THE MONEY SUPPLY AND INTEREST RATES IN SOUTH AFRICA 1950 - 1971: AN ECONOMETRIC INQUIRY

by

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ABSTRACT

In response to the debate between the Monetarists, who believe that the money supply can be exogenously controlled by the monetary authorities, and the Neo-Keynesians, who believe that the money supply is determined mainly by endogenous forces, there has arisen a body of empirical research into the money supply process in various countries, which appears to support the Monetarist view.

This thesis subjects current money supply theory to empirical inquiry, using hitherto untested data from South Africa, thereby furnishing an integrated body of empirical evidence on the money supply and interest rate determination process in South Africa. The major findings broadly support the Monetarist view, and challenge the wisdom of the Reserve Bank's commitment to stabilizing interest rates to the neglect of money supply control.

The analytical framework used is a Brunner-Meltzer credit market model of the money supply with modifications to incorporate institutional relationships specific to South Africa. The thesis examines the comparative static effects of changes in the exogenous variables of the model on the money supply and credit market rate, and the transmission mechanism is analysed.

The empirical analysis is conducted for the period 1950-1971, and commences with a conspectus of the instruments and goals of monetary policy in South Africa. This profile is supported by the findings of the thesis.

Broadly, the evidence shows that the monetary base varies pro-cyclically in response to pro-cyclical movements in the balance of payments, and furthermore, accounts for over half the average annual growth rate in the money supply. The credit market rate fluctuates contra-cyclically in response to the base, imparting a contra-cyclical movement to the money multiplier, which dampens the pro-cyclical influence of the base on the money stock. Observed pro-cyclical variations in the money supply are explained by the interest rate stabilization programme pursued by the Monetary Authorities in the expansion phase of the cycle, and by a balance of payments protection policy in the contraction phase. Thus, the stabilization programme abrogates money supply control through the monetary base; contra-cyclical policy is only weakly exercised through open market operations and Reserve Bank discounting policy; Bank Rate policy is geared to the stabilization programme and the balance of payments protection policy; and variable supplementary statutory reserve requirements are assigned to credit control.

The theoretical comparative static analysis of the thesis is supported by the evidence, which suggests that changes in the monetary base exert the strongest influence on the money supply and credit market rate, followed by statutory reserve requirements on demand deposits and Bank Rate, and that the interest rate mechanism dominates the money supply process through its influence on the money multiplier.

Other findings suggest that the interest rate effects of open market operations may be enhanced by abandonment of the stabilization programme, and the development of the secondary market for government debt. As key dealers in government debt, the Public Debt Commissioners stabilize the credit market rate and influence the money supply.

A redistribution of income in favour of a low income group raises the money supply, thereby reversing a prediction of traditional money supply models which exclude the interest rate mechanism.

Further results indicate that the money market is crucial in a South African money supply model. It performs as hypothesized, permitting (in consequence) a convenient theoretical simplification of the model.

The evidence indicates further, that, in contrast with other countries, the currency ratio is unimportant in the money supply process; that the money supply process functions much like the Classical Gold Standard system; and that destabilising endogenous forces are more likely to controvert monetary policy over longer periods.

The policy conclusions emerging from this thesis are that the South African Monetary Authorities can control the money supply through variable statutory reserve requirements, Bank Rate, and the monetary base, if the stabilization programme is abandoned.

"What's the use of their having names," the Gnat said, "If they won't answer to them?"

"No use to them," said Alice; "but it's useful to the people that name them, I suppose. If not, why do things have names at all?"

"I can't say," said the Gnat.

Through the Looking-glass

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CHAPTER 1

AN INTRODUCTION TO THE STUDY: ISSUES IN MONETARY POLICY AND MONEY SUPPLY THEORY

1. INTRODUCTION TO THE STUDY

Standard Keynesian macroeconomic theory in the Hicksian IS-LM tradition, dichotomises the economy into a goods and money market,providing a theoretical framework for analysing the determinants of national income and employment in terms of a set of real and monetary variables. Within each set there is a sub set of policy variables by means of which the monetary authorities may influence the level of income and employment. We are primarily concerned here with the monetary variables under control of the monetary authorities. Post Keynesian developments in the theory of the demand for money have stimulated a concurrent interest in money supply theory. The classical assumption in monetary theory, associated with the working of the old Gold Standard, that the money supply is essentially exogenous, has been modified with the recognition of the endogenous effects on the money supply exerted by the portfolio allocation behaviour of both private wealth holders and financial institutions. Modern money supply theory is formulated in terms of a simultaneous equation model of the financial sector in which both endogenous and exogenous forces are permitted to determine the equilibrium money stock.

Accompanying these developments in money supply theory, a wide variety of empirical research has been conducted on the financial systems of America, Canada, Great Britain and several other countries, to establish the nature of the money supply mechanism; and a broad consensus of opinion is being established, in the light of the accumulated evidence, suggesting that the monetary authorities can effectively control the money supply (see K.Brunner [13], p.99; [11], p.19).

In this study we follow the main stream of empirical research in the area of money supply theory by examining the forces that determine the money supply and interest rates in South Africa. Our analytical framework is based on the credit market approach to money supply theory developed by K. Brunner and A.H. Meltzer [15]; [17]; which we modify to accommodate the South African financial system. The sources of many of our ideas are attributable also to the work of A.K. Kelly [67], G.I.Weber [97] and M. Fratianni [38], who use a Brunner-Meltzer type model to explain the money supply process for Canada and Italy. The credit market approach is singularly appropriate for our purpose, falling within the category of more manageable small scale econometric models (rather than the large scale models for the American economy), providing us with a general analytical framework for assessing the process of money supply and interest rate determination and the monetary effects of monetary and fiscal policy. It incorporates the main elements of post war developments in monetary theory by applying the theory of relative prices to analysis of the money supply.

The achievements of our study are both general and specific. In general, by conducting an empirical test of current money supply hypotheses using new data, we augment the existing body of supporting evidence in this area, which has been accumulated for other countries. In testing the credit market money supply theory, "It is particularly important to cover a large range of different experiences with respect to the money supply process".

(K.Brunner [11], p.18). More specifically, we fill the gap in monetary analysis for South Africa by providing an integrated body of evidence on the functioning of the South African financial system as a whole.

The South African financial structure presents an ideal laboratory apparatus replete with hitherto scientifically unsubstantiated hypotheses. During the period 1950 to 1971, the South African financial system underwent a series of structural changes similar in nature to those experienced by the more developed economies of Great Britain and America. The most notable of these occurrences was the establishment and rapid development of a South African money market modelled on the lines of its London counterpart, and the proliferation of near banks. With respect to monetary policy, the South African Monetary Authorities implicitly committed themselves to a Neo-Radcliffian or New View (Tobin et al.) approach to monetary control by ignoring control of the monetary base and the money supply in favour of stabilizing interest rates, controlling the supply of banking sector credit and emphasising the relevance of a broader monetary aggregate defined as money plus near money, or liquid assets in the hands of the public. We challenge this approach by estimating a money supply function which is stable and dependent on the monetary base and other policy variables, showing that in principle the Monetary Authorities can control the money supply. Apart from a large body of descriptive literature on various aspects of the South African financial system, and on the nature of South African monetary policy, no econometric evidence exists to support established views in South Africa on how the system operates. This study seeks to rectify the omission. If monetary policy is to be exercised through control of the money supply then

> ...the actual money supply which emerges should be the result of a conscious decision rather than the fortuitous outcome of changes in unacknowledged or overlooked forces ...[it] deserves to be something better than a residual. A planned money supply presupposes, of course, some understanding of the true nature of the forces shaping the outcome.
> R.L. Crouch [27], p.150.

We now provide a synopsis of the course of our inquiry. The remaining sections of this chapter are devoted to a discussion of current views on the problems of monetary policy and control and to a selective survey of the development of money supply theory in the twentieth century.

