadjusted data, the results did not change significantly. They are therefore not reported here. In fact, similarity in the results with seasonally adjusted and unadjusted series has been reported in a number of studies. Coghlan (1978) for example, concluded that ".....overall there is little to choose between them".

Second, when comparing with 1871-1913 results, we see that first the frequency of data is different; that is for the period 1871-1913 we used annual data and for the interwar period we use quarterly data. We cannot, however, check whether the solution to the problem lies here, since we do not have enough degrees of freedom to apply the three stage procedure to annual data. A related problem could be that the quality of the quarterly data is poor. We cannot, however, resolve this problem since we do no have any better measure of income and prices in quarterly form. We can, however, estimate complete and partial adjustment models for M1 using annual data*. The estimation results are as follows:

M1: Complete adjustment: 1922-1939

$$\left(\frac{M}{P}\right)_t \quad \underset{(0.84)}{6.13} + \underset{(0.10)}{0.76}\, Y_t + \underset{(0.18)}{0.34}\, P_t$$

$$\underset{(1.36)}{-0.96}\, r^S_t \quad \underset{(4.46)}{-11.75}\, r^L_t \qquad (6.1A)$$

$R^2 = 0.96 \quad T = 18 \quad D.W = 2.59 \quad s = 0.033$

M1: Partial Adjustment: 1923-1939

$$\left(\frac{M}{P}\right)_t \quad \underset{(1.31)}{3.85} + \underset{(0.29)}{0.58} \left(\frac{M}{P}\right)_{t-1} + \underset{(0.30)}{0.16}\, Y_t$$

$$\underset{(0.295)}{-0.008}\, P_t \quad \underset{(1.331)}{-0.47}\, r^S_t \quad \underset{(4.9)}{-6.99}\, r^L_t \qquad (6.2A)$$

$R^2 = 0.91 \quad D.W = 2.8 \quad T = 17 \quad s = 0.0304$

The results for the complete adjustment model seem reasonable but those for the partial adjustment model look quite poor. The most striking result, however, from the foregoing two equations is the difference in estimated parameters in the two models (complete and partial adjustment models). This suggests that some misspecification is apparent in these models and any further discussion on the possible implications of these models might be misleading.

---

*Data sources: M, r^L and r^S refer to M1, the consol yield and the bank bill rate respectively. Source: Capie and Webber (1985).

Y and P refer to GNP and GNP deflator respectively. Source: Feinstein (1972).

The second difference with the previous period lies in the definition of the monetary aggregate. We used a broad measure, M2, for 1871-1913 and a narrow measure, M1 for the interwar period. Let us now attempt to see whether the source of the problem lies here. Even though in chapter four the endogeneity of M2 with respect to Y, P and r was rejected implying that these latter variables did not have any information to explain monetary changes let us still estimate an adjustment equation for M2 balances. These results can then be compared with those obtained for the earlier period and for M1 over the interwar period.

6.2.2 M2 balances

Again as the starting point in the specification search for M2, the partial-adjustment equation was estimated by OLS. The results obtained are as follows:

$$M_t = \underset{(0.75)}{3.16} \underset{(0.05)}{+0.81M_{t-1}} \underset{(0.04)}{+0.006Y_t}$$

$$\underset{(0.03)}{-0.052P_t} \underset{(0.24)}{+0.20r_t^S} \underset{(0.84)}{-2.77r_t^L} \qquad (6.7)$$

$R^2 = 0.966$ DW = 0.74 $h = 5.26$

$R^2 = 0.963$ T = 59 $s = 0.0135$

where the series are as for (6.1) except for M which now stands for M2 series.

As for (6.1), the results for (6.7) show that the income term is insignificant and P has negative coefficient. The positive coefficient of the short-term interest rate can be explained in that the money-stock series used, M2, comprise interest-bearing deposits. The only problem for an econometrician using the conventional approach would be the DW and the Durbin h test results, which show signs of misspecification. Application of the Cochrane-Orcutt method yields:

$$M_t = \underset{(1.14)}{2.54} \underset{(0.07)}{+0.85}M_{t-1} \underset{(0.03)}{-0.06}P_t \underset{(0.05)}{-0.05}Y_t \underset{(0.27)}{-0.12}r^S_t \underset{(1.19)}{-1.99}r^L_t \qquad (6.8)$$

$R^2 = 0.92$ $\qquad s = 0.0099$ $\qquad T = 59$

$\bar{R}^2 = 0.91$ $\qquad DW = 2.06$ $\qquad \rho = 0.58(0.107)$

The DW results seem to suggest that the serial-correlation is in fact 'cured'. But the inspection of the residual correlogram for (6.8) showed that $\hat{r}_1 = 0.58$ and $\hat{r}_2 = 0.28$ suggesting the possibility of mis-specified first and second order dynamics.

Having investigated the 'conventional' approach let us now start from the general hypothesis with fourth order lag polynomial, as for M1.

Again there are k = 24 coefficients plus a constant term. The period of estimation is 1922 Q1 - 1936 Q4, the first four observations are lost due to the setting of the lag operator at four.

The estimation of this general specification yields:

TABLE (6.2)

Estimation results of the general specification

for M2: 1922 Q1 - 1936 Q4

j	0	1	2	3	4
Y_{t-1}	-0.037 (0.068)	0.05 (0.098)	-0.043 (0.099)	0.019 (0.09)	0.007 (0.058)
P_{t-j}	0.001 (0.14)	0.16 (0.19)	-0.16 (0.19)	-0.11 (0.19)	0.096 (0.15)
r^S_{t-j}	0.17 (0.36)	-0.73 (0.58)	0.97 (0.65)	-0.76 (0.64)	0.39 (0.42)
r^L_{t-j}	-0.39 (0.22)	-0.95 (2.87)	-2.65 (2.99)	2.39 (2.87)	-0.95 (2.01)
M_{t-j-1}	1.25 (0.17)	-0.27 (0.29)	-0.13 (0.31)	0.09 (0.15)	-

a_0 = 0.88 (1.17) DW = 2.06 $Z_1(4,23)$ = 0.87

R^2 = 0.99 T = 56

$\bar{R}^2$ = 0.98 s = 0.0096

The intermediate stage reached after the elimination process by performing a sequence of t-tests is as follows:

$$
\begin{aligned}
(M-P)_t = {} & \underset{(0.66)}{1.24} \; \underset{(0.12)}{-1.23}\,(M-P)_{t-1} \; \underset{(0.13)}{-0.31}\,(M-P)_{t-2} \\
& \underset{(0.11)}{-0.85P}{}_{t-1} \; \underset{(0.18)}{+1.11P}{}_{t-2} \; \underset{(0.15)}{-0.35P}{}_{t-3} \\
& \underset{(0.20)}{-0.50r}{}^{s}_{t-1} \; \underset{(0.18)}{+0.38r}{}^{s}_{t-4} \; \underset{(0.22)}{+0.71r}{}^{s}_{t-2} \; \underset{(0.73)}{-2.25r}{}^{L}_{t-1}
\end{aligned}
\qquad (6.9)
$$

$R^2 = 0.997$ $\quad s = 0.00825$ $\quad T = 56$

$\bar{R}^2 = 0.9969$ $\quad DW = 1.97$ $\quad Z_1(4) = 3.17$

$Z_5(15,46) = 0.19$

Again, the evidence of mis-specified dynamics in the partial adjustment specification (equation (6.7)) has been modelled in (6.9) by first and second order lag polynomials on money, prices and interest rates. Since in this stage no evidence of mis-specification was obtained, from here it was further progressed to obtain the final form as:

$$
\begin{aligned}
\Delta(M-P)_t = {} & \underset{(0.014)}{0.064} \; \underset{(0.11)}{+0.23}\,\Delta(M-P)_{t-1} \; \underset{(0.105)}{-0.84}\,\Delta P_{t-1} \\
& \underset{(0.14)}{+0.26}\,\Delta P_{t-2} \; \underset{(0.11)}{-0.48}\,\Delta_3 r^{s}_{t-1} \; \underset{(0.47)}{-2.04r}{}^{L}_{t-1} \; \underset{(0.16)}{+0.71r}{}^{s}_{t-2}
\end{aligned}
$$

(6.10)

$DW = 1.84$ $\quad Z_1(4) = 3.55$ $\quad Z_4(7,42) = 2.20$

$s = 0.00828$ $\quad Z_2(21) = 32.67$ $\quad Z_5(18,49) = 0.3$

$R^2 = 0.78$ $\quad Z_3(8) = 7.98$ $\quad Z_6(10,32) = 1.706$

$\bar{R}^2 = 0.76$

Again the period was split into two subperiods. The results of the estimated equations are as follows:

1922 Q1 - 1932 Q2

$$\Delta(M-P)_t = \underset{(0.05)}{0.16} \; \underset{(0.157)}{+0.307} \; \Delta(M-P)t-1 \; \underset{(0.11)}{-0.84} \; \Delta P_{t-1}$$

$$\underset{(0.15)}{0.32} \; P_{t-2} \; \underset{(0.12)}{-0.41} \; \Delta_3 r^s_{t-1} \; \underset{(1.21)}{-4.34} r^L_{t-1} \; \underset{(0.16)}{+0.65} r^s_{t-2} \qquad (6.11)$$

$R^2 = 0.81$ $s = 0.007383$

$\bar{R}^2 = 0.77$ $DW = 2.0$

1932 Q4 - 1939 Q4

$$\Delta(M-P)_t \; \underset{(0.054)}{-0.14} \; \underset{(0.27)}{+0.12} \; \Delta(M-P)_{t-1} \; \underset{(0.29)}{-0.91} \; \Delta P_{t-1}$$

$$\underset{(0.39)}{0.006} \; \Delta P_{t-2} \; \underset{(0.43)}{-0.64} \; \Delta_3 r^s_{t-1} \; \underset{(1.68)}{-4.73} r^L_{t-1} \; \underset{(1.22)}{+1.07} r^s_{t-2} \qquad (6.12)$$

$R^2 = 0.85$ $s = 0.00964$

$\bar{R}^2 = 0.76$ $DW = 2.31$

The Chow test and the residual variance test following equation (6.10) did not show any instability between these two subperiods. In fact no obvious differences from estimated parameters can be seen in the two subperiods considered.

Comparing the final specification for M1, equation (6.4) with that of M2, equation (6.10), we find that, as before, no steady state solution can be found and no income term appears significant. The long-run interest rate elasticity can not be obtained, and the signs on the parameters show the rate of growth of money balances being a negative function of the long interest rate and a positive function of the short rate. Finally, the price elasticity turns out to be 0.3, significantly below unity.

A possible explanation for these puzzling results is the different exchange rate regimes implemented in the period. Over the period (1922-1936) there were different exchange rate regimes: floating exchange rates (1922-1925), a new gold exchange standard (1925-31), and a managed currency (1932-1936). Different exchange rate regimes might lead to money being determined by demand as well as supply. We talked about this in chapter two. Under fixed exchange rate regime for example domestic money is determined by the need to preserve the fixed exchange rate. Excess supplies of money will result in the long run, in loss of reserves and balance of payments crisis which might eventually lead to a devaluation. In the short-run these excess supplies will lead to an increase demand for bonds, and for domestic and foreign goods. Prices and interest rates will change as a result. These repurcussions for the arguments of the demand function, however, will, in the long-run be eliminated. Money can therefore be said to be determined by demand under fixed exchange rate regime.

Under floating exchange rate regime, however, the effect of excess money supplies will have repurcussions for the arguments of the money demand function not only in the short-run but also in the long-run when the economy will end up at new levels of income, prices and exchange rates. Demand for money will therefore change as a result of these movements in its arguments. The interesting implication is not just for the differences in long-run results under different exchange rate regimes but also for those in the short-run. Even though we noted that similar movements in prices and interest rates might be observed under both exchange rate regimes the reaction of money holders will differ since they are aware of the ruling exchange rate regime and its the long-run constraints.

The interwar period, however, is quite short. It does not provide enough degrees of freedom to permit estimation of adjustment equations under different exchange rate regimes.

This brings us to another interesting result, namely that changes in M1 are explained by the level of interest rates, positively with the short rate and negatively with the long-rate. A similar result is obtained for M2 balances: see equation (6.10). If in this period, the supply side effect dominates the functions for monetary aggregates, then one explanation can be found in the monetary authorities reaction function. The monetary authorities policy for example, might be to 'lean into the wind'. That is, when short interest rates are higher than some target level r_o, then the authorities try to reduce it by raising the money supply. Their policy function, therefore, can be written as:

$$M^s_{t-1} = M^s_{t-2} + \lambda(r^s_{t-2} - r_o) \qquad (6.13)$$

where M^s = money supply

r^s = short rate of interest

In order to raise the money supply the authorities will need to buy securities. This will then lead to a fall in their rates (i.e. a rise in their price). That is:

$$r^L_{t-1} = - \gamma(M^S_{t-1} - M^S_{t-2}) \qquad (6.14)$$

where r^L = long rate of interest

Monetary policy during the 'dear money' phase, up till 1931/2 was implemented through manipulation of the Bank rate. At the same time there were offsetting open-market operations in order to offset this deflationary effect of high rates of interest.

We have tried in this section to analyse the adjustment equation for money balances. Two interesting results emerged. First no steady-state solution is obtainable from our final specification and, second, supply side effects seem to have dominated the function. We tentatively conclude therefore that it is not possible to fit a single adjustment equation when there are switches in the exchange rate regime over the period.

Let us now, as in the previous chapter, examine the money multiplier components over the same period. The analysis of public's behaviour might in fact shed some light to some of the puzzles encountered in this section.

6.3 Money Multiplier Components

We start by examining the components of the money multiplier. We use two ratios to analyze the public's behaviour: the currency to demand deposits ratio and the time to demand deposits ratio. For the banking sector we use, as before, the reserve to total deposits ratio.

The currency to demand deposits ratio has a distinct cyclical appearance rising from the beginning to a peak in 1925/6 and falling to a trough in 1932/3 before swinging upwards until the end of the period. The starting point has a value of about 26 per cent and that rises to over 30 per cent around 1925/6. The trough that comes in 1932/3 is about 24 per cent and the steep path from that low point finishes up at around 32 per cent. The sharpest variations come in the years 1931/2 when the ratio rises to over 33 per cent. Given the fear that spread through Europe in 1931 it would be surprising if we did not find some increased demand for currency relative to demand deposits that year. The second steep rise comes in 1937 and this is attributable to the political situation which was rapidly deteriorating as war was believed by many to be imminent.

The time deposit ratio follows the movement in the interest rates quite closely, rising steadily from 80 per cent in 1923 to around 110 per cent in 1930. It rises quite sharply in 1931 to about 130 per cent and then follows a gradually falling trend.

The reserve ratio, on the other hand, shows only small movement across the interwar years with a value of around 11 per cent and with very little variation around that. Until 1936 there is no drop below 10.5 per cent and almost no occasion when it rises above 12 per cent, apart, that is, from 1933. This rise in 1933 to over 13 per cent is attributable to the considerable inflow of funds from abroad drawn by the attractiveness of a sterling exchange rate that was deemed certain to improve. The Exchange Equalisation Account was established in 1932 with a view to keeping the sterling rate advantageous. However it was unable to sterilise completely the inflow of funds and these therefore found their way into the domestic money supply.

6.3.1 Currency to Demand Deposits Ratio (c'- ratio)

In chapter one, we examined the factors that were expected to affect the currency to demand deposits, c', ratio. Equation (1.31) gave these theoretical variables. In the subsequent section we then went on to analyse relevant empirical studies, most of which found interest rates and real income to be the most important variables explaining the c' - ratio. Our results for the currency/total deposit ratio, over the 1871-1913 period, identified one more variable, the bank failure rate. Since however, most of the amalgamation movement in the U.K. banking sector happened in the period prior to World War One and all the banking crises in the interwar period seem to have occurred outside the U.K., mainly in countries like the U.S., Austria and Germany, the bank failure rate variable will therefore be ignored in our examination of the c' ratio.

The following dynamic function will be used to explain the behaviour of c' - ratio.

$$c'_t = a_o + \sum_{j=o}^{4} (a_{1+j} Y_{t-j} + a_{6+j} P_{t-j} + a_{11+j} r^b_{t-j} + a_{16+j} r^t_{t-j}$$
$$+ a_{21+j} c'_{t-j-1}) + v_t \qquad (6.15)$$

Period: 1922 (Q1) to 1936 (Q4)

where r^b = (1 + bbr), bbr = three month Bank-Bill rate

r^t = (1 + tdr), tdr = time-deposit rate

Y = Composite Index of Economic Activity

P = Ministry of Labour retail price index

The currency-demand deposit ratio is seasonally unadjusted. To account for seasonality three dummies have been used. All variables are transformed logarithmically at the outset.

The results of the estimation of this maintained specification are shown in table (6.3)

TABLE (6.3)

Estimation results of the general specification for the currency ratio: 1922 Q1 - 1936 Q4

j	0	1	2	3	4
Y_{t-j}	-0.27 (0.17)	0.39 (0.23)	-0.39 (0.20)	0.16 (0.20)	-0.04 (0.11)
P_{t-j}	-0.55 (0.31)	0.20 (0.41)	0.30 (0.40)	0.13 (0.39)	-0.16 (0.28)
r^b_{t-j}	-0.02 (1.39)	4.5 (1.51)	-3.54 (1.74)	1.99 (1.88)	-0.95 (1.71)
r^t_{t-j}	-0.61 (2.18)	0.04 (2.09)	-0.85 (1.98)	-0.92 (1.74)	0.21 (1.57)
c'_{t-j-1}	0.78 (0.20)	0.18 (0.26)	-0.32 (0.26)	-0.02 (0.16	-

a_0 = 0.56 (0.69)

D_1 = -0.02 (0.02)

D_2 = -0.01 (0.02)

D_3 = 0.004 (0.02)

s = 0.020

DW = 2.04

R^2 = 0.91

$\bar{R}^2$ = 0.83

T = 56

$Z_1(4,20)$ = 1.62

Performing the sequence of t-tests to eliminate the insignificant variables led to the following intermediate stage:

$$c'_t = \underset{(0.37)}{0.48} \underset{(0.11)}{+0.80}\, c'_{t-1} \underset{(0.14)}{+0.25}\, c'_{t-2} \underset{(0.10)}{-0.35}\, c'_{t-3} \underset{(0.16)}{-0.44}\, P_t$$

$$\underset{(0.18)}{+0.35}\, P_{t-2} \underset{(0.11)}{-0.14}\, Y_t \underset{(0.14)}{+0.20}\, Y_{t-1} \underset{(0.10)}{-0.16}\, Y_{t-2} \underset{(0.02)}{+0.15}\, r^b_{t-1}$$

$$\underset{(0.02)}{-0.13}\, r^b_{t-2} \qquad (6.16)$$

D_1 = -0.02 (0.01) $\quad$ s = 0.0184 $\quad$ $\bar{R}^2$ = 0.86

D_2 = -0.006 (0.009) $\quad$ DW = 2.17 $\quad$ T = 56

D_3 = 0.014 (0.01) $\quad$ R^2 = 0.89 $\quad$ $Z_1(4)$ = 2.5

Since this intermediate stage has not shown any evidence of misspecification, from here it has been progressed further to obtain a more parsimonious specification. The resulting regression is as follows:

$$\Delta c'_t = \underset{(0.005)}{0.005} \underset{(0.09)}{+0.31}\, \Delta c'_{t-2} \underset{(0.15)}{-0.33}\, \Delta_2 P_t \underset{(0.08)}{+0.15}\, \Delta Y_{t-1} \underset{(0.4)}{+4.39}\, \Delta r^b_{t-1} \qquad (6.17)$$

D_1 = -0.031 (0.009) $\quad$ s = 0.018 $\quad$ $\bar{R}^2$ = 0.72

D_2 = -0.01 (0.007) $\quad$ DW = 2.01 $\quad$ T = 56

D_3 = 0.017 (0.009) $\quad$ R^2 = 0.76 $\quad$ $Z_1(4)$ = 5.7

$Z_2(10)$ = 8.45, $\quad$ $Z_3(12)$ = 8.7 $\quad$ $Z_5(20,48)$ = 0.69

$Z_4(8,40)$ = 4.17* $\quad$ $Z_6(24,16)$ = 1.31

The tests results following equation (6.17) all check out well except for Chow test for parameter stability. Let us then see the differences in the estimated parameters when the period was split into the 1920s and the 1930s.