Current discourse on monetary policy (Section 2) is dominated by the debate between the Monetarists and Neo-Keynesian Schools of thought about whether or not the money supply can and should be controlled by the monetary authorities. While the former School emphasises the exogeneity of the money supply and that the monetary authorities should exert their influence through some monetary aggregate under their control, the latter School asserts that the money supply is primarily dominated by endogenous forces emanating from the real sector. We discuss the problem of monetary control by using the traditional non linear money multiplier formulation, and show that exogenous control of the money supply depends upon the stability of the multiplier and the ability of the monetary authorities to influence variations in the multiplier.

In Section 3, the problems of monetary policy and control are illuminated by a survey of the developments of money supply theory. We show how money supply theory has evolved from a simple constant multiplier formulation in the pre war era, to a complex set of financial interrelationships, which allow the multiplier to respond to the endogenous portfolio allocation behaviour of the banking and private sectors, to the policy actions of the monetary authorities and to real forces. We demonstrate that post Keynesian developments in the theory of the demand for money provide the catalyst for the post war evolution of money supply theory.

Against this background, we proceed with our study of themoney supply in South Africa. In Chapter 2,a theoretical structure is formulated appropriate to South Africa, and in Chapter 3, we examine the comparative static implications of the model. Chapter 4, presents the empirical investigation and is concluded with an overall summary of the empirical results.

In Chapter 2, we specify the money supply model for South Africa by modifying the basic Brunner-Meltzer credit market approach to take account of: differential statutory reserve requirements on various classes of deposits; the institutional relationship between the South African Reserve Bank, the banking sector, the money market and other private sector financial institutions; the special role of the Public Debt Commissioners and the monetary implications of National Debt management and fiscal policy; and the significance of the distribution of income in the money supply process. An analytical framework is devised to assess the relationship between the monetary base, fiscal policy and an interest rate stabilization programme. We are indebted to the work of M. Fratianni (ibid.) for many valuable ideas in this section. In Section 7, the solution functions for the equilibrium money stock and the credit market rate are derived, and the model is summarised in Section 8.

The comparative static implications of the model are derived in Chapter 3, providing us with empirically testable hypotheses about the money supply process. We obtain expressions for the response patterns of banking sector reserves with respect to changes in statutory reserve requirements and the distribution of private sector wealth between demand and time deposits, and for the responses of the money supply and credit market rate with respect to changes in the exogenous variables of the model. These expressions have a sign pattern determined by the a priori assumptions embodied in the structural equations of the model. We also obtain hypotheses with respect to an interest rate stabilization programme. and the relative interest rate effects of open market operations and government deficit finance.

The comparative static analysis is conducted in terms of a detailed exposition of the transmission mechanism linking changes in the exogenous variables to the money stock and the credit market rate. A two-path mechanism is identified, composed of a direct and secondary or interest rate effect operating through the money and credit market multipliers. The direct effect reflects the initial or impact adjustment in the banking and private sectors' balance sheet positions, resulting from a change in the exogenous variables; interest rates change in consequence, causing a secondary round of adjustments in asset portfolios and debt. The net effect on the money stock and the credit market rate of a change in the exogenous variables is composed of the direct and secondary effects. Chapter 3 is concluded with a summary of the main comparative static results.

In the final Chapter of this study (Chapter 4), we test the structural equations of the model, estimate the reduced form coefficients for the credit market rate solution function and the money supply function for South Africa, and obtain calculated estimates of the direct and secondary effects comprising the transmission mechanism, in terms of the elasticities of the money and credit market multipliers with respect to the credit market rate and the exogenous variables. The cyclical and secular contributions of the money multiplier and the monetary base to the growth rate of the money stock are examined, as well as the contributions of the portfolio allocation ratios to percentage changes in the money multiplier.

Using this statistical information, we examine the nature and course of monetary and fiscal policy in South Africa and the consequences of the interest rate stabilization programme pursued by the Monetary Authorities. Three additional issues are analysed: the relative influences of open market operations and Government deficit finance on the creditmarket rate, the role of the Public Debt Commissioners in the money supply process, and the significance of income distribution in the money supply and credit market rate determination process.

Throughout the empirical inquiry, we provide detailed historical information on the modus operandi of monetary policy and the course of economic events in South Africa. This data is necessary in the construction of meaningful testable hypotheses and to interpret the econometric results. Chapter 4 is terminated with a summary of our empirical findings.

2. MONETARY POLICY AND MONETARY CONTROL

Most discussions on monetary policy posit some relationship between monetary variables and changes in nominal income, the latter being composed of the product of real income and the price level. However, strong contradictory views prevail between those who believe

> ... that money may be a causal, active and independent factor in changing the level of output, employment and the price level - and those who take a real (nonmonetary) view and argue that money is passive changing primarily in response to changes in the real sector..... D.I. Fand [35], pp.381.

The former view, currently propagated by the Monetarist School, is exemplified by the work of Brunner and Friedman, while the latter, the Neo-Keynesian School (also known as the New View), is characterised by the work of Gurley and Shaw, Tobin, and the Radcliffe Committee.[1]

In summary, the Neo-Keynesians stress that the money supply is essentially an endogenous variable and is neither the appropriate indicator nor the appropriate propagator of monetary policy and that the monetary authorities should rather use their policy instruments to determine some money market variable (such as interest rates); while the Monetarists deny this position by asserting that the nominal money stock can and should be controlled as the proper target variable of monetary policy.[2] Implicit in

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1. K.Brunner [10]; J.Gurley and E. Shaw [49]; J.Tobin [94]; M.Friedman [41], [42]. The Monetarist critique of the Neo-Keynesian School may be found in Brunner [10], [11], [12]. Excellent surveys of the debate together with full citations of source material are provided by: L.C.Andersen [3]; L.R.Klein and K.Brunner [69]; D.I.Fand [36]; and R.L.Teigen [90].

2. D.I.Fand, ibid.,p.13.

these prescriptions, there rests a specific view of the mechanism linking monetary impulses to nominal income.' On the one hand, the Monetarist School emphasises that,

> ...monetary impulses are a major factor accounting for variations in output, employment and prices... [that] movements in the money stock are the most reliable measure of the thrust of monetary impulses.... [and that] the behaviour of the monetary authorities dominates movement in the money stock over business cycles. K.Brunner [10], p.9.

Proponents of the Neo-Keynesian School accept on the other hand, that, fluctuations in the growth rate of the money stock "... result primarily from the behaviour of the commercial banks and the public." (K.Brunner, loc. cit.). They emphasise "... an interest rate transmission mechanism... [linking the monetary and real sectors and regard] monetary aggregates as endogenous variables...." (D.I.Fand, op.cit., p.18).

Now, these issues are essentially empirical questions and cannot be resolved from a priori reasoning. In our study here, we are concerned with that aspect of the debate which focuses attention on the determination of the nominal money stock and interest rates in financial markets. Our task can be formulated in terms of seeking an answer to the question of whether the central bank is able to control the money stock within fairly close limits or whether endogenous forces swamp policy actions. An empirical hypothesis emerges immediately, requiring that we test the relative strengths of the policy variables controlled by the central bank and the endogenous actions of the banking sector and private sector in financial markets.

We couch the problem of monetary control in terms of a formal framework as follows. The central bank sets the monetary aggregate under its control and other policy variables, the banking sector determines the stock of earning assets in its portfolio and the quantity of excess reserves, and the private sector determines its allocation of liquid wealth between currency, demand deposits and time deposits. All these decisions interact simultaneously to determine the nominal money stock. In terms of traditional money supply theory, the determination of the money stock is characterised by the expression

$$M = mX \qquad (1-1)$$

where:

M = the nominal money stock

m = a multiplier coefficient reflecting the endogenous forces in the banking and private sectors and the real sector

X = a reserve aggregate controlled by the central bank .