(*) significance at 0.05 significance level

1923 Q1 - 1930 Q4

$$\Delta c'_t = \underset{(0.006)}{0.008} \underset{(0.22)}{+0.51} \Delta c'_{t-2} \underset{(0.27)}{-0.45} \Delta_2 P_t$$

$$\underset{(0.09)}{+0.04} \Delta Y_{t-1} \underset{(0.86)}{+2.89} \Delta r^b_{t-1} \qquad (6.18)$$

$D_1 = -0.43\ (0.01)$ $s = 0.016$ $R^2 = 0.73$

$D_2 = -0.02\ (0.01)$ $DW = 2.34$ $\bar{R}^2 = 0.65$

$D_3 = 0.01\ (0.01)$ $T = 32$

1931 Q1 - 1936 Q4

$$\Delta c'_t = \underset{(0.007)}{0.004} \underset{(0.07)}{+0.27} \Delta c'_{t-2} \underset{(0.19)}{-0.42} \Delta_2 P_t$$

$$\underset{(0.24)}{+0.59} \Delta Y_t \underset{(0.4)}{+5.06} \Delta r^b_{t-2} \qquad (6.19)$$

$D_1 = -0.01\ (0.01)$ $s = 0.014$ $DW = 0.73$

$D_2 = -0.01\ (0.01)$ $R^2 = 0.93$ $T = 24$

$D_3 = 0.02\ (0.01)$ $\bar{R}^2 = 0.90$

Comparing (6.18) and (6.19) we see that the main differences lie in the income term and the Bank Bill rate. In the earlier subperiod the growth of income appears insignificant. In the latter period however, the income term is significant and the interest rate has a higher coefficient than in the earlier period.

Further, the currency-ratio has different price and interest rate elasticities over the two subperiods.

This problem of parameter instability could be related to the difficulty with estimating the relationship over different policy regimes. There are many breaks in the interwar period with respect to government policy and our results bring out the difficulty in fitting a single regression for the whole period.

Another interesting result is that the final specification, equation (6.17), does not allow for a steady-state solution when we set the growth rates to zero. This same result was obtained for the adjustment equations for M1 and M2 balances (see section 6.2 for possible explanations).

Looking back at the regression results we see that the significant variables are the changes in prices, in income and in interest rates.

The income elasticity is 0.2. This elasticity was found to be -0.9 for the pre-World War One, 1871-1913 period. We could not, however, separate demand deposits from time deposits over the earlier period and the ratio, therefore, referred to currency to total deposits. The different income elasticities could then be implying that currency was a better substitute for transactionary balances than demand deposits, but that total deposits had a higher income-elasticity than currency.

The elasticity with respect to the interest rate, evaluated at the mean, is 0.17. This implies that demand deposits are better substitutes for other assets than currency. This is in conformity with our pre-World War One results (where the interest rate elasticity of the currency to total deposits was found to be 0.06) and with other empirical studies (see section 1.3.4).

Finally , the price elasticated is -0.5. This implies that currency and demand deposits are not both homogenous of the same degree with respect to prices and that demand deposits are more price-elastic than currency. This is difficult to explain theoretically. The only tentative explanation that suggests itself is the following: the physical difficulty of carrying cash in order to pay for high priced goods leads to demand deposits replacing currency for payment of these goods.

Let us now examine the second important ratio for the public's behaviour, the time to demand depositsratio, t-ratio.

6.3.2 Time to Demand Deposits Ratio (t-ratio)

In chapter one, we examined the factors that might affect the t-ratio. Equation (1.32) summarised these theoretical variables. The following dynamic function is used to represent the maintained specification for the t-ratio.

$$t_t = ao + \sum_{j=o}^{4} (a_{1+j}\, Y_{t-j} + a_{6+j}\, P_{t-j} + a_{11+j}\, r^b_{t-j} + a_{16+j}\, r^t_{t-j} + a_{21+j}\, t_{t-j-1}) = u_t \qquad (6.20)$$

Period: 1922 Q1 - 1936 Q4

where r^b = (1+bbr), bbr = three month Bank Bill rate

r^t = (1+tdr), tdr = time deposit rate

Y = Composite Index of Economic Activity

P = Ministry of Labour Retail Price Index

The time to demand deposits ratio is seasonally unadjusted, consequently three dummies have been used to account for seasonality. All variables are transformed logarithmically

Table (6.4) gives the results obtained when equation (6.20) was estimated:

TABLE 6.4

Estimation results of the general specification for the time deposit ratio: 1922 Q1 - 1936 Q4

j	0	1	2	3	4
Y_{t-j}	-0.12 (0.14)	0.22 (0.22)	-0.21 (0.23)	0.19 (0.21)	-0.07 (0.13)
P_{t-j}	-0.34 (0.37)	0.20 (0.44)	0.34 (0.43)	-0.65 (0.43)	0.11 (0.31)
r^b_{t-j}	0.77 (1.34)	0.97 (1.72)	-1.44 (1.77)	3.40 (1.67)	-0.90 (1.60)
r^t_{t-j}	-1.16 (2.05)	4.16 (2.06)	-4.46 (2.09)	0.33 (2.07)	0.34 (1.80)
t_{t-j-1}	0.76 (0.23)	0.12 (0.24)	-0.46 (0.25)	0.41 (0.19)	-

$a_0 = 1.49\ (1.08)$ $\qquad s = 0.02214$ $\qquad T = 56$

$D_1 = 0.002\ (0.02)$ $\qquad DW = 2.06$ $\qquad Z_1(4,20) = 1.3$

$D_2 = 0.00009\ (0.03)$ $\qquad R^2 = 0.975$

$D_3 = -0.03\ (0.02)$ $\qquad \bar{R}^2 = 0.95$

The intermediate stage reached after the application of a sequence of t-tests is as follows:

$$t_t = \underset{(0.66)}{1.71} \underset{(0.09)}{+0.77}\, t_{t-1} \underset{(0.12)}{-0.34}\, \Delta t_{t-3} \underset{(0.47)}{+2.45}\, r^b_{t-3} \underset{(0.06)}{+4.10}\, \Delta r^t_{t-1}$$

$$\underset{(0.10)}{+0.04}\,Y_{t-1}\quad \underset{(0.15)}{-0.05}\,Y_{t-2}\quad \underset{(0.71)}{+0.73}\,Y_{t-3}\quad \underset{(0.19)}{-0.37}\,P_{t}\quad \underset{(0.32)}{+0.33}\,P_{t-2}$$

$$\underset{(0.24)}{-0.41}\,P_{t-3} \qquad (6.21)$$

$D_1 = 0.002\ (0.015)$ $\quad R^2 = 0.97$ $\quad s = 0.019$

$D_2 = 0.012\ (0.011)$ $\quad \bar{R}^2 = 0.96$ $\quad T = 56$

$D_3 = 0.038\ (0.01)$ $\quad DW = 2.01$ $\quad Z_1(4) = 5.44$

$Z_5(14,42) = 0.28$

Further eliminations and modelling of the variables together resulted in the following final specification:

$$\Delta t_t = \underset{(0.44)}{1.92}\ \underset{(0.07)}{-0.23}\,t_{t-1}\quad \underset{(0.12)}{-0.35}\,\Delta t_{t-3}\quad \underset{(0.40)}{+2.47}\,r^{b}_{t-3}$$

$$\underset{(0.57)}{4.09}\,\Delta r^{t}_{t-1}\quad \underset{(0.17)}{-0.35}\,\Delta_2 P_t\quad \underset{(0.1)}{-0.44}\,P_{t-3} \qquad (6.22)$$

$D_1 = 0.002\ (0.01)$ $\quad R^2 = 0.73$ $\quad Z_2(21) = 17.4$

$D_2 = 0.01\ (0.01)$ $\quad \bar{R}^2 = 0.67$ $\quad Z_1(4) = 5.82$

$D_3 = 0.04\ (0.01)$ $\quad s = 0.018$ $\quad Z_3(6) = 7.79$

$Z_5(15,46) = 0.24$ $\quad Z_4(10,36) = 2.39^*$ $\quad Z_6(13,21) = 2.02$

$DW = 2.01$

The test results following equation (6.22) all check out well except the Chow test for parameter stability which is significant at the 5 per cent significance level (at 2.5 per cent level, the null hypothesis of parameter stability in the two sub-periods is not rejected).

The following equations give the estimated parameters when the period is split into two sub-periods.

1923 (Q1) - 1928 (Q4)

$$\Delta t_t = \underset{(0.67)}{2.64} \underset{(0.13)}{-0.49}\, t_{t-1} \underset{(0.15)}{-0.11}\, \Delta t_{t-3} \underset{(0.72)}{+2.16}\, r^b_{t-3}$$

$$\underset{(0.95)}{3.76}\, \Delta r^t_{t-1} \underset{(0.18)}{-0.15}\, \Delta_2 P_t \underset{(0.15)}{-0.60}\, P_{t-3} \qquad (6.23)$$

$D_1 = -0.023\ (0.013)$ $R^2 = 0.093$ $T = 26$

$D_2 = -0.001\ (0.01)$ $R^2 = 0.73$ $s = 0.012$

$D_3 = -0.028\ (0.01)$ $DW = 1.84$

1929 (Q1) - 1936 (Q4)

$$\Delta t_t = \underset{(0.69)}{2.44} \underset{(0.09)}{-0.24}\, t_{t-1} \underset{(0.81)}{-0.46}\, \Delta t_{t-3} \underset{(0.61)}{+3.21}\, r^b_{t-3}$$

$$\underset{(0.75)}{4.79}\, \Delta r^t_{t-1} \underset{(0.28)}{-0.49}\, \Delta_2 P_t \underset{(0.16)}{-0.56}\, P_{t-3} \qquad (6.24)$$

$D_1 = 0.02\ (0.02)$ $R^2 = 0.83$ $T = 30$

$D_2 = -0.001\ (0.013)$ $R^2 = 0.76$ $DW = 2.24$

$D_3 = -0.031\ (0.012)$ $s = 0.018$

We should remark briefly on the short run implications of equation (6.22) before examining the steady-state long run results.

Table (6.5) gives the solved coefficients for the specification (6.22).

TABLE (6.5)

Solved coefficients for the time deposit ratio

1922 Q1 - 1936 Q4

j	0	1	2	3	4
t_{t-j-1}	0.77		-0.35	0.35	-
r^b_{t-j}	-	-	-	2.47	-
r^t_{t-j}	-	+4.09	-4.09	-	-
P_{t-j}	-0.35	-	+0.35	-0.44	-

50 per cent of the (total) response of the series to shocks in the exogenous variables prices and Bank Bill rate - occurs in the first two years. Figures (6.1) and (6.2) show these short-run movements in the t-ratio as a result of 1 per cent increase in prices and Bank Bill rate respectively.

The long-run, steady-state results for (5.38) are as follows:

$$t = 8.35 + 10.74r^b - 1.91P + 5.01\ \pi_2 \qquad (5.4)$$

Where π_2 = inflation rate

Looking at the steady-state results, the long-run elasticity of time to demand deposits ratio with respect to the Bank Bill rate evaluated at the mean yields 0.29. This result is surprising considering that one would expect the t-ratio to fall as yields on other assets rise (assuming the elasticity of time deposits with respect to the yields on their close substitutes being

Figures (6.1) and (6.2)

Short run movements in the time deposit ratio for 1% increase in prices and interest rates

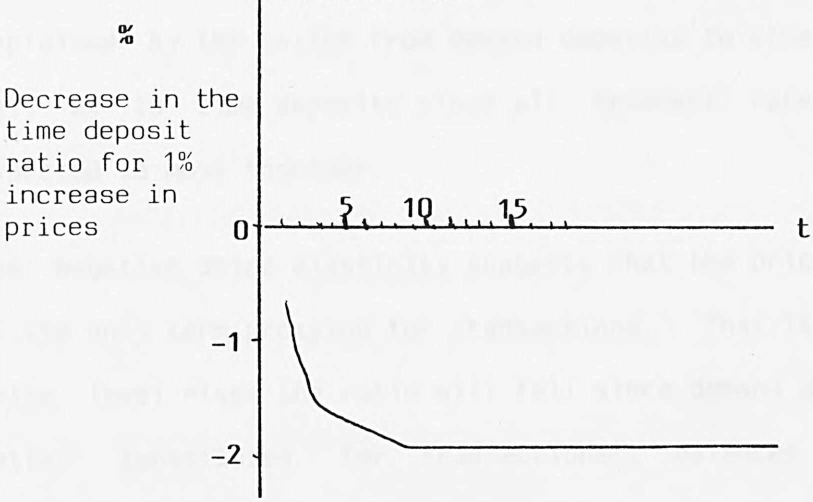

Figure (6.1)

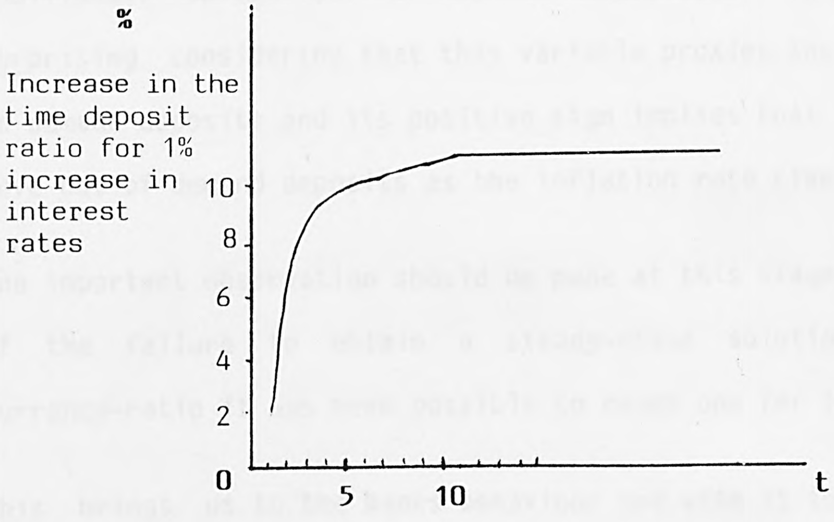

Figure (6.2)

higher than that of demand deposits). Such a substitution effect however will take place only when the interest rate on financial assets rises relative to that offered on time deposits. That is, the positive effect of the Bank Bill rate on the ratio can be explained by the switch from demand deposits to other assets as well as to time deposits since all interest rates might be expected to move together.

The negative price elasticity suggests that the price level here is the only term proxying for transactions. That is, when the price level rises the ratio will fall since demand deposits are better substitutes for transactionary balances than time deposits.

The positive coefficient on the rate of inflation, at the steady-state, shows that as there is an increase in this rate, individuals switch out of demand deposits. This is not surprising considering that this variable proxies the own return on demand deposits and its positive sign implies that individuals move out of demand deposits as the inflation rate rises.

One important observation should be made at this stage: In spite of the failure to obtain a steady-state solution for the currency-ratio it has been possible to reach one for the t-ratio.

This brings us to the banks behaviour and with it to the final ratio in our examination: the reserve ratio.

6.3.3 Reserve to Total Deposits Ratio (r-ratio)

To explain the behaviour of the r-ratio with that of other economic factors, the following dynamic function is used.

$$r_t = a_0 + {}_{jo}(a_{1+j}\, r^{br}_{t-j} + a_{6+j}\, Y_{t-j} + a_{11+j}\, (RTD)_{t-j}$$
$$+ a_{16+j}\, r_{t-j-1}) + u_t \qquad (6.26)$$

where

Y = composite Index of Economic Activity

r^{br} = $(1+br)$, br = the Bank rate

RTD = ratio of time deposits to total deposits

All variables are transformed logarithmically

There are three differences between specification (6.26) and the one used over the period (1871 - 1913) - equation (5.11) -

The Bank Bill rate (bbr) and the bank failure rate (F) both appear in equation (5.11) but not in (6.26), and equation (6.26) has an additional variable: RTD. As it was stated above for the currency-ratio, the reason for excluding (F) is the absence of any major bank failures in the U.K. during the inter-war period. In fact, a large part of the amalgamation movement happened in Britain prior to World War One. The explanation for the exclusion of the short-term rates (e.g. bbr) is their apparent insignificance in the reserve ratio function. In fact two such rates - Bank Bill rate, and time-deposit rate have been tried but they both appeared insignificant and were therefore, dropped at the initial stage. In any case, the results obtained from our specification search for the r-ratio over the period 1871 - 1913 confirm these findings.

Finally, the ratio of the time deposits to total deposits, (RTD), was excluded from equation (5.11) because it was not possible, for that period, to separate time deposits from demand deposits.

As for 1871 - 1913, there are no legal reserve requirements in the interwar period: the dependent variable is 'total' reserves (not 'excess' reserves) to deposits ratio.

The results of the estimation of (6.26) are shown in Table (6.6)

TABLE (6.6)

Estimation results of the general specification for the reserve ratio: 1922 Q1 - 1936 Q4

j	0	1	2	3	4
r^{br}_{t-j}	-1.42 (1.27)	0.20 (2.26)	0.46 (2.55)	1.74 (2.45)	-1.29 (1.31)
Y_{t-j}	0.01 (0.19)	-0.31 (0.29)	0.30 (0.30)	-0.08 (0.29)	-0.06 (0.19)
$(RTD)_{t-j}$	-0.52 (0.48)	1.16 (0.68)	-1.68 (0.68)	1.09 (0.67)	0.04 (0.51)
r_{t-j-1}	0.91 (0.15)	-0.33 (0.19)	0.66 (0.2)	-0.53 (0.17)	-

a_0 = -0.03 (0.83) s = 0.0335 T = 56

D_1 = -0.02 (0.02) R^2 = 0.72 $Z_1(4,25)$ = 1.88

D_2 = 0.002 (0.02) $\bar{R}^2$ = 0.54

D_3 = -0.007 (0.02)

Performing the sequence of t-tests to eliminate the insignificant variables led to the following intermediate stage.

$$r_t = \underset{(0.58)}{-0.39} \underset{(0.13)}{+0.93}\, r_{t-1} \underset{(0.16)}{-0.37}\, r_{t-2} \underset{(0.17)}{+0.68}\, r_{t-3} \underset{(0.15)}{-0.54}\, r_{t-4} \underset{(0.15)}{-0.22}\, Y_{t-1}$$

$$\underset{(0.15)}{+0.17}\, Y_{t-2} \underset{(1.14)}{+2.19}\, r^{br}_{t-3} \underset{(1.02)}{-1.55}\, r^{br}_{t-4} \underset{(2.09)}{-0.61}\, (RTD)_t \underset{(0.44)}{+1.36}\, (RTD)_{t-1}$$

$$\underset{(0.53)}{-1.77}\, (RTD)_{t-2} \underset{(0.43)}{+1.15}\, (RTD)_{t-3} \qquad (6.27)$$

$D_1 = -0.02\ (0.013)$ $\qquad R^2 = 0.71$ $\qquad Z_1(4) = 5.2$

$D_2 = -0.005\ (0.01)$ $\qquad \bar{R}^2 = 0.61$ $\qquad Z_5(7,40) = 0.16$

$D_3 = -0.01\ (0.01)$ $\qquad DW = 1.99$ $\qquad s = 0.030$

The F-test (Z_5) for testing the restrictions imposed on (6.26) to obtain (6.27) passes with flying colours. Further, the tests following this intermediate specification do not show any evidence of mis-specification. Equation (6.28) gives the final specification reached.

$$\Delta r_t = \underset{(0.20)}{-0.66} \underset{(0.09)}{-0.32}\, r_{t-2} \underset{(0.13)}{+0.58}\, \Delta r_{t-3} \underset{(0.14)}{-0.22}\, \Delta Y_{t-1} \underset{(0.84)}{+1.07}\, \Delta r^{br}_{t-3}$$

$$\underset{(0.3)}{+0.31}\, r^{br}_{t-3} \underset{(0.25)}{-0.76}\, \Delta_3 (RTD)_t \underset{(0.4)}{+1.51}\, \Delta (RTD)_{t-1} \qquad (6.28)$$

$D_1 = -0.02\ (0.01)$ $\qquad R^2 = 0.53$ $\qquad T = 56$

$D_2 = -0.01\ (0.01)$ $\qquad DW = 2.06$ $\qquad Z_1(4) = 3.94$

$D_3 = -0.02\ (0.01)$ $\qquad s = 0.03$ $\qquad Z_4(11,34) = 1.88$

$Z_3(4) - 9.30$ $\qquad Z_5(12,45) = 0.27$

$Z_6(13,21) = 1.03$ $\qquad Z_2(28) = 17.7$

The tests results following equations (6.28) all confirm that the specification reached is a robust one.

The Chow test (Z_4) shows no parameter instability between the two subperiods considered. The following two equations show the results of estimating equations (6.28) for these two sub-periods.

1923 (Q1) - 1929 (Q4)

$$\Delta r_t = \underset{(0.48)}{-1.31} \underset{(0.21)}{-0.58}\, r_{t-2} \underset{(0.19)}{+0.61}\, \Delta r_{t-3} \underset{(0.14)}{-0.17}\, \Delta Y_{t-1} \underset{(1.6)}{+0.57}\, \Delta r^{br}_{t-3}$$

$$\underset{(0.86)}{+1.33}\, r^{br}_{t-3} \underset{(0.14)}{-0.13}\, \Delta_3\, (RTD)_t \underset{(1.97)}{+0.99}\, \Delta (RTD)_{t-1} \qquad (6.29)$$

$D_1 = 0.0027\ (0.03)$ $R^2 = 0.53$ $T = 32$

$D_2 = 0.002\ (0.02)$ $s = 0.029$

$D_3 = 0.01\ (0.03)$ $DW = 2.51$

1930 (Q1) - 1936 (Q4)

$$\Delta r_t = \underset{(0.25)}{-0.71} \underset{(0.12)}{-0.33}\, r_{t-2} \underset{(0.23)}{+0.88}\, \Delta r_{t-3} \underset{(0.53)}{-0.36}\, \Delta Y_{t-1} \underset{(1.1)}{+2.22}\, \Delta r^{br}_{t-3}$$

$$\underset{(0.9)}{+0.74}\, r^{br}_{t-3} \underset{(0.4)}{-1.33}\, \Delta_3 (RTD)_t \underset{(0.6)}{+1.71}\, \Delta (RTD)_{t-1} \qquad (6.30)$$

$D_1 = -0.045\ (0.025)$ $R^2 = 0.71$ $T = 24$

$D_2 = -0.045\ (0.027)$ $DW = 2.21$

$D_3 = -0.027\ (0.023)$ $s = 0.03$

The resulting specification, equation (6.28) shows all the variables to have the expected signs. Further, specification (6.28) allows for a long-run steady-state solution. The long-run elasticity with respect to the rate of growth of income is -0.69.

This elasticity, compared to -1.52, the elasticity obtained for the period 1871-1913, is considerably lower. The explanation for this could be found in the income term itself which for this period is represented by the index of economic activity. This variable might not be as good as representation of the income variable as the GNP series was for the pre-World War One period. Similar problems were encountered when this variable was used in the money adjustment equation and in the two ratios describing the public's behaviour for the interwar period.

The elasticity with respect to the Bank rate was found to be 0.14 for the pre-World War One period. In equation (6.28) the coefficients on the Bank rate however are not significant. (Dropping this variable does not change any of the results significantly). Nevertheless, if this variable is considered to obtain a long-run elasticity, it turns out to be 0.03 (evaluated at the mean). Its positive coefficient shows that as the expected cost to the bank of obtaining funds from the Bank of England increases, this encourages banks to hold larger reserves. This is, in fact, what we would expect.

In the maintained specification of the pre-World War One period, equation (5.11), the Bank Bill rate was included to represent the interest rate on a close substitute for reserves. An increase in this rate would increase the opportunity cost to the banks of holding cash reserves that yield no interest; consequently it was predicted that such increases would decrease the demand for reserves. In the final specification, however, this variable does not appear. This is because it was dropped at the initial stage when its current and past values all appeared insignificant. In spite of this result obtained with the Bank Bill rate for the inter-war period, a further specification search is undertaken by including a different short rate in the general specification. This variable is the Money at Call rate, r^{mc}. Since the spread between this rate and the Bank rate is higher and more fluctuating for this period than say between the Bank Bill rate and the Bank rate, it is thought that Money at Call rate would provide an alternate representation of the opportunity cost to the banks of holding non-interest bearing reserves.

Progressing from the general specification towards a more parsimonious one resulted in the following final specification.

$$\begin{aligned}\Delta r_t = & \underset{(0.19)}{-0.60}\ \underset{(0.09)}{-0.28}\ r_{t-2}\ \underset{(0.14)}{+0.72}\ \Delta r_{t-3} \\ & \underset{(0.13)}{-0.27}\ \Delta Y_{t-1}\ \underset{(4.66)}{-9.40}\ \Delta_2\ r^{br}_{t-2}\ \underset{(0.58)}{-1.5}\ \Delta_3 r^{br}_t \\ & \underset{(4.95)}{+11.30}\ \Delta_2 r^{mc}_{t-2}\ \underset{(0.31)}{-0.3}\ \Delta(RTD)_t\ \underset{(0.29)}{+0.6}\ \Delta(RTB)_{t-1}\ \underset{(0.39)}{-1.15}\ \Delta(RTB)_{t-2}\end{aligned} \qquad (6.31)$$

$D_1 = -0.012\ (0.011)$	$R^2 = 0.55$	$Z_5(13,30) = 0.87$
$D_2 = +0.008\ (0.01)$	$\bar{R}^2 = 0.42$	$Z_6(11,19) = 1.34$
$D_3 = -0.002\ (0.01)$	$DW = 2.17$	$Z_3(4) = 9.21$
$s = 0.029$	$Z_1(4) = 5.85$	$Z_4(15,28) = 0.24$

The standard error of equation (6.31) is lower than that of (6.28). Further two quarterly changes in Money at Call rate is significant and the R^2 is higher. In these respects equation (6.31) is superior to (6.28). Analogous to (6.28) however, (6.31) does not allow for a long-run elasticity with respect to the interest rate to be obtained. Further, the sign of the coefficient of $\Delta_2\, r^{mc}_{t-2}$ implies a positive relationship between r^{mc} and r-ratio and this is contrary to our theoretical expectations.

Homogeneity

Before we conclude this section, it is necessary, as for 1871-1913, to test the homogeneity of currency and time deposits with respect to demand deposits, and that of reserves with respect to total deposits.

In the case of the t and r-ratios this has been tested by including the level of deposits (lagged one period for the t-ratio and lagged two periods for the r-ratio) as a separate variable. In both cases this appeared insignificant confirming the homogeneity assumption. Equation (6.32) and (6.33) give the results of including deposits as a separate variable in (6.22) and (6.28) respectively.

$$
\begin{array}{llll}
\Delta t_t = & 3.58 & -0.29 t_{t-1} & -0.09 D_{t-1} \\
 & (1.29) & (0.084) & (0.07 \\
 & -0.35\, \Delta t_{t-3} & +\ 2.32\, r^b_{t-3} & +\ 3.91\, \Delta r^t_{t-1} \\
 & (0.12) & (0.41) & (0.58) \\
 & -0.39\, \Delta_2 P_t & -0.15 P_{t-3} & \\
 & (0.17) & (0.1) &
\end{array}
\qquad (6.32)
$$

$D_1 = 0.014\ (0.01)$ $\quad R^2 = 0.74$ $\quad s = 0.018$

$D_2 = 0.01\ (0.008)$ $\quad \bar{R}^2 = 0.68$

$D_3 = -0.04\ (0.01)$ $\quad DW = 2.04$

$$
\begin{aligned}
\Delta r_t = & \underset{(1.58)}{-1.52} \underset{(0.1)}{-0.31} r_{t-2} \underset{(0.11)}{+0.06} D_{t-2} \\
& \underset{(0.13)}{+0.58} \Delta r_{t-3} \underset{(0.14)}{-0.24} \Delta Y_{t-1} \underset{(0.06)}{+0.98} \Delta r^{br}_{t-3} \\
& \underset{(0.58)}{+0.55} r^{br}_{t-3} \underset{(0.25)}{-0.74} \Delta_3(RTD)_t \\
& \underset{(0.4)}{+1.52} \Delta(RTD)_{t-1} \qquad (6.33)
\end{aligned}
$$

where D = logarithm of deposits

$D_1 = -0.02\ (0.01)$ $\quad s = 0.03$

$D_2 = -0.01\ (0.01)$ $\quad DW = 2.08$ $\quad T = 56$

$D_3 = -0.02\ (0.01)$

$R^2 = 0.58$

The previous two equations tested the homogeneity assumption only in the long-run. It is, however, necessary to test this assumption in the short-run as well. In the case of time deposit ratio, this test can be performed by including ΔDD_t (DD = logarithm of demand deposits) and ΔDD_{t-3} as separate regressors and then check their significance. Equation (6.34) gives the results of such an estimation.

$$
\Delta t_t = \underset{(0.34)}{1.80} \underset{(0.05)}{-0.19} t_{t-1} \underset{(0.12)}{-0.27} \Delta t_{t-3}
$$

$$\underset{(0.32)}{+1.96}\, r^{b}_{t-3} \quad \underset{(0.60)}{+1.80}\, \Delta r^{t}_{t-1} \quad \underset{(0.14)}{-0.15}\, \Delta_2 P_t$$

$$\underset{(0.08)}{-0.41}\, P_{t-3} \quad \underset{(0.13)}{-0.72}\, \Delta DD_t \quad \underset{(0.11)}{-0.16}\, DD_{t-3} \qquad (6.34)$$

$D_1 = 0.01\ (0.009)$ $\quad DW = 203$ $\quad s = 0.014$

$D_2 = 0.012\ (0.007)$ $\quad R^2 = 0.85$ $\quad T = 56$

$D_3 = -0.012\ (0.008)$ $\quad \bar{R}^2 = 0.81$

The foregoing equation shows that the homogeneity assumption fails in the short-run for the time deposit ratio because the variable ΔDD_t appears significant. The variable, however, is collinear with the inflation term $\Delta_2 P_t$ and its inclusion renders $\Delta_2 P_t$ insignificant.

Similarly in the case of the reserve-ratio this homogeneity can be tested by including ΔD_t (D = logarithm of total deposits) and ΔD_{t-3} as separate regressors, and then checking their significance. Equation (6.35) gives the results of such an estimation:

$$\Delta r_t = \underset{(1.70)}{-0.80} \quad \underset{(0.09)}{-0.32}\, r_{t-2} \quad \underset{(0.14)}{+0.61}\, \Delta r_{t-3}$$

$$\underset{(0.14)}{-0.28}\, \Delta Y_{t-1} \quad \underset{(0.84)}{+1.27}\, \Delta r^{br}_{t-3}$$

$$\underset{(0.60)}{0.60}\, r^{br}_{t-3} \quad \underset{(0.25)}{-0.82}\, \Delta_3 (RTD)_t \quad \underset{(0.39)}{+1.57}\, \Delta (RTD)_{t-1}$$

$$\underset{(0.28)}{-0.19}\, \Delta D_{t-1} \quad \underset{(0.24)}{+0.54}\, \Delta D_{t-3} \qquad (6.35)$$

$D_1 = -0.017\ (0.013)$ $DW = 2.20$ $s = 0.029$

$D_2 = -0.014\ (0.013)$ $R^2 = 0.53$ $T = 56$

$D_3 = -0.02\ (0.014)$ $R^2 = 0.41$

As for the time deposit ratio, the homogeneity test fails in the short-run since the variable ΔD_{t-3} appeared significant.

Finally, homogeneity will be tested for the currency-ratio. The final specification reached for this ratio, equation (6.17), did not allow for a steady-state solution. The homogeneity test, therefore, will only be tested for the short-run. This can be performed by including ΔDD_t and ΔDD_{t-2} as separate regressors in regression (6.17) and then check their significance. Equation (6.36) gives the results of such an estimation.

$$\Delta c'_t = \underset{(0.005)}{-0.01} \underset{(0.14)}{-0.74}\,\Delta DD_t \underset{(0.13)}{+0.36}\,\Delta c'_{t-2}$$

$$\underset{(0.16)}{+0.43}\,\Delta DD_{t-2} \underset{(0.13)}{-0.09}\,\Delta_2 P_t \underset{(0.06)}{+0.13}\,\Delta Y_t$$

$$\underset{(0.6)}{+1.78}\,\Delta r^b_{t-1} \tag{6.36}$$

$D_1 = -0.01\ (0.008)$ $R^2 = 0.85$ $s = 00149$

$D_2 = 0.002\ (0.008)$ $R^2 = 0.83$

$D_3 = 0.04\ (0.008)$ $DW = 2.46$

Both ΔDD_t and ΔDD_{t-2} appear significant. It seems that the short-run homogeneity is rejected for the currency-ratio too.

The conclusions that emerge from this section are:

Firstly, it is not possible to obtain robust specifications for the currency and time deposit ratios. The parameters appear to be unstable when the period is divided into sub periods. It seems that the main differences lie in the coefficients of interest rates and the income term. One possible explanation can be found in the switches of the authorities policies with respect to the exchange rate. An alternative explanation is found in the data series used to proxy the income variable. If this proxy, the index of economic activity, is not a good representation of its theoretical counterpart, then it is possible that it will manifest itself in parameter instability. (For details, see Hendry, 1979).

Second, the adjustment equation for the currency ratio does not allow for a steady-state solution. Similar results were obtained for money adjustment equations. This might imply that currency and demand deposits can not be modelled as a ratio nor as a sum in a single adjustment equation over this period.

Thirdly, banks seem to adjust their reserves in relation to deposits without considering the opportunity cost of holding cash reserves. This is in conformity with our prewar results. The interwar results further suggest that banks do not take account of the penal rate either. This is in conformity with the results obtained by Cagan (1965) for the U.S.

Finally, it seems that at least in the short-run, the homogeneity assumption is rejected for all three ratios. Same result was obtained for the currency-ratio over the 1871-1913 period.

CHAPTER SEVEN

Estimation: 1955-1969

In previous two chapters the adjustment process for money balances and for money multiplier components have been examined first, over the pre World War One period and then, over the interwar period. We will now complete our examination in this chapter by performing a similar exercise for the post World War Two period.

As before, we will commence by describing the major events in the period. In the second section we will estimate money adjustment processes for M1 and for M2 balances. The starting year for official quarterly income and prices series is 1955; the period considered here will therefore start in 1955 and end in 1969. We will estimate first the partial adjustment process for M1, examine the problems, if any, with this specification, and then go on to apply the three-stage estimation method to it. Once the results are examined, similar exercise will be performed for M2 balances.

In the third section we will deal with the money multiplier components in a similar fashion to money balances. As for the interwar period, with the currency to demand deposits ratio and time to demand deposits ratio, we will examine the public's behaviour, and discuss the results that we obtain.

The reserve ratio, however, will not be examined in the same fashion since it hardly fluctuates around the 8 per cent minimum cash ratio set by the monetary authorities for the London clearing banks (which dominate the series). This suggests that banks were not, by and large, holding any excess cash reserves over this period.

7.1 The Post World War Two Period

The Bretton Woods - fixed exchange rate - system and the progressive liberalisation in world trade are the main features of world economy in this period.

In the UK economy three main characteristics stand out (1) Steady economic growth faster than ever before but slower than other industrial economies (2) Persistent balance of payments problems (3) Demand Management policy of successive governments with the objective of keeping the creeping inflation in check and achieving full employment.

Immediately after World War Two the authorities maintained a cheap money policy. Around 1951 there was a switch to dear money policies. Bank rate fluctuated between 4 and 7 per cent between 1955 and 1967 and remained at 7 per cent thereafter. Both M1 and M2 rose steadily over this period. The result of the switch in government monetary policies can be seen on monetary growth in that both M1 and M2 grew faster between 1946 and 1951 (3.8 and 4.4 per cent per annum respectively) than during the dear money phase (between 1955 and 1969 they grew by 2.4 and 3.8 per cent per annum respectively).

Let us now examine in the next section the money balances over this period in relation to income, prices and interest rates.

7.2 Money Adjustment Process, 1955-1969

7.2.1 M1 Balances

The first step, before we apply the three-stage procedure to estimate the adjustment equation for M1, is as before, the estimation of the conventional partial adjustment equation over the period 1955-1969(*) with quarterly data. Equation (7.1) gives the results of such an estimation.

$$\begin{array}{lllll} M_t = & \underset{(0.37)}{-0.03} & \underset{(0.07)}{+0.95}\, M_{t-1} & \underset{(0.05)}{+0.07}\, P_t & \\ & \underset{(0.07)}{+0.07}\, Y_t & \underset{(0.39)}{-0.67}\, r_t^L & \underset{(0.21)}{-0.64}\, r_t^s & \qquad (7.1) \end{array}$$

$DW = 1.77 \qquad s = 0.00925 \qquad \bar{R}^2 = 0.09939$

$T = 59 \qquad R^2 = 0.9945 \qquad Z_4(6,47) = 0.58$

$h = 1.02 \qquad Z_1(4) = 15.58^{(+)} \qquad Z_3(6) = 2.12$

where:

Y = GDP at 1980 market prices

P = Implied GDP deflator

r^S = (1+tbr), tbr = Treasury Bill rate

r^L = (1+cr), cr = Consol rate

M = M1

P, Y and M series are seasonally adjusted. All variables are in natural logarithms.

(*) The choice of the starting year is dictated by the data - the quarterly data for income and price series do not date back any further than 1955.

+ Significance at the 5 per cent level.

An inspection of the residual correlogram showed $r_2 = 0.42$ which suggests mis-specification. Further, the Lagrange Multiplier test, Z_1, fails at the 5 per cent significance level, suggesting again the possibility of mis-specification.

The Chow-test for parameter stability and the predictive failure test however, both pass at the 5 per cent significance level, suggesting no further problem with the specification.

Coefficient estimates are correctly signed implying rather high price and income elasticities. The interest elasticities are -0.75 with respect to the long rate and -0.62 with respect to the short rate. (Both elasticities are evaluated at their respective means).

However, although equation (7.1) appears to be an adequate description of the data, the evidence of dynamic mis-specification should not be ignored. Let us then proceed with the application of the three-stage procedure outlined in chapter two to estimate the adjustment equation for M1 balances (see equation (2.1).

Table (7.1) gives the results of estimating the general specification for M1.

TABLE (7.1)

Estimation results of the general specification for M1: 1955 (Q1) - 1969 (Q4)

j	0	1	2	3	4
Y_{t-j}	0.09 (0.12)	0.06 (0.13)	-0.024 (0.13)	-0.05 (0.12)	0.05 (0.12)
P_{t-j}	-0.14 (0.17)	0.03 (0.18)	0.11 (0.19)	-0.01 (0.17)	0.1 (0.15)
r^s_{t-j}	-0.29 (0.33)	-0.44 (0.39)	0.32 (0.37)	0.35 (0.38)	0.45 (0.32)
r^L_{t-j}	0.40 (0.85)	-0.90 (1.32)	-0.43 (1.38)	-0.02 (1.46)	-0.52 (1.13)
M_{t-j-1}	1.15 (0.21)	-0.76 (0.29)	0.75 (0.29)	-0.20 (0.19)	-

$a_0 = 0.06\ (0.77)$ $R^2 = 0.997$ $s = 0.00823$

$DW = 1.93$ $\bar{R}^2 = 0.995$ $T = 56$

$Z_1(4,23) = 1.02$

Performing the sequence of t-tests led to the following intermediate stage:

$$
\begin{aligned}
M_t = {} & \underset{(0.59)}{-0.29} \ \underset{(0.16)}{+1.23}\, M_{t-1} \ \underset{(0.22)}{-0.77}\, M_{t-2} \ \underset{(0.22)}{+0.75}\, M_{t-3} \\
& \underset{(0.14)}{-0.21}\, M_{t-4} \ \underset{(0.13)}{-0.16}\, P_t \ \underset{(0.15)}{+0.11}\, P_{t-2} \ \underset{(0.11)}{+0.08}\, P_{t-4} \\
& \underset{(0.08)}{+0.07}\, Y_t \ \underset{(0.26)}{-0.22}\, r^s_t \ \underset{(0.28)}{-0.46}\, r^s_{t-1} \\
& \underset{(0.29)}{+0.35}\, r^s_{t-2} \ \underset{(0.3)}{-0.39}\, r^s_{t-3} \ \underset{(0.24)}{+0.39}\, r^s_{t-4} \ \underset{(0.37)}{-0.98}\, r^L_{t-1}
\end{aligned}
\tag{7.2}
$$

$s = 0.0073$ $R^2 = 0.997$ $T = 56$ $z_1(4,33) = 0.82$

$DW = 2.006$ $\bar{R}^2 = 0.996$ $Z_5(10,41) = 0.156$

The standard error of the specification, s is lower than that of the general specification. Further, the F-test for testing the restrictions implied by (7.2) against the maintained passes without any problems. Progressing from (7.2) towards a more parsimonious equation resulted in the following final specification:

$$\begin{aligned}
\Delta M_t = & \underset{(0.06)}{-0.29} \; \underset{(0.16)}{-0.77}\, \Delta M_{t-2} \; \underset{(0.09)}{+0.25}\, \Delta_3 M_{t-1} \\
& \underset{(0.1)}{-0.13}\, \Delta_2 P_t \; \underset{(0.04)}{+0.04}\, P_{t-4} \; \underset{(0.04)}{+0.07}\, Y_t \\
& \underset{(0.14)}{-0.31}\, r^s_t \; \underset{(0.14)}{-0.42}\, \Delta_3 r^s_{t-1} \; \underset{(0.31)}{-1.01}\, r^s_{t-1} \qquad (7.3)
\end{aligned}$$

$R^2 = 0.73$ $s = 0.00689$ $T = 56$ $Z_5(16,47) = 0.12$

$\bar{R}^2 = 0.68$ $DW = 2.006$ $Z_1(4) = 3.25$

$Z_4(9,38) = 0.35$ $Z_3(6) = 14.53^*$ $Z_6(16,22) = 1.54$

The tests following (7.3) all pass at the 5% significance level except for the predictive failure test. Further it does not allow for long-run solution to be derived. In view of these problems (7.3) cannot be said to be the final stage in the specification search. Similar problems were encountered in the inter-war period model. We can, however, for this present period obtain quarterly series for the wage rate. Since this variable

* denotes significance at five per cent level

was found to have significant effect for the USA in the transactionary money balances the maintained specification is extended to include the wage rate as an additional regressor. (For a detailed analysis on how this variable could be an important argument in the demand for money function see section 1.2). That is, our general specification is now of the following form:

$$M_t = a_o + \sum_{j=o}^{4} (a_{1+j} \; Y_{t-j} + a_{6+j} \; P_{t-j}$$

$$+ a_{11+j} \; r^S_{t-j} + a_{16+j} \; r^L_{t-j} + a_{21+j} \; W_{t-j}$$

$$+ a_{26+j} \; M_{t-j-1}) + u_t \qquad (7.4)$$

Where W = basic weekly wage rates of manual workers in all industries.