The multiplier coefficient is dependent on a vector of interest rates in financial markets (i), a vector of monetary assets (A) held in the portfolios of the banking and private sectors (typically; currency, demand and time deposits in the portfolios of the private sector and excess reserves held by the banking sector), some measure of nominal income (Y), and a vector (r) containing other policy variables of the central bank (discount rate and statutory reserve requirements). Thus, m is expressed as a functional relationship:

$$m = m(i,A,Y,r) \qquad (1-2)$$

and the money stock expression is converted into a behaviour equation:

$$M = m(i,A,Y,r)X \qquad (1-3)$$

The control problem centres on the linkage between changes in X and changes in the arguments of function m.[3] A given exogenous change in X disturbs portfolio equilibrium in the balance sheets of financial institutions and the private sector, setting in motion a process of portfolio adjustment. After the adjustment process has worked itself out, a new equilibrium position is established with a new value of the nominal money stock and a new set of equilibrium interest rates, mutatis mutandis. The essential dividing line between the Neo-Keynesians and the Monetarists rests with an assumption about the stability of m, which of course is an empirical issue. The Monetarist School would argue that m is stable and does not modify any initial monetary impulse exerted through a change in X; the linkage between X and M is tight, providing the central bank with adequate control of the nominal money stock. In contrast, the Neo-Keynesian School would argue that m is unstable. Changes therein tend to dominate variations in the money stock, and in consequence, money supply control through variations in X is abrogated by many a slip betwixt cup and lip.

The stability of m depends on the elasticity of the arguments of function m with respect to changes in X and the elasticity of function m with respect to changes in its various arguments. For example, most empirical work on the money supply indicates that the interest rate response with respect to changes in X is negative and that the interest elasticity of m is positive. Hence, an increase in X lowers m, which attenuates the initial impact effect of an increase in X on the nominal money stock.[4]

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3. R.H.Rasche [83], p.11,12.

4. See A.E.Burger [19], Chaps.4,5; and K.Brunner and A.H. Meltzer [68], for a discussion of the relationship between the money multiplier, the banking and private sectors, and the monetary authorities.

Most of the debate fails to point out that the monetary authorities can in fact exert an influence on m through the vector r and thereby counteract other forces operating through A, i and Y.

Having outlined broadly the current state of the debate on monetary policy and control, we turn to a survey of the development of money supply theory.

3. A SELECTIVE REVIEW OF MONEY SUPPLY THEORY

Resolution of the control problem for South Africa requires that a suitable money supply function be specified, which incorporates the specific institutional relationships peculiar to the South African financial system. In this section, we discuss the historical development of money supply theory commencing with the simple models of the pre war period. We show how developments in various areas of monetary economics are incorporated into money supply models and conclude with the modern Brunner-Meltzer non linear money supply formulation, which constitutes a simultaneous equation system describing the behaviour of the banking and private sectors, and from which, reduced form equations for the rate of interest and the money supply are derived. Specification of a money supply function requires that we distinguish between the supply of real balances and the nominal money supply. It is well established in the literature that in a non Keynesian world where both real output and prices are endogenous variables, the monetary authorities may be able to control the nominal money stock but that the stock of real money balances is determined endogenously by the interaction of the financial and real sectors, and is therefore not controllable by the monetary authorities.[5] Because of this relationship, there exists a nexus between changes in the nominal money stock, money market conditions and the general equilibrium of the economy. On this account, money supply theory and money supply functions are specified in terms of the nominal money stock.

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5. H.G. Johnson [62], p.135. In a Keynesian world, the price level is assumed constant so that real and nominal balances move together and both determine the nominal interest rate, the real interest rate and the equilibrium quantity of real balances (Fand, ibid., p.16,17).

Money and banking text books frequently presume that a simple mechanical link exists between some policy controlled monetary aggregate, such as commercial bank reserves, and the money supply. This is an appropriate analytical framework for a world in which there are no changes in the cost of banking sector credit, no excess or borrowed reserves and no portfolio adjustments of the banking and private sectors. Under these conditions, the determination of the money supply is simply a matter of arithmetic.[6] The money multiplier is assumed constant and the money stock varies directly with exogenous changes in the reserve aggregate controlled by the monetary authorities. These more primitive money supply functions do not account for the possibility of the endogenous determination of the multiplier, and the monetary aggregate controlled by the monetary authorities is defined as banking sector reserves, with no provision for an explanation of the sources of these reserves. A modern money supply function describes the relationship between the nominal money stock, the policy controlled monetary aggregate (the monetary base), endogenously determined financial variables (banking and private sector portfolio behaviour, interest rates, and the quantity of banking sector credit) and real variables. Such a function is derived from a given set of behaviour assumptions about the banking sector and the private sector, and the sources of the monetary base incorporates the broadest spectrum of central bank activity. In terms of our generalised money supply function referred to in the previous Section, $M = mX$, we view the development of money supply theory as a process of

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6. D.I.Fand [35], p.380.

specifying the underlying economic determinants of m and X to varying degrees of complexity. An advanced level of sophistication will take account of the institutional environment, the policy instruments available to the monetary authorities and the fiscal operations of the government.

3.1 Pre War Developments in Money Supply Theory

In our discussion of pre war money supply theory, we focus attention on the work of J.S.Mill, W.F.Crick and J.E.Meade as a useful sample of the progression of money supply theory from a simple commodity standard to a modern deposit issuing banking system.[7]

The cornerstone of modern money supply theory rests on the portfolio selection behaviour of economic units, directing attention to the existence of alternative means of wealth holding. In his discourse on the supply of monetary gold, J.S.Mill may be regarded as a precursor to this approach. His theoretical framework is summarised as follows. In a pure commodity standard in which gold coin is the only circulating medium of exchange, the stock of monetary gold is determined by the cost of producing new gold, the international flow of specie and the propensity of wealth holders to melt and mint non monetary gold hoards. Mill's theory is linked to modern portfolio theory in his (Mill's) discussion of short-run changes in the stock of monetary gold through the melting and minting of gold hoards.[8]

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7. For an early analysis of the American money supply, see L.Currie [29]. The pre war literature on money and banking is well documented in Readings in Monetary Theory [23]. Crick [24] and Meade [75] analyse the money supply in Great Britain in the pre war era and Mill [78], pp.488-611, is concerned with the determinants of the supply of monetary gold. Haverilesky [50] provides a useful analysis of Mill's money supply theory.

8. T.Haverilesky, ibid., p.73,78.

These hoards vary inversely with the real value of monetary gold, imparting a short run responsiveness to the stock of monetary gold, to changes in its relative price.[9] The other sources of supply of monetary gold have their modern counterparts in the conditions underlying the operations of the banking system, which is treated as a money producing industry equivalent to the gold producing industry, and in the flows of international financial assets (including gold).

A simple money supply model may be constructed for the case of a pure commodity standard and a competitive gold mining industry. In such a world, the long run supply of monetary gold is determined by the cost of production, and in equilibrium, its value is equal to the marginal real resource cost of producing an additional unit. An exogenous increase in the demand for monetary gold puts upward pressures on the real price of gold: gold is imported, additional gold is mined and hoards are run down.

Now, assume that the international flow of specie is exogenously determined and that the net inflow per period is measured by variable X; and let the vector m contain variables that determine the output of newly mined gold (the real price of gold and marginal real resource cost) and the

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9. If the nominal price of monetary gold is equal to unity and the absolute price level is given by an index P, then the relative price of monetary gold (in terms of a representative bundle of commodities) is equal to 1/P. An increase in the demand for nominal monetary gold will, ceteris paribus, lower the absolute price level and raise the relative price of monetary gold in terms of real purchasing power. Since 1/P is the real opportunity cost of holding non monetary gold, an increase in 1/P will lower the demand for non monetary gold, which, imparts a positive short-run elasticity to the supply of monetary gold. See J.S.Mill, ibid., pp.499, 544 and H.G. Johnson, ibid., p.176.

demand for gold to hoard (the real opportunity cost of holding gold and the yield on other assets in real terms).' Then the stock of monetary gold (M) is given by the expression M = mX. An exogenous inflow of gold specie from abroad, represented by a rise in X, raises the supply of monetary gold on impact; the real price of gold declines causing a contraction in the supply of newly mined gold and an increase in the demand for gold to hoard, and the money multiplier (m) declines.