Estimation of (7.4) yields:

TABLE (7.2)

Estimation of the general specification for M1

in the extended model: 1955 (Q1) - 1969 (Q4)

j	0	1	2	3	4
Y_{t-j}	0.13 (0.17)	0.097 (0.16)	0.04 (0.15)	-0.08 (0.12)	-0.0006 (0.12)
P_{t-j}	-0.17 (0.23)	0.03 (0.22)	0.19 (0.2)	0.03 (0.18)	0.19 (0.19)
r^{s}_{t-j}	-0.31 (0.35)	-0.47 (0.39)	0.35 (0.38)	-0.27 (0.39)	0.24 (0.33)
r^{L}_{t-j}	0.61 (1.03)	-1.09 (1.39)	-0.22 (1.39)	-0.06 (1.46)	-0.79 (1.12)
W_{t-j}	0.25 (0.25)	0.14 (0.34)	-0.20 (0.40)	-0.009 (0.36)	-0.27 (0.26)
M_{t-j-1}	1.02 (0.22)	-0.70 (0.29)	0.67 (0.29)	-0.21 (0.23)	-

$DW = 2.026$ $R^2 = 0.9979$ $s = 0.0081$

$a_o = 0.95(1.09)$ $\bar{R}^2 = 0.995$ $T = 56$

$Z_1(4,18) = 1.16$

The tests performed on this general specification and an inspection of residual correlogram suggests no serious mis-specification. Consequently the sequence of t-tests has been applied to this general specification. The intermediate stage obtained is as follows:

$$M_t = \underset{(0.57)}{0.599} \underset{(0.15)}{+0.99} M_{t-1} \underset{(0.19)}{-0.62} M_{t-2} \underset{(0.2)}{+0.60} M_{t-3} \underset{(0.14)}{-0.14} M_{t-4} \underset{(0.08)}{+0.01} Y_{t-1}$$

$$\underset{(0.14)}{-0.28} P_t \underset{(0.15)}{+0.22} P_{t-2} \underset{(0.13)}{+0.17} P_{t-4} \underset{(0.13)}{0.36} W_t \underset{(0.14)}{-0.27} W_{t-4} \underset{(0.24)}{-0.20} r^S_t$$

$$\underset{(0.21)}{-0.56} r^S_{t-1} \underset{(0.23)}{+0.15} r^S_{t-2} \underset{(0.58)}{+0.62} r^L_t \underset{(0.63)}{-1.47} r^L_{t-1} \underset{(0.63)}{-0.81} r^L_{t-4} \qquad (7.5)$$

$DW = 2.01$ $T = 56$

$R^2 = 0.9976$ $Z_5(13,39) = 0.14$

$s = 0.006875$ $Z_1(4) = 4.48$

No evidence of mis-specification can be obtained from the tests results following specification (7.5). Progressing from here towards a more parsimonious specification resulted in the following final stage:

$$\Delta M_t = \underset{(0.43)}{0.68} \underset{(0.12)}{-0.63} \Delta M_{t-2} \underset{(0.07)}{-0.18} M_{t-4} \underset{(0.11)}{-0.25} \Delta_2 P_t \underset{(0.04)}{+0.18} P_{t-4}$$

$$\underset{(0.12)}{+0.12} Y_{t-1} \underset{(0.09)}{+0.31} \Delta_4 W_t \underset{(0.13)}{-0.19} \Delta_2 r^S_t \underset{(0.17)}{-0.59} r^S_{t-1}$$

$$\underset{(0.32)}{0.71} \Delta_4 r^L_t \underset{(0.31)}{-1.50} r^L_{t-1} \qquad (7.6)$$

$R^2 = 0.7787$ $s = 0.006416$ $Z_1(4) = 2.41$

$\bar{R}^2 = 0.7295$ $T = 56$ $Z_3(6) = 8.355$

$Z_4(11,34) = 0.598$ $Z_5(19,45) = 0.115$

$Z_6(14,20) = 1.42$

Estimating (7.6) over the two sub-periods yields:

<u>1956 Q1 - 1963 Q3</u>

$$\begin{aligned}\Delta M_t = & \underset{(0.94)}{+1.82} \underset{(0.17)}{-0.69} \Delta M_{t-2} \underset{(0.15)}{-0.34} M_{t-4} \\ & \underset{(0.13)}{-0.26} \Delta_2 P_t \underset{(0.09)}{+0.20} P_{t-4} \underset{(0.11)}{+0.18} Y_{t-1} \\ & \underset{(0.19)}{+0.41} \Delta_4 W_t \underset{(0.19)}{-0.29} \Delta_2 r^s_t \underset{(0.27)}{-0.88} r^s_{t-1} \\ & \underset{(0.57)}{+1.29} \Delta_4 r^L_t \underset{(0.65)}{-1.03} r^L_{t-1}\end{aligned} \tag{7.7}$$

$R^2 = 0.84$ $DW = 1.85$ $s = 0.0062334$

$\bar{R}^2 = 0.76$ $T = 31$

<u>1963 Q4 - 1969 Q4</u>

$$\begin{aligned}\Delta M_t = & \underset{(1.01)}{+0.97} \underset{(0.22)}{-0.66} \Delta M_{t-2} \underset{(0.17)}{-0.23} M_{t-4} \\ & \underset{(0.33)}{-0.22} \Delta_2 P_t \underset{(0.13)}{+0.07} P_{t-4} \underset{(0.18)}{+2.25} Y_{t-1} \\ & \underset{(0.20)}{+0.45} \Delta_4 W_t \underset{(0.29)}{-0.15} \Delta_2 r^s_t \underset{(0.35)}{-0.49} r^s_{t-1} \\ & \underset{(0.99)}{-0.57} \Delta_4 r^L_t \underset{(0.77)}{-0.53} r^L_{t-1}\end{aligned} \tag{7.8}$$

$R^2 = 0.775$ DW = 2.55 $s = 0.00744$

$\bar{R}^2 = 0.614$ T = 25

The diagnostic statistics following (7.6) show no evidence of mis-specification, and this specification is accepted when tested against the maintained hypothesis by the F-test, Z_5. The two wage-rate coefficients (the current and the one lagged four quarters) that appear in this specification can be modelled together as annual rate of growth of wages, $\Delta_4 W_t$. This formulation is not rejected at the 5% significance level by an F-test.

The introduction of the wage rate variable as an additional variable changes the money adjustment specification considerably. Comparing the results of (7.6) with that of (7.1) we see that the two specifications are radically different from one another. Firstly with (7.6) the residuals have been reduced to white-noise. Secondly (7.6) is a relatively more flexible function incorporating a more general short-run dynamics. There has been no loss of estimation precision, only one coefficient and the constant have t-ratios less than two. Finally, there has been an almost 31 per cent decrease in the standard error of the regression.

The following table gives the solved coefficients for the specification (7.6):

TABLE (7.3)

Solved coefficients for M1

1955 (Q1) - 1969 (Q4)

j	0	1	2	3	4
M_{t-j-1}	1.00	-0.63	0.63	-0.18	-
P_{t-j}	-0.25	-	0.25	-	0.18
Y_{t-j}	-	0.12	-	-	-
r^S_{t-j}	-0.19	0.59	0.19	-	-
r^L_{t-j}	0.71	-1.50	-	-	-0.71
W_{t-j}	0.31	-	-	-	-0.31

When we examine the response time paths of the series to shocks in the exogenous variables we find that in relation to prices the response is an initial negative movement with subsequent increases taking the total effect to unity in almost six years. Similarly the response of the money balances to one per cent increase in income takes about six years to reach its long-run effect. Figures (7.1) and (7.2) illustrate these reponses with respect to prices and income respectively. With respect to the interest rates, about 80 per cent of the response is observed within four years. Figures (7.3) and (7.4) depict these responses with respect to one per cent increase in the short rate

Figure (7.1) and (7.2)

Short-run movements in M1 for 1% increase in prices and in income

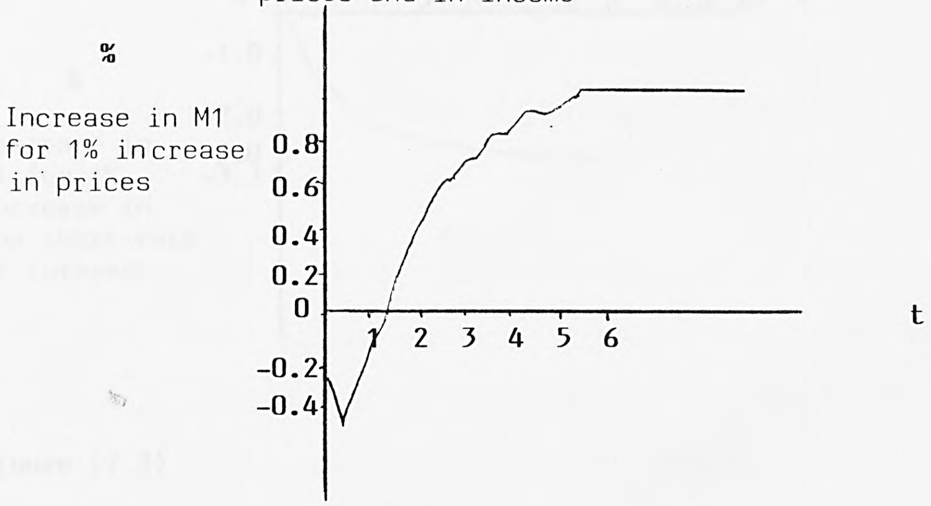

Figure (7.1)

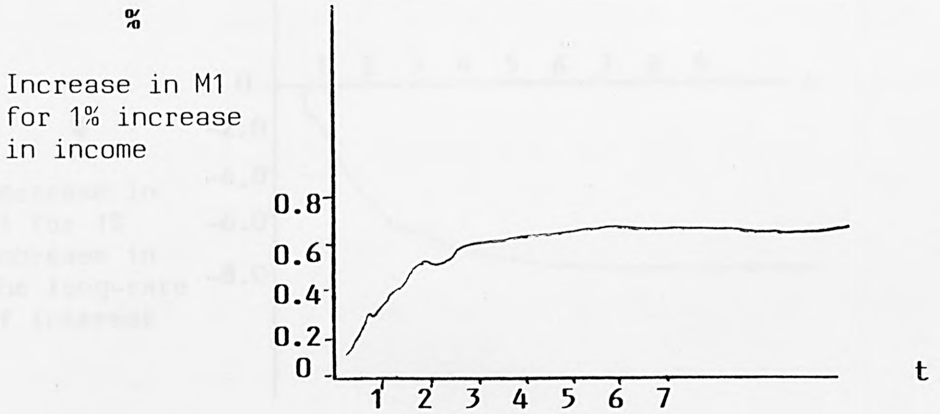

Figure (7.2)

t = number of years

Figures (7.3) and (7.4)

Short-run movements in M1 for 1% increase in the short-rate of interest and in the long-rate

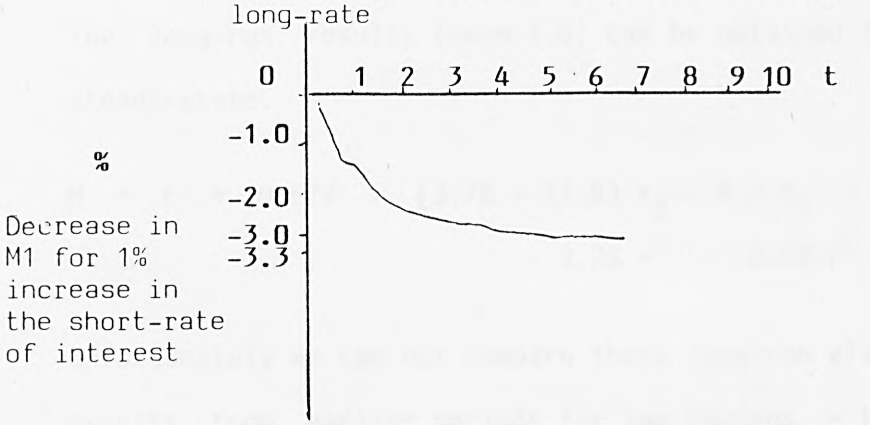

Figure (7.3)

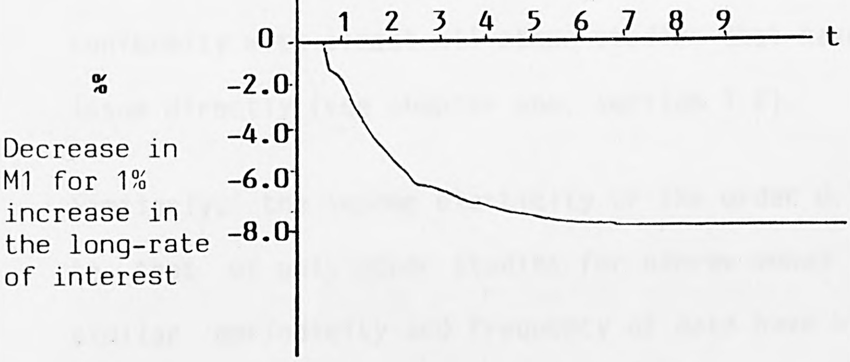

Figure (7.4)

t = number of years

and in the long rate respectively.

The long-run results (from 7.6) can be obtained if we assume a steady-state.

$$M = P + 0.67Y + [3.78 - 11.83\,\pi_2 - 4.0\,\pi_1 + 6.89\,\pi_4] - 3.28\,r^S - 8.33\,r^L \quad (7.9)$$

Unfortunately we can not compare these long-run elasticities with results from earlier periods for two reasons - the adjustment equation obtained for the period 1871 - 1913 was for M2 balances (no M1 series could be constructed for that period), and the final specification obtained for M1 balances over the interwar period did not allow for a long-run solution to be obtained.

We can, however, compare these elasticities with those of other empirical studies. Our unitary price elasticity seems to be in conformity with almost all other studies that have examined this issue directly (see chapter one, section 1.2).

Similarly, the income elasticity of the order 0.7 is comparable to that of only other studies for narrow money balances where similar periodicity and frequency of data have been used. (see Table (1.4), section 1.2). Among these, our result seems to be lower than that of Crouch (1967) and that of Goodhart and Crockett (1970) but exactly equal to that of Fisher (1968).

The interest elasticities evaluated at their respective means are -0.2 with respect to the short rate and -0.5 with respect to the long rate. Again comparing these with those of other studies we find that they are well within the average range of other empirical studies (see Table (1.3), section 4.2).

With respect to the wage rate, our results confirm its importance for transactionary balances and provide statistical evidence for its inclusion as a separate variable in the specification for M1 balances. There are, however, no other empirical studies for the UK that have tried to test the importance of this variable directly. Those which have used this variable focus on the USA, and their findings do confirm our results - Dutton and Gramm (1973) and Karni (1974).

The importance of the rate of inflation, π_2, and that of the growth of income, π_1 has been confirmed by a large number of studies (see chapter one, section 1.2) most of which are, however, for different periods. Compared to these studies, our obtained elasticities seem to be somewhat larger for the inflation rate. For the growth rate of income, on the other hand, our results are in conformity with other studies (See Currie, 1981).

Before we go on to estimate the adjustment equation for M2 balances it will be interesting to consider the estimation of the extended model (where the wage rate is included as a separate variable) assuming a partial adjustment mechanism. Equation (7.10) presents the results of such an estimation.

$$M_t = \underset{(0.37)}{-0.081} \underset{(0.06)}{+0.96} M_{t-1} \underset{(0.13)}{+0.15} P_t$$

$$\underset{(0.08)}{+0.005} Y_t \underset{(0.22)}{-0.51} r_t^s \underset{(0.39)}{-0.86} r_t^L \underset{(0.13)}{+0.23} W_t \qquad (7.10)$$

$R^2 = 0.9948$ $T = 59$ $Z_4(7,45) = 1.19$

$\bar{R}^2 = 0.9942$ $s = 0.0091$ $Z_5(6) = 2.34$

$DW = 1.879$ $Z_1 = (4) = 18.29^*$

Equation (7.10) shows that the additional regressor contributes nothing to the function. The apparent dynamic mis-specification of equation (7.1) is still observed. Most of the important regressors are insignificant at conventional significance levels (shows by t-tests). In fact, Granger and Newbold (1974) showed that t-ratios are inflated when there is serial correlation in the specification. But with (7.10), even though we observe serial correlation most of the t-ratios are still insignificant. An explanation for the observed decrease in the significance of the regressors could be that W_t, P_t and Y_t are correlated. Davidson et al (1978), however, agree that multicollinearity problems are likely to occur with ommitted variable problems. Specification (7.6) suggests that the problem with (7.1) could be one of ommitted variables but their introduction is not enough (see equation 7.10). The dynamic specification with the additional variables should be capable of modelling short-run behaviour and the residuals should be white-noise so that there

* denotes significance at the 5% level

is no evidence of mis-specificaton and the obtained specification is a robust one.

7.2.2 M2 Balances

As for M1 balances, we will start by estimating the conventional partial-adjustment specification for M2. Equation (7.1) gives the results of such an estimation.

$$M_t = \underset{(0.3)}{+0.59} \quad \underset{(0.05)}{+0.85}\ M_{t-1} \quad \underset{(0.05)}{+0.13}\ P_t \quad \underset{(0.05)}{+0.13}\ Y_t$$

$$\underset{(0.71)}{-0.17}\ r^S_t \quad \underset{(0.27)}{-0.83}\ r^L_t \qquad (7.11)$$

$R^2 = 0.998$ $DW = 2.04$ $s = 0.0080069$

$R^2 = 0.997$ $T = 59$ $Z_1(4) = 9.60*$

$Z_4(6,47) = 0.78$ $Z_6(6) = 18.00*$

Where:

Y = GDP at 1980 market prices.

P = Implied GDP deflator.

$r^S = (1+r^f)$, r^f = the difference between Treasury-Bill rate and the time-deposit rate.

$r^L = (1+cr)$, cr = Consol rate.

Equation (7.11) is very similar to (7.1). The Lagrange Multiplier test for serial correlation suggests the possibility of dynamic mis-specification. Further, the predictive failure test is also significant at the 5 per cent level confirming the possibility of mis-specification.

The long-run elasticities, however, appear to give a good description of the data. But again, the evidence of mis-specification should not be ignored.

Let us now apply the three-stage procedure to estimate the equation for M2 balances.

TABLE (7.4)

Estimation results of the general specification
for M2: 1955 (Q1) - 1936 (Q4)

j	0	1	2	3	4
Y_{t-1}	0.08 (0.09)	0.06 (0.11)	-0.08 (0.11)	0.06 (0.10)	0.19 (0.10)
P_{t-1}	-0.13 (0.16)	0.3 (0.16)	0.29 (0.17)	-0.10 (0.16)	0.15 (0.13)
r^L_{t-j}	1.65 (0.67)	-2.41 (1.11)	-0.25 (1.21)	-0.41 (1.12)	-0.51 (1.79)
r^s_{t-j}	-0.34 (1.03)	-0.26 (1.03)	-1.25 (1.10)	0.78 (1.08)	-0.09 (0.91)
M_{t-j-1}	0.56 (0.17)	-0.04 (0.22)	0.08 (0.22)	0.10 (0.18)	-

$a_o = 1.11$ (0.55) $R^2 = 0.999$ $s = 0.00699$

$T = 56$ $\bar{R}^2 = 0.998$ $Z_1(4,23) = 1.84$

Performing the sequence of t-tests led to the acceptance of the following final specification:

$$
\begin{aligned}
M_t = {} & \underset{(0.42)}{1.16} + \underset{(0.13)}{0.58}\, M_{t-1} + \underset{(0.12)}{0.13}\, M_{t-2} + \underset{(0.12)}{0.13}\, P_t \\
& + \underset{(0.09)}{0.08}\, P_{t-4} + \underset{(0.1)}{0.08}\, P_{t-2} - \underset{(0.79)}{1.35}\, r^L_{t-2} + \underset{(0.64)}{0.97}\, r^L_{t-3} \\
& + \underset{(0.51)}{1.95}\, r^L_t - \underset{(0.53)}{3.04}\, r^L_{t-1} - \underset{(0.37)}{0.57}\, r^L_{t-4} + \underset{(0.07)}{0.10}\, Y_t \\
& - \underset{(0.08)}{0.10}\, Y_t + \underset{(0.01)}{0.09}\, Y_{t-3} + \underset{(0.08)}{0.19}\, Y_{t-1} \qquad (7.12)
\end{aligned}
$$

$DW = 2.01$ $\quad s = 0.0063$ $\quad Z_5(10,41) = 0.21$

$T = 56$ $\quad Z_1(4) = 4.41$

$R^2 = 0.9989$ $\quad Z_4(15,26) = 1.05$

$\bar{R}^2 = 0.9985$ $\quad Z_6(16,10) = 1.496$

The F-test for testing the restrictions implied by equation (7.12) against the maintained equation passes at the 5 per cent significance level. Further the standard error, s, shows (7.12) to be preferable to the maintained. Checking the residual correlogram shows no problems. Hence, in view of these results, progressing from (7.12) towards a more parsimonious equation resulted in the following specification:

$$
\begin{aligned}
M_t = {} & \underset{(0.32)}{1.04} + \underset{(0.12)}{0.60}\, M_{t-1} + \underset{(0.12)}{0.13}\, M_{t-2} \\
& - \underset{(0.07)}{0.11}\, \Delta_4 P_t + \underset{(0.07)}{0.20}\, P_{t-2} - \underset{(0.62)}{0.74}\, r_{t-2}
\end{aligned}
$$

$$\underset{(0.49)}{+2.01}\, r^L_t \quad \underset{(0.51)}{-3.10}\, r^L_{t-1} \quad \underset{(0.37)}{-0.52}\, r^L_{t-4}$$

$$\underset{(0.06)}{+0.10}\, \Delta_2 Y_t \quad \underset{(0.06)}{+0.27}\, Y_{t-4} \qquad (7.13)^*$$

$DW = 0.03$ $s = 0.0062$ $\bar{R}^2 = 0.998$

$T = 56$ $R^2 = 0.999$

$Z_4(11,34) = 0.85$ $Z_1(4) = 5.44$ $Z_5(14,45) = 0.39$

$Z_6(20,14) = 1.76$ $Z_3(10) = 16.37$

Comparing (7.13) and (7.11) we see that lagged coefficients of the regressors turned out to be important for the specification. (Dropping M_{t-2} from (7.13) does not make any difference to the test results following equation (7.13). The relative superiority of (7.13) to (7.11) is that with (7.13) the residuals are reduced to white-noise. No evidence of mis-specification is encountered. The varible coefficients have expected signs and the Chow-test shows the parameters to be stable between the two subperiods.

Re-estimating (7.13) for the two subperiods yields:

<u>1956 Q1 - 1963 Q3</u>

$$M_t = \underset{(0.57)}{1.71} \quad \underset{(0.19)}{+0.54}\, M_{t-1} \quad \underset{(0.18)}{+0.14}\, M_{t-2}$$

$$\underset{(0.11)}{-0.09}\, \Delta_4 P_t \quad \underset{(0.09)}{+0.24}\, P_{t-2} \quad \underset{(0.9)}{+0.28}\, r^s_{t-2}$$

$$\underset{(0.78)}{+2.59}\, r^L_t \quad \underset{(0.87)}{-2.62}\, r^L_{t-1} \quad \underset{(0.59)}{+0.15}\, r^L_{t-4}$$

$$\underset{(0.09)}{+0.19}\, \Delta_2 Y_t \quad \underset{(0.13)}{+0.13}\, Y_{t-4} \qquad (7.14)$$

* Respecifying this equation with the dependent variable in differenced form ΔM, does not constraint (7.13) in any way. The R^2 in this case is reduced to 0.61.

$DW = 2.11 \qquad T = 31 \qquad \bar{R}^2 = 0.991$

$s = 0.0066 \qquad R^2 = 0.994$

<u>1963 Q4 - 1969 Q4</u>

$$
\begin{aligned}
M_t = & \underset{(0.92)}{0.03} \underset{(0.21)}{+0.53} M_{t-1} \underset{(0.25)}{+0.35} M_{t-2} \\
& \underset{(0.22)}{-0.29} \Delta_4 P_t \underset{(0.3)}{+0.025} P_{t-2} \underset{(1.67)}{-0.93} r^s_{t-2} \\
& \underset{(0.78)}{2.05} r^L_t \underset{(0.74)}{-3.38} r^L_{t-1} \underset{(1.09)}{-0.53} r^L_{t-4} \\
& \underset{(0.12)}{+0.096} \Delta_2 Y_t \underset{(0.13)}{+0.33} Y_{t-4} \qquad (7.15)
\end{aligned}
$$

$DW = 2.24 \qquad R^2 = 0.997 \qquad s = 0.00610$

$T = 25 \qquad \bar{R}^2 = 0.994$

The Chow test, Z_5, following equation (7.13) shows no structural instability between the two subperiods considered above. The solved coefficients for equation (7.13) are given in Table (7.5).

Figures (7.5) to (7.8) depict the effect on M2 of increasing each of the explanatory variables by one per cent. These figures show that, in the case of prices and income, 80 per cent of the total effect on M2 is observed within the first two years; and within the first year or so in the case of interest rates.

Figure (7.5) and (7.6)

Short-run movements in M2 for 1% increase in prices and income

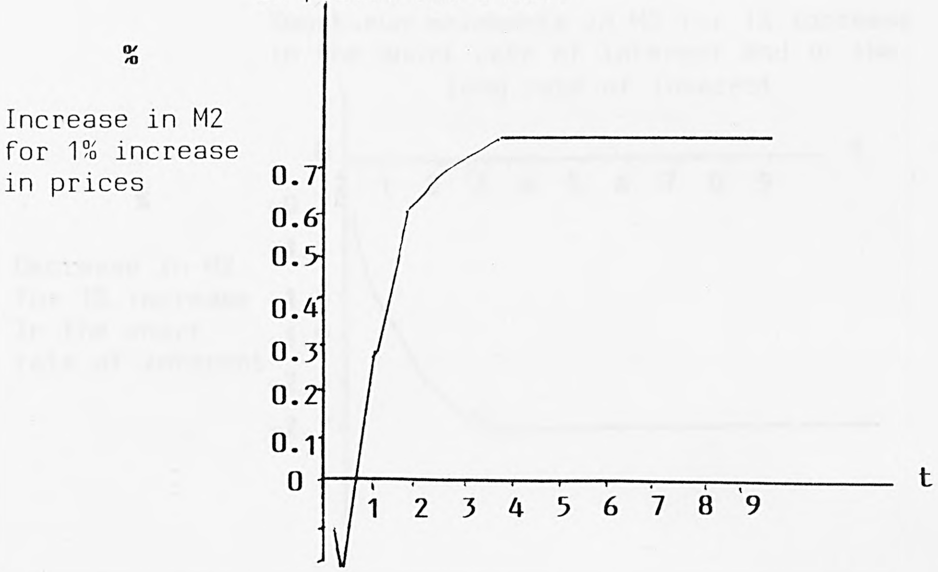

Figure (7.5)

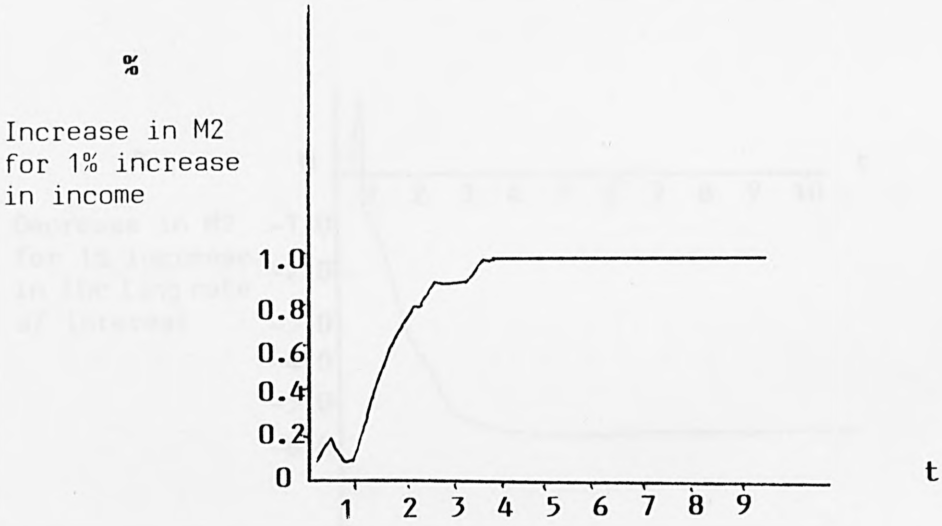

Figure (7.6)

t = number of years

Figures (7.7) and (7.8)

Short-run movements in M2 for 1% increase in the short rate of interest and in the long rate of interest

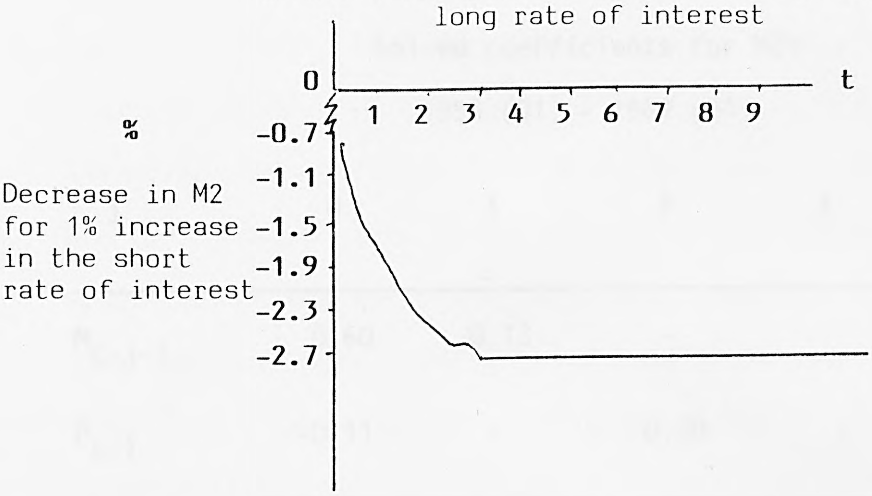

Figure (7.7)

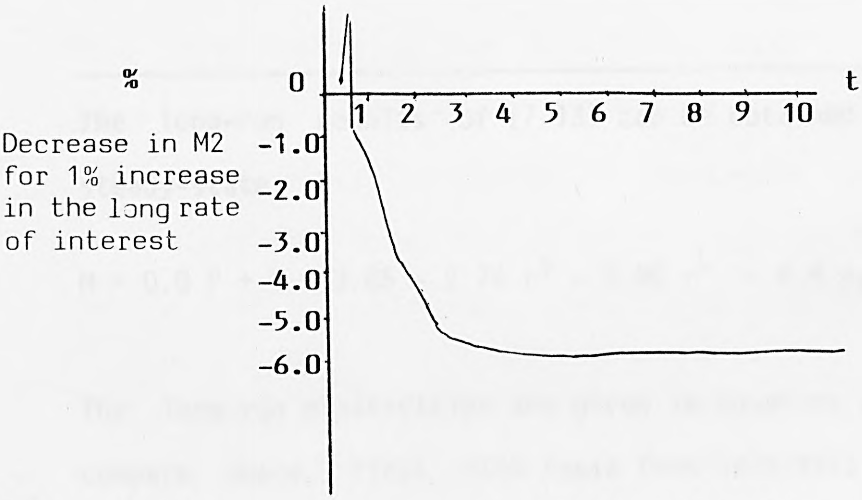

Figure (7.8)

t = number of years

TABLE (7.5)

Solved coefficients for M2:

1955 (Q1) - 1969 (Q4)

j	0	1	2	3	4
M_{t-j-1}	0.60	0.13	-		
P_{t-1}	-0.11	-	0.20	-	+0.11
Y_{t-j}	0.10	-	-0.10	-	+0.27
r^S_{t-j}	-	-	-0.74	-	-
r^L_{t-j}	2.01	-3.10	-	-	-0.52

The long-run results of (7.13) can be obtained if we are in steady-state.

$$M = 0.8\ P + Y + 3.85 - 2.74\ r^S - 5.96\ r^L - 6.4\ \pi_1 - - 5.67\ \pi_2 \quad (7.16)$$

The long-run elasticities are given in equation (7.16). We can compare these, first with those from 1871-1913 and then with other empirical studies. The specification search for the inter-war years, however, did not yield any long-run results, (see section 6.2), hence a comparison with these years can not be made.

The income elasticity seems to be in conformity with most other empirical studies; the price elasticity however is somewhat lower than these studies.

Comparing these long-run results with those for 1871-1913, equation (5.8), we see that, with respect to the short rate of interest, the elasticity is relatively lower in the post World War Two period. This is not surprising considering that in the specification for the period 1955-1969, there are two rates - one long and one short - and only one rate - the short rate - in the other one. When we evaluate these interest elasticities in equation (7.16), at their respective means, they are of the order of -0.04 and -0.37 with respect to the short rate and the long rate respectively. Table (1.3) in chapter 1 (section 1.2) lists some results on interest rate elasticities from major UK and US empirical studies. There are, however, very few studies that have tried to include two rates in the specification for broad money balances. Our results are directly comparable with these few studies and in the case of the short rate, our result seems to be lower than their average (which is of the order of -0.2); For the long rate, however, our result is quite close to theirs.

With respect to the inflation rate, the elasticity of -5.67 is somewhat higher than that of M1 balances suggesting that broad money balances are better substitutes for real assets than narrow balances. Similarly, with respect to the real growth rate the elasticity of M2 is again higher than that of M1 (-6.4 compared to -4.0). This 'negative' elasticity is, however, very interesting compared to that for 1871-1913, which was found to be positive and of the order of 0.76. This confirms our earlier expectations that at higher stages of development - as in the post World War Two period - the relationship between real growth and money balances becomes negative. This result is also in conformity with the study by Hendry and Mizon (1978) for the post World War Two period.

7.3 Money Multiplier Components

Both M1 and M2 multipliers rose quite fast at the beginning of the period. After two years they both fell rapidly until 1955. This fall is what held back the growth in M1 and M2 balances. From there onwards they are relatively flat until the end of the period.

As for the interwar period we examine the public's behaviour with two ratios: the currency to demand deposits ratio and the time to demand deposits ratio. The currency ratio follows the movements in the interest rates in a positive fashion. From a value of around 35 per cent in 1946 it drops to around 26 per cent in 1949. From there onwards it rises until 1958/9 when it reaches about 45 per cent with little variation around that over the rest of the period. The time deposit ratio, on the other hand, starts off relatively flat until 1950. From 1951 onwards it rises with "dear money" policies. The sharpest rise comes in 1955. This coincides with the announcement by the Chancellor of his reliance on the monetary aggregates as part of his monetary policy. From 1957 onwards this ratio rises from about 70 per cent to around 110 per cent. This is again attributable to the behaviour of the interest rates.

7.3.1 Currency to Demand Deposits Ratio (c' ratio)

In the previous chapter section (6.3.1), we analysed the c'-ratio with the variables that we derived from our theoretical discussion in chapter one.

We now analyse this ratio with the same variables in the following dynamic specification:

$$c'_t = a_o + \sum_{j=o}^{4} (a_{1+j} Y_{t-j} + a_{6+j} P_{t-j} + a_{11+j} r^t_{t-j} + a_{16+j} r^b_{t-j} + a_{21+j} W_{t-j} + a_{26+j} c'_{t-j-1}) + V_t \qquad (7.17)$$

Period: 1955 (Q1) to 1969 (Q4)

where r^b = (1+tbr), tbr = Treasury Bill rate

r^t = (1+tdr), tdr = time-deposit rate

Y = GDP at 1980 market prices

P = Implied GDP deflator

W = basic weekly wage rates

The difference between (7.17) and (6.15) is the additional regressor W in (7.17). The reason for its inclusion is that it was found to have important effects in the money adjustment specification for the same period (see section 6.2).

The currency-demand deposit ratio is seasonally unadjusted. Three dummies have been used to account for seasonal effects.