Analogous with modern money supply theory, X represents exogenous factors, m represents the endogenous behaviour of the profit maximising gold industry and the portfolio behaviour of wealth holders. Even in this simple world, the money multiplier is not a constant; it varies in response to endogenous forces, attenuating the direct effect of an initial increase in X on the stock of monetary gold (M).[10]

Moving from a pure commodity standard to a fiduciary standard, we introduce a deposit issuing banking sector into the analysis. In this type of model, deposits are backed by claims against the government (fiat currency and book entry claims against the central bank) and claims against the private sector. In order to construct the most simple of money supply models within this monetary framework, we assume that the banking sector holds claims against the government as cash reserve for transactions and speculative purposes, but that the banking sector's desired reserve to deposit ratio (b_1) is constant. We also assume that only two kinds of money exist; banking sector demand deposits and currency issued by the government,

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10. Friedman and Schwartz provide an analysis of several types of monetary systems in terms of the multiplier formulation and its determining coefficients ([43], Appendix B).

and that the private sector holds currency in some fixed ratio (P_1) to demand deposits. Then the multiplier m is defined by the ratio parameters P_1 and b_1 thus:

$$m = \frac{1 + P_1}{b_1 + P_1} \qquad (1\text{-}4)$$

Defining the money supply (M) as the sum of currency plus demand deposits and the exogenous monetary aggregate (X) as the supply of banking sector reserves, the money supply is given by the expression:

$$M = \frac{1 + P_1}{b_1 + P_1} X \qquad (1\text{-}5)$$

Typically, if we ignore the private sector's currency demand and let $P_1 = 0$, then the response of the money supply to an exogenous injection of reserves is equal to the reciprocal of the banking sector's reserve to deposit ratio ($1/b_1$). If we take the private sector's fixed currency to deposit ratio into account, then the money supply response to an injection of reserves is given by the expression $(1 + P_1)/(b_1 + P_1)$, which is less than $1/b_1$. By incorporating the private sector's demand for currency, the value of the multiplier is lowered and the money supply response to an exogenous injection of reserves is less, since part of the new supply of reserve is withdrawn from the banking sector by the private sector.

This model is typical of many early textbook money supply models. The ratio parameters are assumed constant and are not determined by relative interest rates and a budget constraint. While the monetary system in this model is more advanced than that of the commodity standard, the money supply model is certainly more primitive. The mechanistic character of this model coincides with, and is probably due to a similar mechanistic approach to the demand for money, which prevailed prior to Keynes' "General Theory". Substantial developments in money supply theory, as also in the theory of velocity and the demand for money, had to await the post war development of monetary theory in the Keynesian tradition, with the application of a relative price theoretic framework.[11]

Money supply theory was substantially advanced in 1927 by W.F.Crick [24], in an article entitled "The Genesis of Bank Deposits", where the embryonic principles of modern money supply theory were established in anticipation of the post war application of portfolio selection theory to commercial bank behaviour. His main contribution is twofold: firstly; he clarifies the transmission mechanism linking a change in commercial bank reserves to changes in bank deposits, by emphasising the profit maximising behaviour of the banking sector, and secondly; he questions the stability of the commercial banks' reserve to deposit ratio (b_1) and hence the stability of the money multiplier. This in turn leads to a discussion of the ability of the central bank to control the quantity of deposits by varying the quantity of banking sector reserves.

In his discussion of the transmission mechanism, Crick is concerned with resolving the classical semantic confusion between bankers (who believed that banks could only lend the cash that they received) and economists (who asserted that banks could create deposits through lending). Of course, the bankers' view applies to an individual bank while the economist's view applies to the banking sector as a whole. Resolution of

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11. H.G.Johnson [60], pp.41-43.

this issue establishes that the banking sector can engineer a multiple expansion of deposits for a unit increase in banking sector reserves. As Crick remarks,

> ...disagreement on matters of terminology should not blind us to the relation, in sequence and amount, between the volume of bank credit outstanding and the quantity of bank cash held against it. W.F.Crick, op.cit., p.53.

According to Crick, an individual bank maximises profits subject to a given desired cash reserve to deposit ratio (b_1), this ratio being determined by liquidity considerations and the opportunity cost of holding cash as opposed to interest-bearing earning assets.[12] Since each individual bank conforms to the given b_1, an injection of additional reserves into the banking sector will be distributed between individual banks such that the desired b_1 is satisfied for each bank and for the banking sector as a whole. The adjustment process occurs by an adjustment of bank's earning assets and a consequent increase in deposits.[13] Now, the relationship between the change in reserves and the change in deposits (the money multiplier) is stable only if b_1 is stable. Crick, thus, questions the constancy of the money multiplier and the implications of a purely mechanical relationship between changes in reserves and deposits.[14]

This question of stability directs Crick to the problem of monetary policy and the idea that the Bank of England is able to exert an influence on the money supply by controlling banking sector cash reserves. He points

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12. W.F.Crick [24], p.50.

13. Ibid., p.42,[50].

14. Ibid., p.47,[51].

out that the Bank of England may offset exogenous changes in banking sector reserves (resulting from gold flows) by compensating changes in the Bank's portfolio of securities and"loans and investments".[15] However, control is by no means automatic; the effect on the quantity of deposits of a policy induced change in banking sector reserves depends on the stability of b_1 and hence the money multiplier. "There is certainly no definite and direct relation of cause and effect between the deposits of the banks as a whole and the policy behind the actions of the central institution". (W.F.Crick, op.cit., p.44). While recognising that banking sector behaviour may cause variations in the money multiplier, Crick fails to discuss the feedback effect on the multiplier of changes in banking sector reserves. There is no mention of interest rates and private sector portfolio adjustments. The classical garb remains, awaiting removal by the advent of Keynes's liquidity preference theory.

The final suspension of currency convertibility into gold by western industrial nations in 1925 encouraged economists to evaluate the differences in money supply theory resulting from a change in the financial system. A money supply theory must account for the peculiarities of the institutional structure under examination and must specify the behaviour of economic units. An incisive study of the British monetary system for the period 1925 to 1930 is provided by J.E. Meade [75], which, although written in 1934, contains many features of modern money supply theory. Meade employed a money multiplier model of substantial sophistication to assess the effects

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15. Crick cites evidence to support this contension (ibid., p.43,n.1 and p.44,n.2).

on the money supply of changes in the ratio parameters comprising the multiplier; these ratio parameters represent the behaviour of the Bank of England, the commercial banking system and the private sector.

Assuming that the Bank of England is the sole issuer of bank notes and that there is no circulation of gold coin, Meade considers three different monetary regimes: under regime one, the Bank of England is assumed to hold a differential gold reserve against its total note issue and against its deposit liabilities to the banking sector, where these ratios are referred to respectively as L and m', so that $L \neq m'$; and under regime two, $L = m'$. Under regime three, a fiduciary note issue is introduced. This note issue appears as an asset in the Banking Department of the Bank of England and is held as a desired ratio k to commercial bank deposits with the Bank, which, appear as a liability of the Banking Department.