Table (7.6) gives the results of estimating (7.17)

TABLE (7.6)

Estimation results of the general specification

for the currency-ratio:

1955 Q1 - 1969 Q4

j	0	1	2	3	4
Y_{t-j}	0.02 (0.23)	-0.28 (0.23)	0.09 (0.22)	0.24 (0.19)	-0.02 (0.19)
P_{t-j}	-0.06 (0.39)	0.05 (0.37)	-0.67 (0.40)	-0.03 (0.36)	-0.07 (0.33)
r^t_{t-j}	0.98 (2.18)	-1.55 (2.24)	-0.51 (2.24)	0.87 (2.25)	2.07 (2.17)
r^b_{t-j}	-0.05 (2.10)	2.00 (2.19)	1.20 (2.15)	-1.43 (2.30)	-1.35 (2.16)
W_{t-j}	-0.33 (0.46)	0.18 (0.58)	-0.04 (0.61)	0.31 (0.56)	0.46 (0.43)
c'_{t-j-1}	0.79 (0.21)	-0.28 (0.26)	0.36 (0.28)	-0.10 (0.20)	-

D_1 = -0.02 (0.01) a_o = 0.38 (0.32)

D_2 = 0.004 (0.01) s = 0.01314

D_3 = 0.02 (0.01) DW = 1.97

R^2 = 0.985 T = 56

$\bar{R}^2$ = 0.896 $Z_1(4,15)$ = 2.11

Progressing from this general specification and performing the sequence of t-tests on it led to the following intermediate stage:

$$
\begin{aligned}
c'_t = \; & \underset{(0.18)}{-0.32} \; \underset{(0.14)}{+0.78} \; c'_{t-1} \; \underset{(0.17)}{-0.27} \; c'_{t-2} \; \underset{(0.12)}{+0.28} \; c'_{t-3} \\
& \underset{(0.20)}{-0.71} \; P_{t-2} \; \underset{(0.13)}{-0.22} \; Y_{t-1} \; \underset{(0.13)}{+0.29} \; Y_{t-3} \\
& \underset{(0.19)}{-0.30} \; W_t \; \underset{(0.27)}{+0.34} \; W_{t-3} \; \underset{(0.27)}{+0.45} \; W_{t-4} \\
& \underset{(0.34)}{+1.08} \; r^t_t \; \underset{(1.14)}{-2.13} \; r^t_{t-1} \; \underset{(1.20)}{+2.13} \; r^t_{t-4} \\
& \underset{(1.11)}{+2.62} \; r^b_{t-1} \; \underset{(0.48)}{+0.69} \; r^b_{t-2} \; \underset{(0.42)}{-0.45} \; r^b_{t-3} \; \underset{(1.26)}{-1.37} \; r^b_{t-4}
\end{aligned}
\tag{7.18}
$$

$D_1 = 0.02 \; (0.007)$ $\qquad R^2 = 0.984$ $\qquad s = 0.01078$

$D_2 = 0.001 \; (0.008)$ $\qquad \bar{R}^2 = 0.976$ $\qquad Z_5(13,36) = 0.09$

$D_3 = 0.017 \; (0.007)$ $\qquad DW = 1.92$ $\qquad Z_5(4,28) = 1.49$

Progressing from (7.18) and modelling the regressors together resulted in the following specification:

$$
\begin{aligned}
\Delta c'_t = \; & \underset{(0.15)}{-0.32} \; \underset{(0.09)}{-0.23} \; \Delta c'_{t-2} \; \underset{(0.06)}{-0.25} \; c'_{t-1} \\
& \underset{(0.17)}{-0.71} \; P_{t-2} \; \underset{(0.11)}{-0.25} \; \Delta_2 Y_{t-1} \; \underset{(0.15)}{-0.27} \; \Delta_3 W_t \\
& \underset{(0.14)}{+0.55} \; W_{t-4} \; \underset{(0.30)}{+0.99} \; r^t_t \; \underset{(0.71)}{-1.93} \; \Delta_3 r^t_{t-1} \\
& \underset{(0.74)}{+2.61} \; r^b_{t-1} \; \underset{(0.35)}{+0.56} \; \Delta r^b_{t-2} \; \underset{(0.68)}{-1.09} \; r^b_{t-4}
\end{aligned}
\tag{7.19}
$$

$D_1 = -0.021 \quad (0.005) \qquad s = 0.0102 \qquad T = 56$

$D_2 = -0.001 \quad (0.004) \qquad R^2 = 0.89 \qquad Z_1(4) = 6.24$

$D_3 = 0.018 \quad (0.005) \qquad R^2 = 0.850 \qquad Z_5(18,43) = 0.10$

$Z_4(15,26) = 0.79 \qquad Z_3(6) = 2.67 \qquad Z_6(16,10) = 1.26$

Estimating (7.19) for the two subperiods yields:

1956 Q1 - 1963 Q3

$$\begin{aligned}
\Delta c'_t = \; & \underset{(0.42)}{-0.78} \; \underset{(0.1)}{-0.13} \; \Delta c'_{t-2} \; \underset{(0.12)}{-0.34} \; c'_{t-1} \\
& \underset{(0.26)}{-0.62} \; P_{t-2} \; \underset{(0.14)}{-0.11} \; \Delta_2 \, Y_{t-1} \; \underset{(0.2)}{-0.27} \; \Delta_3 \, W_t \\
& \underset{(0.18)}{0.56} \; W_{t-4} \; \underset{(0.39)}{+0.97} \; r^t_t \; \underset{(1.14)}{-2.90} \; \Delta_3 \, r^t_{t-1} \\
& \underset{(1.08)}{4.00} \; r^b_{t-1} \; \underset{(0.44)}{+0.59} \; \Delta r^b_{t-2} \; \underset{(0.95)}{-1.47} \; r^b_{t-4} \qquad (7.20)
\end{aligned}$$

$D_1 = -0.03 \quad (0.007) \qquad R^2 = 0.94 \qquad DW = 2.16$

$D_2 = -0.003 \quad (0.007) \qquad \bar{R}^2 = 0.89 \qquad s = 0.01013$

$D_3 = 0.002 \quad (0.008) \qquad T = 31$

1963 Q4 - 1969 Q4

$$\begin{aligned}
\Delta c'_t = \; & \underset{(0.72)}{0.25} \; \underset{(0.31)}{-0.21} \; \Delta c'_{t-2} \; \underset{(0.27)}{-0.02} \; c'_{t-1} \\
& \underset{(0.62)}{-0.01} \; P_{t-2} \; \underset{(0.24)}{-0.37} \; \Delta_2 \, Y_{t-1} \; \underset{(0.39)}{-0.31} \; \Delta_3 \, W_t \\
& \underset{(0.44)}{+0.67} \; W_{t-4} \; \underset{(0.82)}{+1.92} \; r^t_t \; \underset{(1.88)}{-0.08} \; \Delta_3 \, r^t_{t-1} \\
& \underset{(2.24)}{-0.12} \; r^b_{t-1} \; \underset{(0.99)}{+0.53} \; r^b_{t-2} \; \underset{(2.21)}{+0.85} \; r^b_{t-4} \qquad (7.21)
\end{aligned}$$

$D_1 = -0.021 \quad (0.01) \qquad R^2 = 0.88 \qquad DW = 1.99$

$D_2 = -0.003 \quad (0.0099) \qquad \bar{R}^2 = 0.73 \qquad T = 25$

$D_3 = 0.0019 \quad (0.01) \qquad s = 0.011374$

The diagnostic statistics following (7.19) show no evidence of mis-specification. On the basis of the F-test, Z_5, the restrictions implied by (7.19) are accepted and the obtained specification is not rejected against the general specification. In comparison with the estimated equation of (7.17), table (7.6), the standard error of the regression has been reduced by 22 per cent. There is no evidence of serial correlation (judged by Z_1), or structural instability, (judged by Z_4). The t-tests show that the regressors are significant at conventional significance levels and specification (7.19) allows for a long-run solution to be derived.

The solved coefficients for equation (7.19) are given in Table (7.7).

Table (7.7)

Solved coefficients for the currency-ratio:

1955 (Q1) - 1969 (Q4)

j	0	1	2	3	4
Y_{t-j}	-	-0.25	-	+0.25	-
P_{t-j}	-	-	-0.71	-	-
r^t_{t-j}	+0.99	-1.93	-	-	+1.93
r^b_{t-j}	-	+2.61	0.56	-0.56	-1.09
W_{t-j}	-0.27	-	-	0.27	+0.55
c'_{t-j-1}	0.76	-0.23	+0.23	-	-

Figures (7.9) to (7.12) show the effect on c'-ratio of increasing each of the explanatory variables by 1 per cent. We see that in the case of the wage rate and the time-deposit rate, the response is an initial undershoot with subsequent positive effects reaching the long-run level in about five to six years. In the case of the Treasury Bill rate the response is rather fast with 85 per cent of total effect being observed within the first 2,3 quarters. With respect to the price level, however, the response is a gradual one reaching its long-run effect in about five to six years.

The long-run steady-state results are given in equation (7.22).

$$c' = -2.96P + 2.29W + 4.13r^t + 6.33r^b \; [-1.33 - 2.08\pi_1] \qquad (7.22)$$

Contrary to our interwar results for c'-ratio we now have a steady-state solution for the ratio. In the case of interest rates, the long-run elasticity implies that a rise in the time-deposit rate leads public to hold a smaller amount of demand deposits relative to their holdings of currency. The elasticity evaluated at the mean yields 0.14 which is well within the range of elasticities obtained by other empirical studies (see section 1.3.4). Similarly, in the case of the Treasury-Bill rate, the elasticity evaluated at the mean yields 0.3 which is again well within the range of elasticities obtained by other studies. This elasticity is marginally larger than the one obtained, 0.17, for the pre World War One period.

The negative price elasticity implies that an increase in the

Figure (7.9) and (7.10)

Short run movements in the currency-ratio for 1% increase in the wage rate and in the time-deposit rate

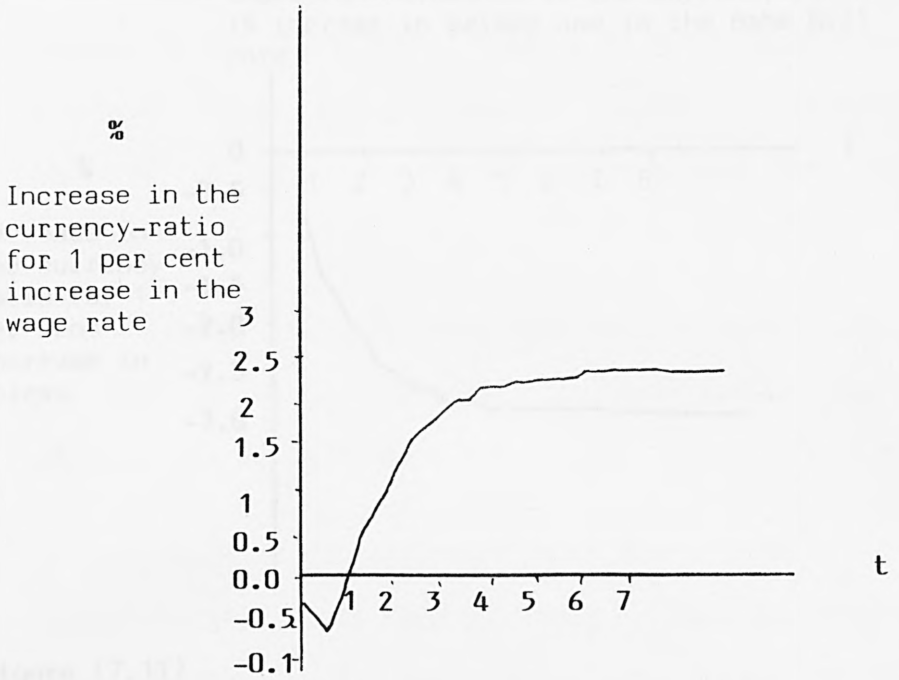

Figure (7.9)

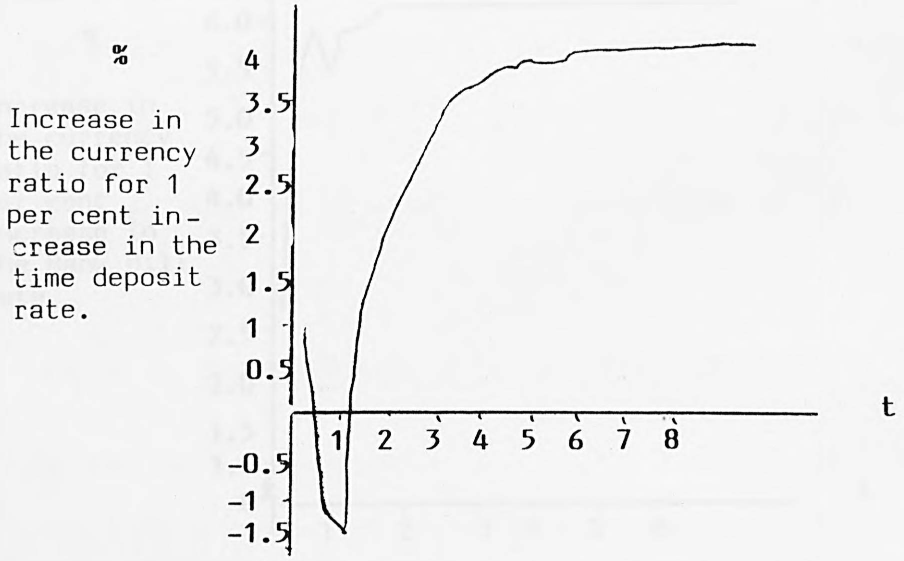

Figure (7.10)

t = number of years

Figure (7.11) and (7.12)

Short-run movements in the currency-ratio for 1% increse in prices and in the Bank Bill rate

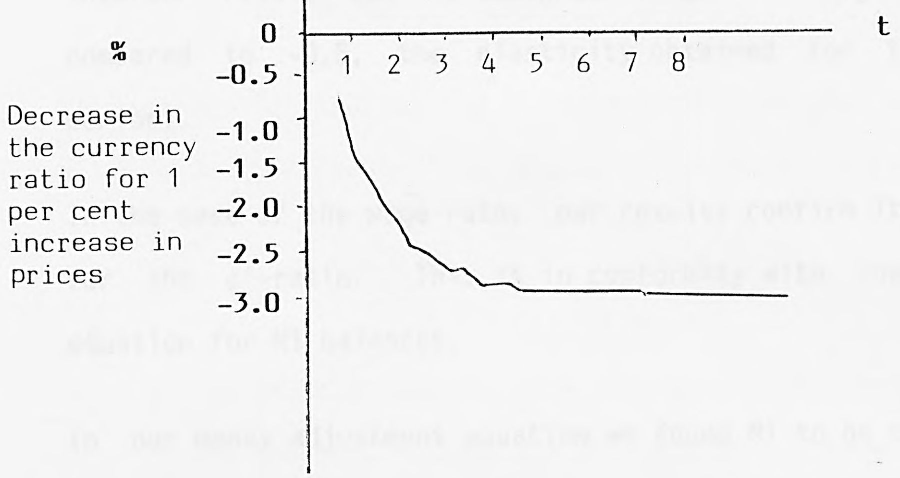

Figure (7.11)

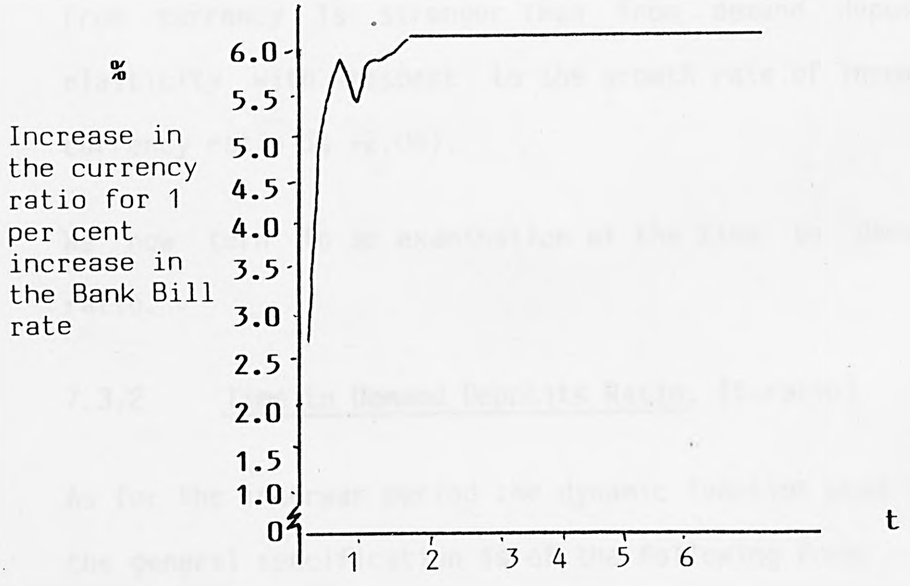

Figure (7.12)

t = number of years

price level leads to a fall in the c'-ratio; that is currency and demand deposits are not both homogenous of degree one with respect to the price level. The sign is in conformity with our interwar result but is somewhat larger in magnitude (-2.9 compared to -0.5, the elasticity obtained for the interwar period).

In the case of the wage rate, our results confirm its importance for the c'-ratio. This is in conformity with the adjustment equation for M1 balances.

In our money adjustment equation we found M1 to be elastic with respect to the growth rate of income. This was found to be -4.0 (see equation (7.9)) implying a flight out of M1 balances as there is a rise in the growth rate of income. Our results for the c'-ratio confirm this and suggest further than the flight from currency is stronger than from demand deposits. (The elasticity with respect to the growth rate of income for the currency ratio is -2.08).

We now turn to an examination of the time to demand deposits ratio.

7.3.2 **Time to Demand Deposits Ratio, (t-ratio)**

As for the interwar period the dynamic function used to represent the general specification is of the following form:

$$t_t = a_o + \sum_{j=o}^{4} (a_{1+j} Y_{t-j} + a_{6+j} P_{t-j} + a_{11+j} r^t_{t-j} + a_{16+j} r^b_{t-j} + a_{21+j} t_{t-j-1}) + v_t \qquad (7.23)$$

Period 1955 (Q1) - 1969 (Q4)

where r^b = (1+tbr), tbr = Treasury-Bill rate

rt = (1+tdr), tdr = time-deposit rate

Y = GDP at 1980 market prices

P = Implied GDP deflator

To account for seasonality three dummies have been used. Table (7.8) gives the results when equation (7.23) was estimated.

TABLE (7.8)

Estimation results of the general specification

for the time deposit ratio: 1955 (Q1) - 1969 (Q4)

j	0	1	2	3	4
Y_{t-1}	-0.32 (0.27)	0.28 (0.26)	-0.01 (0.29)	0.20 (0.27)	0.16 (0.24)
P_{t-j}	0.17 (0.49)	-0.04 (0.47)	-0.21 (0.52)	-0.70 (0.46)	0.59 (0.42)
r^t_{t-j}	3.13 (2.61)	-0.26 (2.81)	1.66 (3.05)	4.05 (2.87)	0.99 (2.93)
r^b_{t-j}	-2.58 (2.45)	1.88 (2.76)	-2.55 (2.87)	-3.86 (2.88)	-1.32 (2.91)
t_{t-j-1}	0.99 (0.21)	-0.10 (0.27)	-0.04 (0.25)	0.05 (0.17)	-

D_1 = -0.03 (0.01)

D_2 = -0.015 (0.01)

D_3 = -0.004 (0.01)

$Z_1(4,20)$ = 2.22

R^2 = 0.993

$\bar{R}^2$ = 0.986

DW = 2.10

s = 0.018

T = 56

a_0 = -0.46 (0.48)

The intermediate stage reached after the application of a sequence of t-tests is as follows:

$$t_t = \underset{(0.33)}{-0.43} \underset{(0.11)}{+1.13}\, t_{t-1} \underset{(0.13)}{-0.24}\, t_{t-2} \underset{(0.29)}{-0.57}\, P_{t-3} \underset{(0.28)}{+0.45}\, P_{t-4}$$

$$\underset{(0.19)}{-0.27}\, Y_t \underset{(0.21)}{+0.14}\, Y_{t-1} \underset{(0.18)}{+0.36}\, Y_{t-3} \underset{(0.40)}{+1.27}\, r^t_t$$

$$\underset{(1.67)}{-4.74}\, r^b_{t-3} \underset{(1.3)}{+4.48}\, r^t_{t-3} \qquad (7.24)$$

D_1 = -0.01 (0.007) R^2 = 0.99 $Z_5(14,45)$ = 0.615

D_2 = -0.02 (0.007) $\bar{R}^2$ = 0.987

D_3 = -0.003 (0.008) s = 0.0170

The F-test for testing the restrictions implied by (7.24) against the maintained, Z_5, is not rejected at the 5 per cent significance level. Further, the standard error of the regression is considerably lower confirming that (7.24) is preferable to the general specification. Modelling the variables together resulted in the following specification:

$$\Delta t_t = \underset{(0.28)}{-0.63} \underset{(0.06)}{-0.19}\, t_{t-2} \underset{(0.27)}{-0.43}\, \Delta P_{t-3} \underset{(0.17)}{-0.23}\, \Delta Y_t$$

$$\underset{(0.08)}{+0.18}\, Y_{t-3} \underset{(0.35)}{+1.27}\, r^t_t \underset{(1.64)}{-5.25}\, r^b_{t-3} \underset{(1.70)}{+5.18}\, r^t_{t-3}$$

(7.25)

D_1 = -0.03 (0.007) R^2 = 0.69 $Z_1(4)$ = 2.97

D_2 = -0.018 (0.007) $\bar{R}^2$ = 0.62 $Z_3(6)$ = 12.11

D_3 = -0.001 (0.006) s = 0.017 $Z_4(11,34)$ = 1.66

$Z_5(17,48)$ = 0.60 $Z_6(20,14)$ = 1.07

The test results following equation (7.25) show no signs of mis-specification. Re-estimating the specification (7.25) for two subperiods gave the following two equations:

1955 (Q1) - 1963 (Q4)

$$\Delta t_t = \underset{(0.49)}{-1.04} \; \underset{(0.09)}{-0.19} \, t_{t-2} \; \underset{(0.28)}{-0.36} \, \Delta P_{t-3} \; \underset{(0.25)}{-0.01} \, \Delta Y_t$$

$$\underset{(0.14)}{+0.29} \, Y_{t-3} \; \underset{(0.61)}{+1.90} \, r^t_t \; \underset{(2.09)}{-6.08} \, r^b_{t-3} \; \underset{(2.31)}{+6.44} \, r^t_{t-3} \qquad (7.26)$$

$D_1 = -0.02$ (0.009) $\quad R^2 = 0.82 \quad DW = 2.47$

$D_2 = -0.02$ (0.008) $\quad \bar{R}^2 = 0.73 \quad T = 31$

$D_3 = 0.006$ (0.009) $\quad s = 0.01619$

1963 (Q4) - 1969 (Q4)

$$\Delta t_t = \underset{(0.97)}{-0.079} \; \underset{(0.12)}{-0.23} \, t_{t-2} \; \underset{(0.71)}{+0.014} \, \Delta P_{t-3} \; \underset{(0.23)}{-0.24} \, \Delta Y_t$$

$$\underset{(0.27)}{-0.001} \, Y_{t-3} \; \underset{(0.74)}{+1.79} \, r^t_t \; \underset{(4.14)}{+0.19} \, r^b_{t-3} \; \underset{(3.69)}{+0.27} \, r^t_{t-3} \qquad (7.27)$$

$D_1 = -0.03$ (0.01) $\quad R^2 = 0.73 \quad s = 0.0156$

$D_2 = -0.01$ (0.01) $\quad \bar{R}^2 = 0.55 \quad T = 25$

$D_3 = -0.01$ (0.01) $\quad DW = 1.74$

The solved coefficients for equation (7.25) are given in table (7.9)

TABLE (7.9)

Solved coefficients for the time deposit ratio:

1955 (Q1) - 1969 (Q4)

j	0	1	2	3	4
t_{t-j-1}	1	-0.19	-	-	-
P_{t-j}	-	-	-	-0.43	+0.43
Y_{t-j}	-0.23	+0.23	-	0.18	-
r^{t}_{t-j}	1.27	-	-	5.18	-
r^{b}_{t-j}	-	-	-	-5.25	-

Figures (7.13) to (7.15) depict the effect on the t-ratio of increasing by 1 per cent income, the time-deposit rate and the Treasury Bill rate respectively. In the case of income, the response is an initial undershoot with subsequent positive effects taking the total effect to its long-run result in about 3 years. This means that initially when faced with increasing levels of income, individuals reduce their proportion of deposits held in demand deposits. After a year or so, they gradually reverse this by increasing the proportion of deposits held in time-deposits.