The preferences of the banking and private sectors are represented by the ratio parameters b_1 and q respectively, where b_1 is the cash reserve to deposit ratio of the banking sector and q is the currency to money ratio of the private sector. As in our discussion of the simple fiduciary standard, the money multiplier is determined by the banking and private sectors' ratio parameters:

$$m = m(b_1, q) \qquad (1\text{-}6)$$

However, Meade imposes constraints on the behaviour of the Bank of England. Changes in the monetary aggregate X are subject to the ratios L, m' and k being satisfied, thus:

$$X = X(L, m', k) \qquad (1\text{-}7)$$

Building upon this framework, Meade incorporates into his model three additional refinements to account for institutional details in the banking sector and the portfolio allocation behaviour of the private sector. Since the banking sector may hold cash reserves either as vault cash or Bank of England deposits, the ratio parameter v is introduced, describing the banking sector's vault cash to reserve deposit ratio. The banking sector issues both demand and time deposits and may choose to hold a differential reserve requirement on each. In consequence, b_1 is no longer a simple ratio, but depends on the desired cash reserve ratio held against demand deposits ($r^{d'}$) and time deposits ($r^{t'}$) and on the portfolio preferences of the private sector. The private sector is assumed to allocate its wealth between demand and time deposits in the ratio γ where γ is the ratio of demand to total deposits. Thus, b_1 is written as an explicit expression:[16]

$$b_1 = r^{t'} + \gamma(r^{d'} - r^{t'}) \qquad (1\text{-}8)$$

The general form of the money multiplier is modified by including the new ratio parameters:[17]

$$m = m(b_1, q, v, \gamma) \qquad (1\text{-}9)$$

Meade anticipates modern money supply theory in two further respects. Firstly, his exogenously determined aggregate X is defined as the sum of

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16. This expression is identical to that used in our money supply model for South Africa. Cf. Equation 2-17 in the text.

17. This general form has three explicit non linear formulations, one for each regime discussed. See Meade [75] , pp.55,56.

the gold stock and the fiduciary note issue, both of which are asset items in the Bank's balance sheet. This definition is one step closer to the modern idea of the monetary base. Secondly, the money supply is defined broadly to include time deposits in the banking sector.

Meade's money supply theory moves well beyond the simple mechanical world of Crick or our simple fiduciary standard, discussed above; by expanding the definition of the money supply and the exogenous variable X, by introducing a more detailed set of banking sector ratio parameters and accounting for differential reserve ratios, and by directing attention towards the private sector's wealth allocation preferences between currency, demand and time deposits. Now, although Meade has taken account of the complexities of the financial system by specifying a larger number of parameters for the central bank and the banking and private sectors, the parameters are still exogenous. The next step is to make these parameters endogenous.

3.2 Post War Developments in Money Supply Theory[18]

Developments in money supply theory beyond the constant multiplier stage are characterised by two basic modifications, both of which extend the theory beyond the limitations of the inherited Keynesian paradigm. Firstly, additional explanatory variables are added to take account of financial behaviour by economic units, and secondly, behaviour postulates are added to render the multiplier coefficient dependent upon endogenous economic forces. We show below, how these extensions to the theory required

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18. Most of the discussion in this section has been surveyed or commented on by Johnson [59], [60], [61], [62]; Brunner [11], [12], [13]; Teigen [90]; and Fand [35].

prior development in the theory of the demand for money.[19]

In 1935, in an article which laid the foundations for the post war evolution of monetary theory, J.R.Hicks wrote,

> It was marginal utility that really made sense of the theory of value; and to come to a branch of economics which does without marginal utility altogether! No wonder there are such difficulties and such differences (in monetary theory)! What is wanted is a 'marginal revolution'! That is my suggestion.[20] J.R.Hicks [56], p.14

The advent of a fully articulated theory of optimum portfolio selection in the late fifties and early sixties, due mainly to the work of Tobin and Friedman, marks a significant stage in the development of a train of thought attributable to a distinguished genealogy of intellectual forbears post dating Hicks.[21]

19."...the most recent tendency in theorising about the supply of money has been to develop a theory of the supply of money more or less parallel with the theory of the demand for money...so that the theory of money supply becomes basically another exercise in capital theory." H.G.Johnson [60], p.97.

20.This article is most explicit in its advocation of: (a) the need to apply standard value theory to monetary analysis ([56], p.14); (b) a microeconomic analysis of the behaviour of economic units who optimise over the items in their balance sheets - stocks ([56], p.25); (c) the idea of wealth as a budget constraint on the allocation of portfolios ([56], p.27 and n.7, and p.28); (d) the idea that transactions costs rationalise the demand for money in a world where earning assets exist ([56], p.19). Actually, Hicks points to a semblance of marginal utility theory in the works of Alfred Marshall and J.M. Keynes (Treatise on Money).

21.Pathbreaking work in this area in the late fifties and early sixties is attributable mainly to M. Friedman, J.Tobin and their respective associated colleagues (Friedman [39], [40]; Tobin [91], [92]; [93]; and Hester and Tobin [53]). D.Patinkin has conclusively shown that Friedman's restatement of the quantity theory of money [39], [40], is really a theoretical development in the Keynesian tradition. It should be added that the work of J.Tobin et al. may be similarly considered. Patinkin lists the following authors whom, amongst others, are part of the early portfolio theoretic tradition: J.M.Keynes (1930), J.R.Hicks (1935), J.M.Keynes (1936), H.Makower and J.Marshak (1938), F.Modigliani (1944), J. Robinson (1951), H. Markowitz (1952), R.F.Kahn (1954); dates in parentheses denote year of publication (Patinkin [82], esp. p.108). See also Brunner [12], p.168 and Johnson [59], p.32.

Responding to Hicks' call for a marginal revolution, the early forerunners of modern portfolio theory develop Keynesian liquidity preference theory into a general theory of the determination of relative prices (or yields) on different types of financial assets. The preferences of economic units and relative quantities of assets with differing risk characteristics are shown to determine the set of relative asset prices in financial markets. Subsequently, Tobin et al. develop the theory of optimum portfolio diversification in a multi asset world which includes money, using a utility function with the risk and yield on financial assets as arguments.[22] Thus, monetary theory is couched in marginalist terms and is incorporated into the more general theory of the demand for financial assets or asset choice. Pursuing a different line of investigation, Friedman treats money as a capital good, the demand for which, depends on the relative prices of all other assets, including realcapital, and is subject to a wealth constraint. Friedman's contribution rests with the generalisation of the demand for money, analogous with the demand for any other commodity and the use of wealth rather than income as a budget constraint.

These theoretical developments constitute a departure from the standard Keynesian paradigm. Financial markets are disaggregated and attention is focused on the allocative forces operating in the markets for assets and debt.[23]

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22. J.Tobin [93].

23. For a discussion of these issues see H.G.Johnson, ibid., pp.29-34 and [60], pp.91-94; and K.Brunner, ibid., pp.167, 168 and [13], pp.26-36.

Applying the tools of portfolio theory, the Yale School provides a microeconomic theory of financial intermediary behaviour in which financial intermediaries are regarded as neo classical profit maximising firms, whose behaviour is determined by cost and yield considerations in their pursuit of achieving an optimum balance sheet position. Within this framework, the supply of banking sector deposits and the purchase of earning assets by the banking sector is subject to cost and yield considerations, much like the production of any other commodity. In a similar vein, Meigs examines the behaviour of American commercial banks with respect to their demand for excess reserves and borrowed reserves from the Federal Reserve System.[24]

Making use of these theoretical developments, Brunner and Meltzer construct a money supply theory using the multiplier framework and advance the theory in two directions; on the one hand, the multiplier is made endogenous and on the other, the banking sector credit market is added to the basic model. This new version, generally referred to in the literature as the non linear money supply hypothesis or thecredit market theory of the money supply,[25] is broadly compatible with current research, notably, that of the Federal Reserve Bank of St. Louis, the Monetarist School, the

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24. See D.D.Hester and J.Tobin [54]. This monograph contains papers on the microeconomic theory of commercial banks' portfolio behaviour; on the supply of commercial bank loans and the behaviour of lenders as purchasers of assets, and on the portfolio patterns of banks. See also Tobin [93]. A review of the monograph is provided by K.Brunner [12].

25. Clearly, the expression $M = mX$ is non linear. Brunner and Meltzer are careful to stress this fact in order to distinguish their non linear formulation from another of their money supply theoriesin which the multiplier enters the money supply relationship in linear form (Brunner-Meltzer [15]).

New View adherents and the major econometric models of the American economy.[26] Since we use this model to analyse the money supply process in South Africa, our discussion here serves to introduce the elements of the credit market approach in the context of the general evolution of money supply theory.

The credit market theory is a simultaneous equation system describing the portfolio allocation behaviour of the banking and private sectors and the actions of the monetary authorities. The banking sector allocates its wealth between statutory and excess reserves, purchases earning assets from the private sector and incurs indebtedness to the central bank by the sale of earning assets in exchange for cash reserves. The private sector, in turn, allocates its wealth between currency, demand and time deposits, and incurs indebtedness to the central bank by the sale of earning assets.

The exogenous variables of the model consist of policy variables controlled by the monetary authorities (the monetary base, statutory reserve requirements, the discount rate and the outstanding stock of government debt) and variables representing the real sector (real income and the price level).

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26. A full discussion of this type of money supply framework and its theoretical underpinnings may be found in K.Brunner [13], pp.26-31, 89-102; and a rigorous treatment is provided in the mathematical appendices (III, IV). Further extensive discussion may be found in Brunner and Meltzer [15], [17]; Brunner and Crouch [14]. The credit market approach of Brunner and Meltzer [17], esp., lies within the microeconomic framework developed by Tobin et al.; cf. Tobin and Brainard in Hester and Tobin [55]. Note that the New View is a term coined by Tobin [94] to describe the Yale view of money supply theory, which emphasises the behaviour of the banking and private sectors. The major econometric models referred to are those constructed for the American economy and associated with the work of the Brookings Institute. See F.Deleeuw [31].

The central bank sets the statutory reserve requirements on banking sector deposits, determines the outstanding stock of government debt in the banking and private sectors by its own portfolio behaviour, announces the discount rate and sets the monetary base, while the treasury exerts a monetary influence through the distribution of deficit finance between the banking and private sectors and the central bank.

In the private sector, the demand for currency, demand and time deposits, depends upon a vector of interest rates and wealth, and the supply of earning assets to the banking sector is determined by interest rates, wealth and the stock of outstanding government debt. The distribution of banking sector wealth between cash reserves and earning assets is determined by statutory reserve requirements and interest rates on earning assets in the credit markets. Banking sector indebtedness to the central bank depends upon the discount rate, credit market rates and liquidity conditions in financial markets.

The credit market rate is endogenously determined by the joint interaction of the banking and private sectors in the credit market, for given values of the exogenous variables, and the solution function is given by:

$$i_e = i_e(r, i_{br}, W, F^o, B) \qquad (1\text{-}10)$$

where:

i_e = the credit market rate

r = statutory reserve requirements

i_{br} = the discount rate

W = wealth

F^o = the stock of outstanding government debt

B = the monetary base.

Since all balance sheet items in the banking and private sectors are determined by endogenous and exogenous variables, the money multiplier is a functional relation, responding to changes in exogenous variables and the credit market rate. The general form of the multiplier is:

$$m = m(i_e, r, i_{br}, W) \qquad (1\text{-}11)$$

Substituting for the credit market rate in the above equation, we obtain the money supply function in terms of the exogenous variables of the system:

$$M = M(r, i_{br}, W, F^o, B) \qquad (1\text{-}12)$$

From Equations 1-10 and 1-12, we see that the money supply and the credit market rate (and hence the supply of credit) are simultaneously determined by the interacting behaviour of the banking and private sectors and the monetary authorities.[27]

Several features of the model are noteworthy with regard to earlier money supply theories.

1. By broadening the scope of portfolio behaviour in the banking sector (to include statutory reserves, excess reserves and banking sector indebtedness to the central bank) and by allowing the private sector to adjust its portfolio of financial assets and debt, the money multiplier responds to endogenous forces in financial markets (interest rates), exogenous changes in the real sector, and to changes in policy variables controlled by the central bank. That the central bank can exercise control

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27. See H.G. Johnson [61], p.104, 105.

over the money multiplier, enhances the case for the possibility of controlling the money supply and mitigates against the opposing endogeneity view of the Neo-Keynesian School.

2. Incorporation of the credit market expands the range of financial behaviour explained by the model, thereby, providing a more complete theory of the money supply.

3. Incorporation of government debt and the monetary base as monetary aggregates controlled by the monetary authorities, permits an explicit assessment of the monetary effects of fiscal policy and the relative efficacy of monetary policy exercised through open market operations, changes in statutory reserve requirements and changes in the discount rate.

4. The mechanism transmitting changes in the exogenous variables to the money supply, operates through the credit market by inducing a change in the credit market rate and the money multiplier. Thus, the multiplier engenders a feedback effect which may attenuate but not necessarily offset changes in the monetary base.

By disaggregating the financial behaviour of the monetary authorities and the banking and private sectors, the credit market approach is rich with testable hypotheses. It is on this criterion that we use this approach to analyse the money supply process in South Africa. Finally, it is interesting to note that although this theory is developed by fervent protagonists of the Monetarist School, the theory is in fact well aligned with the ideas of the Neo-Keynesian adherents to the New View.[28]

In the following Chapter, we specify a money supply model for South Africa by modifying the basic credit market framework to incorporate specific institutional relationships in the South African financial system.

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28. Brainard and Tobin, who are responsible for a large part of New View monetary theory, stress the importance of recognising the interdependence between financial markets, the necessity for a proper specification of the items in financial balance sheets and the need to strictly observe balance sheet identities as constraints (W.C.Brainard and J.Tobin [9], pp.99-105).

CHAPTER 2

THE THEORETICAL MODEL FOR SOUTH AFRICA

1. INTRODUCTION

The money supply model for South Africa constructed in this chapter, incorporates four important relationships. Firstly, the banking sector's statutory reserve ratio equation accounts for the maturity structure of banking sector deposits and differential statutory reserve requirements on demand and time deposits. Secondly, we introduce a behaviour equation which describes the relationship between the Reserve Bank, and the banking and private sectors, based on the working of the South African money market. This equation facilitates an analysis of Reserve Bank discounting and Bank Rate policy. Thirdly, by introducing the stock of government debt as an argument in the equation for the private sector's supply of earning assets to the banking sector, we account for the monetary effects of fiscal policy, and analyse the role of the Public Debt Commissioners as key dealers in government securities. Finally, the distribution of income between wage and non wage income earners is incorporated into the model to reflect a differential marginal demand for currency between high and low income groups.

Two major assumptions are made. We assume a closed economy due to exchange controls on the outflow of private short-term capital (see Chapter 4, Section 2); and following Brunner and Meltzer ([15], p.251), we assume that the equilibration of the credit market and the adjustment of all economic units to exogenous shocks occurs instantaneously, i.e. the equations are independent of time lags. In general, the rules for financial model building expounded by Brainard and Tobin have been observed.[1]

To clarify the context in which we modify the Brunner-Meltzer framework, a conspectus of the model for South Africa is provided below.

The South African financial system is partitioned into three sectors; the Monetary Authorities, comprised of the South African Reserve Bank and the Treasury; the banking sector, consisting of the commercial banks; and the private sector, which constitutes the rest of the economy.