With respect to the time-deposit rate, the response is a gradual

Figures (7.13) and (7.14)

Short-run movements in the time deposit ratio for 1% increase in income and in the time-deposit rate

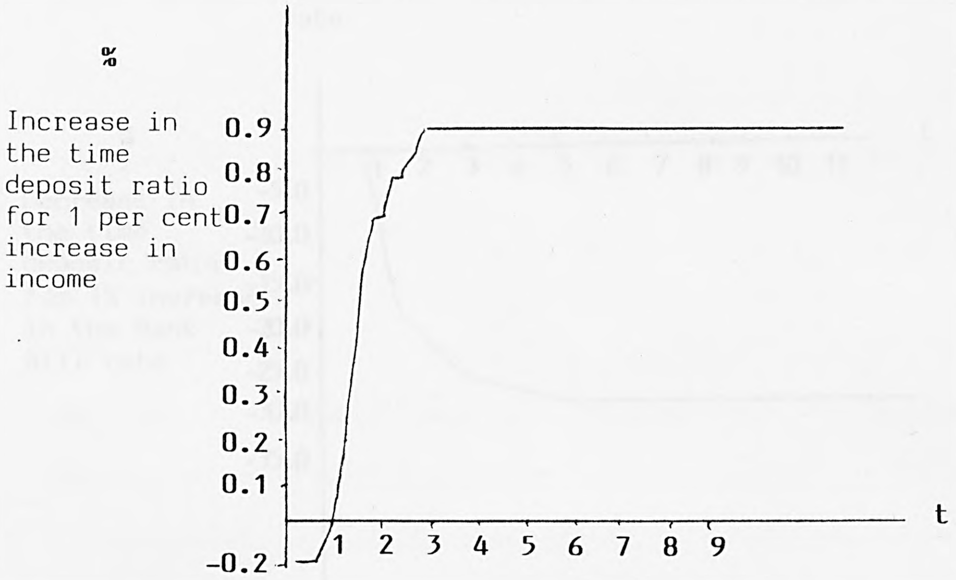

Figure (7.13)

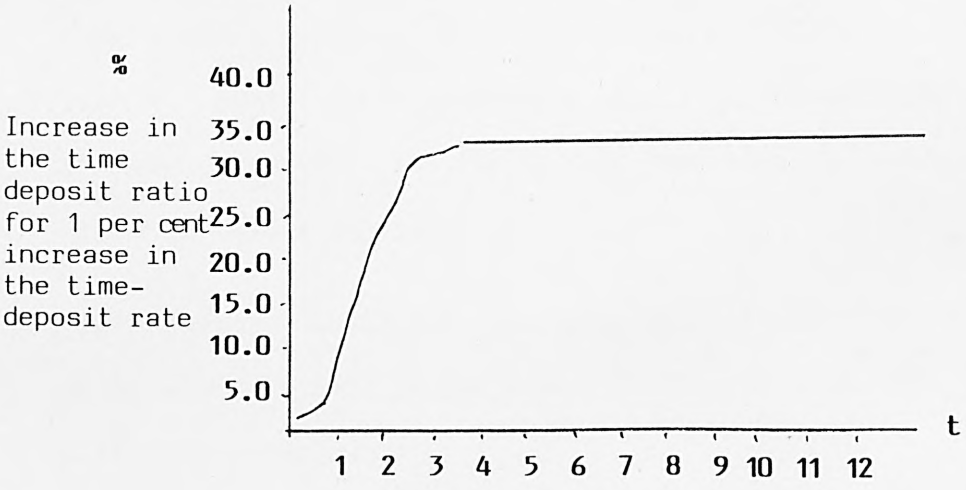

Figure (7.14) t = number of years

Figure (7.15)

Short run movements in the time deposit ratio for 1% increase in the Bank Bill rate

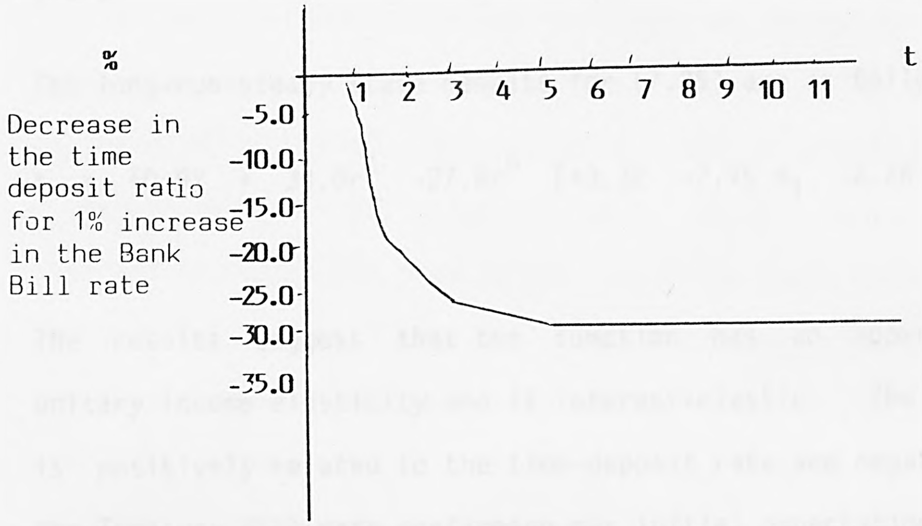

Figure (7.15) t = number of years

increase with the total effect reaching its long-run solution in about three years time. With respect to the Treasury Bill rate about 80 per cent of the effect is observed within the first two years.

The long-run steady state results for (7.25) are as follows:

$$t = +0.9Y + 34.0r^{t} -27.6r^{b} \quad [+3.32 \ -7.15\,\pi_1 \ -2.26\,\pi_2] \qquad (7.28)$$

The results suggest that the function has an approximately unitary income elasticity and is interest-elastic. The function is positively related to the time-deposit rate and negatively to the Treasury Bill rate confirming our initial expectations; that is, when the time-deposit rate increases so does the ratio since we would expect a switch from demand deposits and other assets into time deposits. When the Treasury Bill rate increases however, other interest-bearing assets are substituted for time and demand deposits, the flight from time deposits being stronger than from demand deposits.

The interest elasticities evaluated at their means are 1.19 and -1.35 with respect to the time-deposit rate and the Treasury Bill rate respectively.

Two more variables have been identified as being important in the function: The rate of growth of income, π_1 and the inflation rate, π_2. They are both negatively related to the ratio. Similar relations have been encountered with the money adjustment processs for M1 and M2. These results suggest that time-deposits respond more to the inflation rate and to the rate of growth of income than demand-deposits.

Comparing these steady-state results with those for the interwar period we find that the income term does not appear in the final specification for the interwar period. The reason for that could be found in the series - the composite index of economic activity - used to represent the income variable. This variable, in fact, appeared insignificant even in the demand for money balances (see section 6.2). This was very surprising since there are no empirical studies that reported a similar result. The problems with the data over the interwar period, however, have been reported by many other empirical studies. We should not therefore rely on the interwar results too much.

Similarly, with respect to the interest rates, the results reported for the interwar period - i.e. no long-run results with respect to r^t and a positive elasticity with respect to r^b - are contrary to those which we have obtained for the post World War Two period.

The most interesting difference in the results, however, concerns the inflation rate. The positive elasticity reported for the interwar years is now negative. This negative sign is difficult to explain theoretically since we would expect demand deposits to be more inflation-elastic than time deposits.

We conclude this section by testing the homogeneity of currency and time deposits with respect to demand deposits. We tested this assumption for the long-run by including the level of demand deposits (lagged one period for the currency-ratio and two periods for the time-deposit ratio), and for the short-run by including changes in demand deposits (current and lagged two periods for the currency ratio and current for the time deposit ratio).

Equations (7.29) and (7.30) give the results obtained. In both cases the additional variable in level form appeared insignificant confirming the long-run homogeneity assumption. The short-run homogeneity, however, is rejected because the current changes in deposits appear significant in both adjustment equations.

$$
\begin{aligned}
\Delta c'_t = {} & \underset{(1.02)}{0.71} \; \underset{(0.11)}{-0.16} \; \Delta c'_{t-2} \; \underset{(0.10)}{-0.31} \; c'_{t-1} \\
& \underset{(0.16)}{-0.60} \; P_{t-2} \; \underset{(0.10)}{-0.19} \; \Delta_2 Y_{t-1} \; \underset{(0.14)}{-0.11} \; \Delta_3 W_t \\
& \underset{(0.27)}{+0.57} \; W_{t-4} \; \underset{(0.66)}{+0.76} \; r^t_t \; \underset{(0.66)}{-1.65} \; \Delta_3 r^t_{t-1} \\
& \underset{(0.68)}{+2.12} \; r^b_{t-1} \; \underset{(0.31)}{+0.58} \; \Delta r^b_{t-2} \; \underset{(0.61)}{-0.90} \; r^b_{t-4} \\
& \underset{(0.09)}{-0.09} \; DD_{t-1} \; \underset{(0.08)}{-0.31} \; \Delta DD_t \; \underset{(0.08)}{-0.001} \; \Delta DD_{t-2}
\end{aligned}
\tag{7.29}
$$

where DD = logarithm of demand deposits

$D_1 = -0.01$ (0.006) $DW = 1.74$ $s = 0.009$

$D_2 = +0.006$ (0.004) $R^2 = 0.92$ $T = 56$

$D_3 = +0.002$ (0.005) $\bar{R}^2 = 0.88$

$$
\begin{aligned}
\Delta t_t = \; & \underset{(1.17)}{1.28} \; \underset{(0.06)}{-0.19} \; t_{t-2} \; \underset{(0.25)}{-0.50} \; \Delta P_{t-3} \\
& \underset{(0.17)}{-0.09} \; \Delta Y_t \; \underset{(0.12)}{+0.31} Y_{t-3} \; \underset{(0.38)}{+1.18} r^t_t \\
& \underset{(1.64)}{-3.29} \; r^b_{t-3} \; \underset{(1.69)}{+3.22} \; r^b_{t-3} \\
& \underset{(0.10)}{-0.16} \; DD_{t-2} \; \underset{(0.13)}{-0.35} \; \Delta DD_t
\end{aligned}
\tag{7.30}
$$

where DD = logarithm of demand deposits

$D_1 = -0.013$ (0.009) $DW = 2.40$ $\bar{R}^2 = 0.67$

$D_2 = -0.008$ (0.007) $T = 56$ $s = 0.016$

$D_3 = +0.008$ (0.007) $R^2 = 0.75$

7.3.3 Reserve to total Deposits Ratio

In previous chapters we examined the behaviour of the banking sector through their holding of cash relative to deposits. There were no official minimum ratios set by the monetary authorities in the pre World War One or the interwar period. We therefore argued that banks' demand for reserves relative to deposits would respond to movements in the other economic variables. We then went on to test whether we could identify such a function for the reserve ratio and whether it was a stable function with respect to these variables.

The post World War Two period, however, is peculiar compared to previous subperiods, in that from 1946 onwards the clearing banks, by official prescription, maintained a minimum of 8 per cent of cash reserves to gross deposits. Our reserve ratio includes not just London clearing banks but the Scottish banks, the Northern Ireland banks, the Bank of England and a small number of others. The London clearing banks, however, dominate this group by size, with nearly 90 per cent of total deposits. Table (7.10) gives the reserve to deposits for various groups. The first column includes Bank of England's till money in its numerator and its denominator refers to net deposits (i.e. excluding transit items and interbank deposits) and it is this ratio that we used in our previous examinations of the behaviour of the banking sector. The second column refers to reserves (excluding Bank of England's till money) relative to 'gross' deposits, and the 8 per cent minimum set by the authorities apply to this ratio. This ratio is consistently lower than that of the London clearing banks (column 3) suggesting that other banks not facing the minimum 8 per cent held lower ratios. Out of a total banking sector excluding London clearing banks, Scottish banks dominate the group holding 59 per cent deposits of the group in 1946 and about 70 per cent in 1969. (For details, see Table III (4) in Capie and Webber, 1985). Their reserve ratio fluctuated between 2 and 3 per cent of deposits suggesting a self-inflicted lower cash ratio relative to clearing banks.

What we are interested in here is the excess reserves over and above the minimum required level. Table (7.10) suggests that the London clearing banks did not hold any excess reserves. Similarly the Scottish banks, following a similar pattern to that of the clearing banks, did not hold any reserves above the self-observed two to three per cent ratio.

The foregoing argument suggests that there is not much to be gained by performing a specification search for the reserve ratio over this period since the ratio was set by the authorities and that banks preferred to hold any excess in some other form of reserves, preferably where they could earn interest. Banks' liquid assets, however, were also restricted to 28 to 30 per cent of their deposits for the London clearing banks from 1951 onwards. (See Blackaby, 1978). In 1957 this was set at 30 per cent, and in 1963 it was reduced to 28 per cent. The Scottish banks observed a somewhat smaller (and self-inflicted) ratio of 16 to 17 per cent. (This is in annual averages, monthly figures would be as low as 14 per cent; (for details see Gaskin, 1965).

What are the interesting results that emerge from this section?

First, it has been possible to obtain a robust specification for the currency-ratio and time-deposit ratio over this post World War Two period. Further, both of these specifications allow for steady-state solutions to be obtained.

Second, in our specification search for the currency-ratio we have identified the influence of an additional variable; that of the wage rate. The importance of this variable was also established in the adjustment equation for M1 balances.

Third, it seems that banks do not hold any excess cash reserves over and above the minimum required level.

Finally, as for the earlier period, the homogeneity assumption is rejected in the short-run for both the currency and time deposit ratios.

TABLE (7.10)

Reserve to Total Deposits Ratio for various groups of Banks

	UNITED KINGDOM		**LONDON CLEARING**	**NON-CLEARING**	**SCOTTISH BANKS**	**IRISH BANKS**
YEAR	M3 Determinant R/D	$\frac{\text{Reserves}}{\text{Deposits}}$	$\frac{\text{Reserves}}{\text{Deposits}}$	$\frac{\text{Reserves}}{\text{Deposits}}$	$\frac{\text{Reserves}}{\text{Deposits}}$	$\frac{\text{Reserves}}{\text{Deposits}}$
1946	8.200	7.495	8.783	1.035	0.933	0.991
1947	8.600	7.176	8.456	1.060	0.607	0.869
1948	7.300	6.897	8.089	1.108	0.992	1.120
1949	8.000	7.335	8.571	1.157	0.900	0.515
1950	7.800	7.289	8.481	1.169	0.692	2.278
1951	7.700	7.220	8.380	1.403	0.835	0.517
1952	7.900	7.468	8.506	1.456	1.875	1.838
1953	7.900	7.110	8.095	1.488	1.802	1.119
1954	7.900	7.212	8.231	1.512	1.897	1.091
1955	8.100	7.537	8.546	1.479	2.199	2.707
1956	8.300	7.575	8.583	1.467	2.542	0.145
1957	8.400	7.672	8.667	1.539	2.399	1.039
1958	8.000	7.267	8.144	1.655	2.284	1.870
1959	7.600	7.178	8.071	1.622	2.090	1.758
1960	8.700	7.834	8.747	1.508	2.833	2.507
1961	8.200	7.469	8.286	1.514	3.030	3.018
1962	8.800	7.970	8.857	1.498	3.048	2.654
1963	8.200	7.514	8.276	1.432	3.219	3.624
1964	8.500	7.759	8.526	1.540	3.264	3.310
1965	8.100	7.620	8.378	1.606	3.284	2.476
1966	8.000	7.749	8.419	1.547	3.278	3.017
1967	7.900	7.257	8.010	1.462	3.071	2.571
1968	7.700	7.313	8.057	1.989	2.995	2.099
1969	8.200	7.570	8.336	2.236	2.997	2.443

* Source: Capie and Webber (1985)

CHAPTER EIGHT

Summary and Comparisons

This chapter is in two sections: the first comments on the results obtained and compares them with other studies. The second examines the implications of these results and sets out the major findings of this thesis.

The thesis began by listing a number of important empirical questions concerning the demand for, and the supply of, money. In subsequent chapters these empirical issues were examined for the UK over three periods: pre-World War One, the interwar, and post-World War Two. In the first section of this chapter these results are brought together. We first analyse the demand for money and go through all the seven questions set out in section 1.2.4. We then go on to the supply of money and analyse in a similar fashion, the components of the money multiplier: the currency-ratio, the time deposit ratio and the reserve ratio.

8.1 RESULTS AND COMPARISONS

A summary of all the results obtained is shown below.

8.1.1 DEMAND FOR MONEY

There were seven key issues.

1. The role of interest rates. Table 8.1 gives a summary of our elasticity results. The elasticities are within the range of elasticities obtained in other empirical studies (see section 1.2.4.), though they tend to be at the lower end of this range. One possible explanation is that all the specifications include a short and a long rate rather than one rate only. Most other empirical studies use just one rate. The single rate, in these studies, roughly picks up the same effect as the total of our two rates.

   Two important implications emerge. First, both short and long rates are important in money demand functions. This holds irrespective of the definition of money or of the respresentative short rate chosen (i.e. whether it is the Treasury Bill rate or the Bank Bill rate). Second, the elasticity (both the impact and the steady-state - see Table 8.1 for definitions) with respect to the long rate is consistently higher than that with respect to the short rate.

   All the foregoing results are based upon the specifications derived from the periods 1871-1913 and 1955-1969. Over the interwar period no interest-elasticity could be derived since money demand specification did not allow for a steady-state solution. More interestingly, the changes in money balances, over this period, were explained positively with the short rate of interest and negatively with the long rate. We tentatively argued (see section 6.2) that this paradoxical result was due to switches in the policy of the monetary authorities over this period. This leads to the supply side dominating the function over a certain policy period and the demand side over another.

2. Homogeneity with respect to the price level.

The price elasticity is unity for the period 1871-1913. For the period 1955-1969 this is also true for M1, but for M2 the elasticity is, at 0.8 slightly lower. This however is not significantly different from unity (F-test = 1.81 as against a critical value at the 5 per cent of 4.06 for F(1,45)). For the interwar period the price elasticities are much lower: 0.2 and 0.4 for M1 and M2 respectively. Among the few other empirical studies which have investigated this issue (for post-World War Two period) most found a unit price elasticity both with quarterly and annual data. The relatively low price elasticities I obtained for the interwar period might be an indication of either data problems as discussed in Chapter 5 or the existence of money illusion. It is hard to see how this ambiguity could be resolved.

TABLE (8.1)

Demand for Money;

SUMMARY RESULTS ON INTEREST RATES.