In Section 2, the adjusted monetary base is introduced as the crucual policy variable in the analysis, measuring the policy behaviour of the Monetary Authorities. A description of the monetary base is presented in terms of its sources and uses and a detailed derivation is provided in Appendix A.1, together with balance sheets of the South African Reserve Bank and the South African Mint. The adjusted monetary base is found to be under the control of the Reserve Bank by virtue of the Reserve Bank's ability to choose the size of its portfolio of government securities.

Section 3, describes the behaviour of the banking sector in terms of a balance sheet identity, a definition for banking sector earning assets and the demand for cash reserves. Banking sector behaviour is determined by a vector of relevant credit market interest rates, Bank Rate, and statutory reserve requirements imposed by the Monetary Authorities. The statutory reserves equation is derived in Appendix A.2.

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1. These authors emphasise that such models should take account of market interdependencies and balance sheet accounting identities ([9], p.99).

The behaviour of the private sector is described in Section 4, and commences with an exposition of the economic environment confronting the private sector. This environment is characterised by a set of developed financial markets within which, the private sector allocates wealth between financial assets. A balance sheet identity is defined together with the demand functions for currency, demand deposits and time deposits, and a supply function for earning assets supplied to the banking sector. These functions, depend in general, on a vector of interest rates containing the endogenously determined credit market rate, exogenously determined interest rates and other exogenous variables. The income distribution between wage and non wage income earners is an essential argument in the private sector's asset demand function, due to the economic dichotomisation between white and black labour in South Africa, which forms the basis for the hypothesis that wage earning black labour has a higher marginal propensity to hold currency as a form of liquid wealth relative to that of white labour. Private sector behaviour is also affected by the profit maximising behaviour of the banking sector and the competitive inter linkage of financial markets, which establishes a mutatis mutandis positive relationship between the time deposit rate and other interest rates.

In Section 5, we describe the institutional relationship between the South African Reserve Bank as a lender of last resort, and the banking and private sectors. Worthy of special emphasis is the relationship between the Reserve Bank and the South African money market institutions, the Land Bank, and other financial institutions who supply earning assets to the Reserve Bank. All these financial institutions form part of the private sector in this analysis. Two supply functions for earning assets supplied to the Reserve Bank are specified, one for the private sector and one for the banking sector. Finally, an aggregate supply function for both sectors is derived and facilitates an evaluation of the role of last resort lending in the money supply and rate of interest determination process.

It is generally accepted that the interest rate effects of fiscal policy vary with the method used to finance the Government's budget. An analytical framework for analysing the relationship between the Government's budget, the adjusted monetary base and credit market rates is formulated in Section 6. Of central importance to this relationship is the institutional role of the Public Debt Commissioners in South Africa, as key holders of government debt. Their significance as members of the private sector is explained in the second part of Section 6.

Section 7 concludes the formal structure of the model by introducing a money supply definition, setting out the equilibrium conditions for the credit market rate and the stock of earning assets in the bank credit market, and deriving the solution functions for the money supply and the credit market rate. In addition, the money and credit market multipliers are defined.

Section 8 terminates this chapter with a summary of the money supply model for South Africa.

2. THE MONETARY BASE

2.1 An Overall View

The monetary base (B) is a variable linking the behaviour of the Monetary Authorities to that of the banking and private sectors. In addition, the monetary base reflects movements in the level of international reserves which link the South African economy to the rest of the world. In this study, the level of international reserves is assumed to be exogenous. It will be shown below, when considering the sources and uses of the monetary base, that the base after adjustment for an endogenous component, is in principle controllable by the South African Reserve Bank, and consequently enters the theoretical framework as a crucial policy variable, thus, directing attention to the Reserve Banks responsibility for control of the money supply.

2.2 The Monetary Base: Its Sources and Uses

The supply and demand for base money are known generally as the sources and uses of the monetary base, respectively.[2]

2.2.1 Sources. The source components of the monetary base consist of the assets and certain liabilities in the consolidated balance sheet of the South African Reserve Bank and the South African Mint. They are comprised of net claims held by the Reserve Bank against the Central Government, the banking and private sectors and against foreigners. The consolidated balance sheet of the South African Reserve Bank and the South African Mint is presented in Table A.1.III (Appendix A.1), from which the source base identity is derived. Separate balance sheets for the

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2. See L.C.Andersen and J.L. Jordan [4].

Reserve Bank and the Mint are also provided. We define the source base as:

$$B = C + IR + GLOAN + AFI + S + OLOAN + o - RFI - RG - F^* \quad (2\text{-}1)$$

where:

C = minted coin

IR = international reserves

GLOAN = loans to the Central Government

AFI = supply of earning assets to the Reserve Bank by the banking and private sectors

OLOAN = other loans

S = Reserve Bank's portfolio of government debt

RFI = other financial intermediary deposits

RG = Government deposits

F* = other deposits (domestic and foreign)

o = difference between other assets (O), and foreign loans, capital and other liabilities (FCO).

Monetary policy, measured by the monetary base, is constrained by the balance of payments in relation to the level of international reserves, and that part of the Government's budget deficit which is financed by a change in net indebtedness to the Reserve Bank, given by (C + GLOAN - RG). All source components other than the supply of earning assets to the Reserve Bank (AFI), are policy determined or exogenous variables; the endogenous nature of AFI is discussed in Section 5.[3] As a policy instrument, the monetary base is in principle directly controllable since the Reserve Bank can use its portfolio of government debt(S) to offset exogenous changes in the level of international reserves, the Government's budget financed by the Reserve Bank and other components of the source identity. Since the supply of earning assets to the Bank is endogenous, we deduct it from the monetary base to yield the adjusted monetary base (B^a), which summarises completely the policy actions of the Reserve Bank as well as its traditional functions as a central bank.

$$B^a = B - AFI \qquad (2\text{-}2)$$

These functions are outlined to elaborate the institutional aspects of Reserve Bank actions.

As custodian of the major portion of the gold and foreign exchange reserves, the balance sheet item (IR) reflects the economic relationship between South Africa and the rest of the world, with the Reserve Bank acting as an intermediary.[4] Movements in the balance of payments affect

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3. Let $AFI = AFI^b + AFI^p$, where AFI^b = commercial bank indebtedness to the Reserve Bank and AFI^p = private sector indebtedness to the Reserve Bank. Then, $B^a = R + C_p - AFI^b - AFI^p$(where R = banking sector reserves at the Reserve Bank). In American and Canadian money supply analysis, the adjusted base is defined in terms of banking sector unborrowed reserves (R^u), which is the difference between total reserves (R) and borrowed reserves (R^b); i.e. $R^u = R - AFI^b$, where $AFI^p = 0$. Thus, in this situation, $B^a = R^u + C_p$. In the case of South Africa, we analyse the total effect of banking sector and private sector indebtedness to the Reserve Bank, so that $B^a = R + C_p - AFI$.

4. International reserves are affected by Reserve Bank purchases of the major portion of the output of newly mined gold, for the disposal of which, the Reserve Bank is responsible ([73], p.171).

the adjusted monetary base through this variable.

As banker to the Government, the Reserve Bank renders financial services by handling the bank accounts of Government departments (RG) and extending temporary advances to the Government in anticipation of its revenue receipts (GLOAN). These advances are limited by act of parliament to a maximum of three months. Taken together, the difference GLOAN - RG represents Government net indebtedness to the Reserve Bank, changes in which are determined by the method of deficit finance.[5]

Since its inception in 1921, the Reserve Bank has recognised its responsibility to the financial system by acting as a lender of last resort. In the post war period, the Bank played a significant part in the establishment of a money market by standing ready to rediscount eligible commercial paper and Treasury bills, or to lend to the financial system against pledge of such assets.[6]

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5. Government deposits (RG) comprise the accounts of the Central Government and Provincial Administrations. The financial operations of the Central Government are reflected predominantly by the transactions recorded in the Exchequer account, the latter recording the day-to-day operations of the Treasury. The Provincial Administration and the Central Government hold small balances with private financial institutions as well. Exchequer balances include any transfers to the Stabilization account, the latter representing funds borrowed in excess of current financial needs ([89], Dec. 1971, pp.5,6).