Data Used	Definitions of Money	Interest Rate Used	Interest Elasticity		
			Impact	Steady-State	
			A	B	(C)
Annual:	Broad:	Short:bbr	-0.86	-4.10	(-0.11)
1871-1913	M2	Long:cr	-6.21	-(*)	
Quarterly:	Narrow:	Short:bbr	-1.5	+(*)	
1922-1936	M1	Long:cr	-1.9	-(*)	
Quarterly:	Broad:	Short:bbr	-0.5	+(*)	
1922-1936	M2	Long:cr	-2.0	-(*)	
Quarterly:	Narrow:	Short:bbr	-0.2	-3.3	(-0.2)
1955-1969	M1	Long:cr	+0.7	-8.3	(-0.5)
Quarterly:	Broad:	Short:rf	-0.07	-2.7	(-0.4)
1955-1969	M2	Long:cr	+2.0	-6.0	(-0.4)

Where:

bbr = Bank Bill rate
cr = Consol rate
rf = the difference between Treasury Bill rate and the the time deposit rate
* = indeterminate
A: The impact elasticities are the effects on money of one percent change in (1 + the rate) over the first period only.
B: The steady-state elasticities are calculated for 1 per cent change in (1 + the rate).
C: The steady-state elasticities are as evaluated at the means.

3. Wages

The importance of the wage-rate is not examined directly for the interwar period because of the lack of quarterly data. For the post-World War Two period, however, the introduction of the wage-rate for narrow money balances improves the robustness of the specification (See Z_3, the predictive failure test result in specifications (7.3) and (7.8)) and reduces the standard error of the specification considerably (by about 31 per cent). It seems, however, that the wage-rate affects money balances only in the short-run and not in the long- run. That is, a steady-state long-run elasticity is not obtainable. The impact elasticity is 0.31. This suggests that if the marginal valuation of an hour of leisure (as measured by the wage-rate) goes up then the individual's transactions with money (and hence their savings on time) go up as well. This, however, is only temporary. No lasting effect is observed. In the long run, the annual rate of growth of wages (rather than its level) affects the ratio.

4. The scale variable.

Table (8.2) summarizes the different definitions of income used in the three subperiods with their respective elasticities. Whether or not wealth or income was the appropriate scale variable is not investigated directly since this would have involved considerable complications in constructing an appropriate wealth variable. Instead, past

TABLE (8.2)

Demand for Money;

SUMMARY RESULTS ON THE INCOME TERM.

Data Used	Definition of Money	Scale Variable Used	Income Elasticity
Annual 1871-1913	Broad: M2	GNP	1.00
Quarterly 1922-1936	Narrow: M1	Index of Economic Activity	Insignificant
Quarterly 1922-1936	Broad: M2	Index of Economic Activity	Insignificant
Quarterly 1955-1969	Narrow: M1	GDP	0.7
Quarterly 1955-1969	Broad: M2	GDP	1.00

levels of income are incorporated in the initial specifications. We then let the data tell us in what form (i.e. levels or changes) this variable affected money balances.

Table (8.2) shows that the income elasticity is unity for broad money balances for the periods 1871-1913 and 1955-1969. For M1 this elasticity is 0.7 over the latter period, but this is not significantly different from unity (F-test = 1.33 as against a critical value at the 5 per cent of 4.06 for F(1.45)). It should be emphasized that this specification includes an additional variable, the wage-rate. A possible collinearity between this variable and the income variable could be the explanation for the low income elasticity. One interesting result on the interwar period is that the representative income variable appears insignificant. It should be remembered that there are no quarterly GNP or GDP series for this period and that the index of economic activity is the only available series. It is possible that this variable is not a good proxy for the scale variable and this is why we do not obtain any significant effect of this variable. As with the price elasticity it is hard to see how we could determine whether or not this low interwar elasticity is genuine.

With respect to the income variable two more interesting implications seem to emerge from the final specifications. First, it is shown that past levels of income are important in money demand functions and they should therefore be incorporated in these functions from the initial stage. The second result follows directly in that the rate of growth of income proves to be an important variable. The elasticity with respect to this variable varies from 0.76 with M2 for the period 1871-1913, to about -4 and -6 with M1 and M2 respectively, for the period 1955-1969. (It is indeterminate for the interwar period). This is consistent with our initial expectations (see section 5.2) in that at relatively low levels of income (1871-1913), the relationship between money and the growth in the economy is positive; while other financial assets are introduced rapidly as alternative stores of value, the relationship becomes negative (1955-1969).

Other empirical studies (see section 1.2.4.) seem to confirm these results at least for the post World War Two period.

5. The role of the inflation rate.

   As with the rate of growth of income, inflation, the rate of growth of prices, has not been included as a separate variable in the initial stage of our search procedure for a robust money demand specification. The price level, however, is entered in logarithms. A change in such a variable might proxy the inflationary expectations provided of course that the expectations are extrapolative. It should be emphasized that persistent positive inflation has only come to be important in the post-World War Two period. The fact that we could not find a significant effect for this variable for the period 1871-1913 might simply be due to the lack of variation in this variable which made it difficult to identify its effect statistically.

The results for the post World War Two period show that the elasticity with respect to this variable is considerably higher for M1 than for M2 (-11.0 compared to -6.0). This suggests that during inflationary episodes there is substitution from M1 into the time deposits component of M2 since time deposits pay explicit interest which is market determined.

6. Adjustment/Expectation lags in the function.

As for the importance of time lags in money demand functions it is difficult to separate the adjustment lags from expectation lags (see section 1.2.4) in our results.

With quarterly data, almost all the effect of, say a one per cent change in the regressors is seen within the first 4 to 5 years (see figures (7.1) to (7.4) and (7.5) to (7.8). With annual data, however, only 40-50 per cent of the total effect is observed within the first 5 years (see figures (5.1) to (5.3)). These adjustments seem almost incredibly long lived. However, they do appear to be observed quite frequently in estimates of 'error-correction' models (See for example, Gordon, 1984). Goodfriend (1985) suggested that these problems could be related to the regressor measurement error problem. He argues that if all regressors were measured accurately then there would be no need for any lags in the dependent or independent variables in the regression.

This, however, is difficult to verify. He argues that even the GNP series might not be a reliable measure since he says they are probably not statistically measured appropriately.

7. The stability of the function.

Our search procedure has allowed us to obtain stable money adjustment functions in all three periods. These functions have two components: one representing the short-run dynamics, the other representing the long-run steady-state. The steady-state solution for the pre-1913 and post-1955 periods show many similarities. The short-run dynamics, however, appear to differ from one period to the next. This is to be expected since the dynamics probably embody expectations formation processes and these processes in turn reflect the policy environment of the period. As we have discussed above, we failed to find a steady-state solution for the interwar period. This is probably due to data inadequacy over this period. Another explanation is found in policy changes which lead to the difficulty of fitting a single adjustment equation for the whole period.

8.1.2 MONEY MULTIPLIER COMPONENTS

We now turn to the results on the components of the money multiplier: the currency ratio, the time deposit ratio and the reserve ratio. The first two of these ratios describe the public's behaviour and the latter the bank's behaviour.

8.1.2.1 THE PUBLIC'S BEHAVIOUR

For the period 1871-1913 we examined the currency to 'total' deposits ratio since for these years demand and time deposits cannot be separated. Thereafter the currency to demand deposits ratio is examined. Table (8.3) summarizes the results of our specification searches over the three periods.

TABLE (8.3)

SUMMARY RESULTS FOR THE CURRENCY-RATIO.

Function	Data Period	Income Elasticity	Price Elasticity	Interest Rates Elasticities+			Comments
				a	b	c	
C/D	1871-1913 annual	-0.9(GNP)	*	0.9	0.06	*	-the elasticity with respect to bank failure rate is 0.4. no instability. The elasticity with respect to the inflatio rate is -0.9.
C/DD	1922-36 Quarterly	+0.22 (Index of Economic Activity)	-0.5	*	*	0.17 (bbr)	no steady-state parameter instability
C/DD	1955-69 Quarterly	*(GDP)	-2.9	*	0.14	0.3 (tbr)	the wage elasticity is +2.29 the real growth elasticity is -2.08 no instability

(*) not found
(+) the interest rates are (a) the inflation rate (the own rate of return = - the inflation rate); (b) time-deposit rate; (c) rate on a close substitute to time deposits: either the Bank Bill rate (bbr) or the Treasury Bill rate (tbr).

For the period 1871-1913 the income elasticity is negative. For the interwar period the elasticity is positive at around 0.22. The importance of the income variable is also confirmed with the post World War Two data but not in levels form. For the period 1955-1969 it is the rate of growth of income that is important. It should again be stressed that the data for the pre World War One period refers to currency to 'total' deposits ratio (and not to 'demand' deposits as for the postwar period). This implies that the currency to demand deposits ratio has a positive income elasticity but currency to 'total' deposits ratio has a negative income elasticity. The results from other empirical studies - especially those for the U.S. - seem to be in conformity with our results except for the interwar years where these studies found the influence of real income to be negative on the currency to demand deposit ratio. (see section 1.3.4.)

Our results show that interest rates (including the own rate of return for the period 1871-1913) are important for the currency-ratio. The magnitudes of these elasticities are at the lower end of the range of elasticities obtained in other studies (see section 1.3.4.).

One important result that seems to emerge from the Table (8.3) is that currency and demand deposits do not have the same price elasticities. Their ratio in fact has a negative price elasticity implying that demand deposits are more price-elastic than currency. This suggests more substitution between currency and interest-bearing assets other than deposits rather than between demand deposits and those other assets. Further, it seems that the price-elasticity of the ratio is higher for the post-World War Two period than for the interwar period. There are no other empirical studies which have investigated this matter directly, assuming a priori unit price elasticity for both currency and demand deposits (See Section 1.3.4).

For the periods 1871-1913 and 1955-1969 a stable specification for the currency ratio is reached but this is not the case for the interwar period. As we found for the money adjustment equations, this is perhaps due to the impossibility of fitting a single adjustment equation for the currency-ratio when there are switches in policy within the period of estimation.

Before concluding this section we should remark that the homogeneity assumption (with respect to deposits) is rejected in the short run for both ratios. That is, in the short run at least, currency is not homogeneous with respect to total deposits nor with respect to demand deposits. This suggests that a unit elasticity with respect to deposits should not be assumed a priori when analysing the currency-ratio.

The time to demand deposits ratio

Table (8.4) gives the results obtained over two periods for the time-deposit ratio. For the period 1871-1913 the time-deposit ratio could not be estimated since time-deposits could not be separated from demand deposits. Table (8.4) gives the interwar and post-World War Two results.

TABLE (8.4)

SUMMARY RESULTS FOR THE TIME DEPOSIT RATIO

Function	Data Period	Interest Rate Elasticity (+)		Income Elasticity	Price Elasticity	Comments
		(a)	(b)			
TD/DD	1922-36 Quarterly	* positive impact	0.29 (bbr)	*	-1.9	parameter instability the elasticity with respect to the inflation rate is +5.01
TD/DD	1955-69 Quarterly	1.19	-1.35 (tbr)	0.9	*	the elasticity with respect to the inflation rate is -2.26 the real growth elasticity is -7.15 no instability

(*) not found
(+) Interest rates are:
  (a) time-deposit rate
  (b) rate on a close substitute to time deposits:
    tbr = Treasury Bill rate
    bbr = Bank Bill rate

Taking the interest rates first, the results confirm their importance for the time deposit ratio. We have examined two interest rates: the time deposit rate, and the rate on a close substitute for time deposits. The post-World War Two results confirm those obtained by other studies. (see section 1.3.4.) The interwar results, however, contradict these findings. The elasticity with respect to the Bank Bill rate, for example, is positive. The explanation for this paradoxical result might be that the Bank Bill rate moves so closely in this period with the time deposit rate that a rise in the Bank Bill rate induces individuals to switch from demand deposits into other assets as well as into time deposits, implying therefore a positive relationship between the ratio and the Bank Bill rate.

The positive relationship between the time deposit ratio and real income over the postwar period confirms the results in other postwar studies. Over the interwar period the only variable that proxies for transactions is the price level - the income variable was insignificant -but its sign is in contradiction with the postwar result. That is, with increases in income, the time to demand deposits ratio falls initially - over the interwar period - and then rises - over the post-World War Two period. This implies that as time passes individuals use more sophisticated assets for their transactions. Whereas demand deposits were being used for this purpose in the interwar period, in the post war period time deposits are used for the same purpose.

Similarly, the elasticity with respect to the inflation rate is positive over the interwar period and negative in the postwar period. This may imply that as inflationary expectations increase at early stages of financial development, individuals tend to switch from demand deposits into time deposits; at later stages, they tend to switch into more sophisticated assets. This is also evident from the demand for money results where it was found that M1 had a higher elasticity than M2 with respect to the inflation rate (See section 8.1.1)

Thus for the postwar period a stable specification for the time deposit ratio is reached but once again this is not the case for the interwar period where similar problems were once more encountered.

Finally, as for the currency ratio, homogeneity with respect to demand deposits is accepted only in the long run but not in the short run. This suggests that demand deposits should be incorporated in any initial model specifications for the time deposit ratio.

8.1.2.2 THE BANKS' BEHAVIOUR

The reserve ratio:

Table (8.5) presents the main results. Excluded is the post-World War Two period, since over this period the London clearing banks were required to hold a minimum of 8 per cent cash reserves to gross deposits. The data (see Table 7.10) suggest that banks did not hold any excess over and above this requirement.

Our results show that both the penal rate of interest and the interest rate representing the opportunity cost of holding reserves are insignificant, implying that banks adjust their reserves relative to deposits without considering interest rates. This result contradicts those found by other studies but is in accordance with Cagan (1965) for the US.

The effect of real income in our results is again in conformity with Cagan (1965) suggesting a negative relationship between the reserve ratio and the rate of growth of income.

Finally, the specification for the early period shows that banks do in fact take account of financial uncertainties (as proxied with the 'bank failure rate' variable) when adjusting their reserves.

The specification for the later period shows the importance, at least in the short run, of the proportion of demand deposits in total deposits.

Homogeneity with respect to total deposits is rejected, as for other ratios, only in the short run, for the interwar period, implying that the level of deposits should be incorporated in any function explaining the reserve ratio.

TABLE (8.5)

SUMMARY RESULTS FOR THE RESERVE RATIO

Function	Data Period	Interest Rate Elasticities		Real Growth Elasticities	Comments
		Bank Rate	Bank-Bill Rate		
R/D	1871-1913 Annual	0.14^{+}	*	-0.17	elasticity with respect to the bank failure rate is 0.2 no parameter instability
R/D	1922-36 Quarterly	0.03^{+}	*	-1.0	short run effect of the time to total deposit ratio no parameter instability

* not found
\+ t-statistic of about one i.e. not significant at conventional significance levels

8.2 CONCLUSIONS

In the previous section we summarised our empirical results obtained on the demand for and supply of money. We now draw some wider conclusions from the results and consider their implications for the economy.

On the demand side, it has been possible to establish a long-run steady-state relationship between money, income, prices and interest rates. In this respect there are four conclusions.

First, the long-run elasticities with respect to prices and income are not (statistically) significantly different from unity.

Second, narrow money balances (M1) are more interest elastic than broad money balances (M2) and both balances have higher interest elasticity with respect to the long rate than to the short rate. Further, comparing these interest elasticities over three sub-periods, we see that there is a definite downward trend in these elasticities as time goes on. This has two important consequences for policy. One is that since the interest elasticity is less than infinite, monetary control via interest rate targeting is feasible. The other implication, again due to the fact that the interest rate elasticity is not approaching infinity (not even increasing) as the number of other assets increases (for example over post-World War Two period) is that growth in non-bank financial intermediaries will not render the control of money stock impotent. (For details, see Mills and Wood, 1977).

Third, three more variables have been identified to have important effects on money balances: the wage rate (for M1), the rate of growth of income, and the rate of growth of prices.

Finally, over the three periods the money demand function is derived as a stable function. The short-run dynamics of the function depend on the conditions giving rise to the expectation process. The interwar period is, as I have constantly reiterated, an exception. No steady-state solution is found. The readiest explanation is that there were several changes in the exchange rate regime.

None of these results seems to contradict significantly any of the findings in other empirical studies. The supply side on the other hand is somewhat more interesting.

As on the demand side, there are four major results that should be listed.

First, the reserve-ratio is found to be a stable function in all three periods. The currency ratio and the time deposit ratio are likewise stable in the first and third periods, but not in the interwar period. As for money demand functions, these functions show similarities in their long-run results. And, as before, the short-run dynamics of these functions probably embody the expectations formation processes. They, therefore, reflect the policy environment of the period. The stability of these money multiplier components in two of the three periods has been an important consequence for policy: namely, that monetary control via the monetary base approach would have been feasible in these periods.

Second, the currency and time deposit ratios are both related positively to real income and negatively to the price level. This implies that currency, demand deposits and time deposits do not have unitary price and income elasticities even though their sums (M1 and M2) do.

Third, three more variables are identified to have important effects on these ratios: financial uncertainty (as proxied with the bank failure rate), the rate of growth of income, and the rate of growth of prices.

Last, the effect of interest rates on these ratios seem to imply (in some cases) that the supply of money is negatively rather than positively related to the level of interest rates. This deserves more detailed examination. The reserve ratio is insensitive to interest rates. Given this, what is then the effect of increasing interest rates on money balances? There are two ways of approaching this question. First, we can examine the effect of raising one interest rate (the short rate) by 'one per cent'. Over the period 1871-1913 the currency to total deposits ratio has an interest elasticity of +0.06. This means that the money multiplier (hence the money supply - assuming the base to be exogeneous) has an interest elasticity of -0.029. That is, the money supply is <u>negatively</u> related to short term interest rates.

Since the interwar results do not allow for a long-run solution this exercise cannot be performed for that period. Over the post-World War Two period both the currency to demand deposits ratio and the time deposit ratio are interest sensitive. Raising interest rates by one per cent implies M1, for example, will rise by 0.023 per cent. This implies that money stock is positively related to the interest rates.

A more appropriate exercise however would be to raise all rates (short and long rates) by one percentage point. That is, to shift the whole yield curve upwards. For this exercise we need to obtain the long-run semi-elasticities. Since all the rates in the specifications are entered as logarithms of (1 + the rate), this is straightforward.

Performing this exercise for 1871-1913 it turns out that money supply (M2) has an elasticity with respect to the general level of interest rates of the order of -1.15 per cent. Over the period 1955-1969 we can obtain these elasticities for M1 and for M2. They turn out to be -4.92 and -3.84 respectively.

Taking this exercise one step further and comparing these elasticities with those obtained on the demand for money reveals that the demand for money is consistently more interest-elastic than the supply of money. (The long-run semi-elasticities are -4.10 over the period 1871-1913; and -11.61 for M1 and -8.7 for M2 over the period 1955-1969).

What are the implications of this result? Both demand for money and supply of money are negatively related to the general level of interest rates.

But since the demand for money is relatively more elastic than the supply of money then the LM curve (in the Hicksian IS-LM framework) is still positively related to interest rates. This means that any exogenous increases in the supply of money necessitates falls in the interest rates so as to bring the money market into equilibrium. For example, assume that there is an exogenous increase in monetary base which will raise the supply of money. This will then reduce interest rates. As a result both demand for and supply of money will rise. Since, however, demand is more elastic than supply, the demand for money will rise to accommodate both the initial and secondary increases in supply.

The paradoxical result of our model is with respect to the exogenous changes in the demand for money. Any exogenous increases in the demand for money, for example, will raise interest rates. This will then reduce both the supply and the demand for money. The demand for money will have to fall more than the supply so the initial increases in the demand for money are accommodated. When the money market comes into equilibrium the stock of money is at a <u>lower</u> level. This result contradicts that of the conventional models where the supply of money is modelled as either interest insensitive or as positively related to the interest rate, which would suggest that exogenous increases in the demand for money <u>should</u> result in <u>higher</u> levels of money stock.

In view of these results, we could argue that our application of a consistent modelling strategy to the newly developed historical data base has been justified, in the sense that it has provided new insights into the determination and interaction of money demand and supply. However, our findings do relate solely to the historical periods covered. In recent years, there is evidence that the increased pace of financial innovations has led to further changes in the functions of money demand and supply. Although the precise elasticity estimates obtained above may not therefore be currently relevant, it would be interesting to see whether an application of our modelling strategy would detect such structural changes.

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