6. The role of the Reserve Bank as lender of last resort to the money market will be discussed in Section 5.

2.2.2 Uses. While the supply of base money is determined by policy, demand is determined by the interaction of the banking and private sectors in financial markets. The distribution of demand between these two sectors is known as the "uses" of the base and is measured by the residual liability items in the consolidated balance sheet of the Bank and the Mint. The uses of, or demand for base money directs attention to the Bank as a supplier of an important class of financial assets to the economy, viz. currency in the hands of the banking and private sectors and claims on the Bank held as reserves by the banking sector. Base uses are defined as:

$$B = R + Cp \qquad (2\text{-}3)$$

where:

R = total cash reserves of the banking sector (vault cash plus Reserve Bank deposits)

Cp= currency held by the private sector.

Writing the adjusted monetary base in terms of its uses:

$$B^{a} = R + Cp - AFI \qquad (2\text{-}4)$$

2.3 The Monetary Base and Monetary Analysis in South Africa

It is appropriate to emphasise at this stage how the theoretical relevance of the adjusted monetary base has been ignored, to a large extent, in South African monetary analysis, an omission we seek to rectify.

Contrary to the views of Tobin, the South African Reserve Bank, in its Quarterly Bulletin, employs a method of analysis that eliminates the base as an analytical variable, by implicitly consolidating the balance sheets of the Bank and the commercial banks, as in Table 2.I.[7] Defining the money supply as currency plus demand and time deposits, changes in the money supply are mirrored identically by changes in the assets and residual liability items in the consolidated balance sheet.

This approach may be criticised on two grounds. Firstly, Reserve Bank loans to the banking sector are eliminated, whereas these loans constitute a source of supply of reserves to the commercial banks. Indeed, total banking sector reserves are removed, thereby, precluding analysis of banking sector behaviour in the allocation of financial assets between cash reserves and earning assets. Secondly, consolidation serves to confound the causes and effects of two distinct sets of decisions clearly distinguishable in economic analysis; decisions taken by the Monetary Authorities and those taken by the banking sector. While the latter are motivated, clearly, by private profit considerations, the former are not, thusly, motivated.[8] Whereas the Reserve Bank makes decisions about economic policy with social repercussions, the commercial banks maximise private profits subject to policy constraints imposed by the Bank.

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7. In his review of Friedman-Schwartz [43], Tobin points out that the monetary base (high powered money) is vital for an understanding of the money supply in America (Tobin [95], p.468).

8. The principle that central banks perform an economic function different from that of other banks was well established by the middle of the nineteenth century. Through bitter experience, the Bank of England learned of its responsibilities not only to its shareholders but also to the financial system (Bagehot [6]).

TABLE 2.1

CONSOLIDATED BALANCE SHEET OF THE SOUTH AFRICAN RESERVE BANK AND THE COMMERCIAL BANKS

	Assets	Liabilities	
	Reserve Bank Assets :	Currency with the Private Sector	C_p
		Commercial Bank Deposits	D+T
IR	Gold and Foreign Exchange Reserves	Reserve Bank Liabilities :	
GLOAN	Loans to Government		
AFI	Loans to Financial Institutions	Other Deposits	F^*
S	Government Securities	Government Deposits	RG
OLOAN	Other Loans	Other Liabilities	OLIAB
O	Other Assets		
	Commercial Bank Assets :		
CKP	Private Sector Claims		
CKG	Government Claims		

As a result, the consolidation procedure, by eliminating the supply of banking sector reserves, precludès an analysis of the supply conditions, thereby, camouflaging the influence of the Bank on the money supply and interest rates. In fact, attention is diverted from the central function of the Reserve Bank as a central bank and its control over the adjusted monetary base.

3. THE BANKING SECTOR

The establishment of the Lombard Bank by the governing Dutch East India Company, in 1793, initiated the development of a commercial banking system in South Africa. By 1865, a branch banking system was in operation and by the early 1920's, amalgamations and absorbtions had resulted in the concentration of 95 per cent of commercial bank assets under the ownership of two London based banks -- the Standard Bank and Barclays D.C.O.[9] This concentration has remained relatively unchanged to the present day.

Aggregate banking sector behaviour is described in this section in terms of a balance sheet identity, a definition for earning assets, the demand for excess reserves, and an expression for statutory reserves held by the commercial banks.

A model defining explicitly the revenue and cost functions of the banking sector is not provided. Instead, we assume, in accordance with several accepted models of commercial bank behaviour, that each commercial bank maximises profits and attains balance sheet equilibrium by satisfying equimarginal conditions between the marginal productivity of cash reserves, the marginal productivity of earning assets and the marginal cost of deposit acquisition.[10]

3.1 The Balance Sheet Identity and Behaviour Equations

Banking sector equilibrium is defined by a balance sheet identity, net of net worth:

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9. J.A.Marlin[73], pp.138-141.

10. Alhadeff and Alhadeff [2]; Hester-Tobin [54]; Brunner [13], esp., pp. 102-110; and Goldfeld [46].

$$D + T = R + EA^b \qquad (2\text{-}5)$$

where:

D = demand deposits

T = time deposits

R = total cash reserves

EA^b = earning assets held by the commercial banks.

The banking sector determines the level of total deposits (D+T) and the interaction of the banking and private sectors determines the distribution of total deposits between demand and time deposits. The quantity of cash reserves (R) held by the banking sector is determined by statutory reserve requirements imposed by the Reserve Bank and banking sector demand for excess reserves.

From the balance sheet identity, EA^b are defined as:

$$EA^b = D + T - R \qquad (2\text{-}6)$$

We now turn to a discussion of the demand for banking sector cash reserves.

Historically, commercial banks held cash reserves to facilitate interbank clearing of outstanding cheques and to ensure the convertibility of bank deposits into currency at a fixed rate.[11] Shortly after the establishment of the Bank of England in 1694, the London joint stock banks found it advantageous to hold the major portion of their cash reserves as

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[11] A fixed rate implies a one for one exchange rate between currency and bank deposits. Like any other firm, a bank is solvent if it can meet its obligations in full. Inadequate cash reserves may necessitate the repayment of deposits at less than par value; the bank would undoubtedly become suspect resulting in a bank run and insolvency. History is replete with examples.

non interest-bearing deposits at the Bank of England, while retaining small quantities of vault cash to meet daily cash withdrawals. After nearly two centuries of repeated financial crises, the privately owned Bank of England overtly recognised that its operations in financial markets affected the cash reserves of the banking sector. Subsequently, it became customary for the Bank of England to view the commercial banks' reserve balances as targets of monetary control.

Following the lessons of the Bank of England, the American Federal Reserve Bank imposed statutory reserve requirements on member banks in terms of the Federal Reserve Act of 1913. In South Africa, the Currency and Banking Act of 1920 required that commercial banks hold compulsory deposits with the newly established South African Reserve Bank.[12]

The aggregate stock of banking sector reserves (R) is defined as the sum of statutory reserves (R_s) and excess reserves (R_e).

$$R = R_s + R_e \qquad (2\text{-}7)$$

Commercial banks hold excess reserves for transaction and precautionary motives. The transactions demand depends upon the expected value of cash withdrawals, the maturity structure of earning assets relative to that of deposit liabilities and transaction costs; and the speculative demand varies with interest rates on earning assets and other factors such as the riskiness of earning assets.[13] The demand function for excess

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12. E.H.D.Arndt [5], p.455; cited by Truu [96], pp.136-138.

13. Excess reserves may be held either as vault cash (cash balances for daily cash transactions) or non interest-bearing deposits at the Reserve Bank. In principle this distinction is irrelevant if the marginal cost of Reserve Bank deposit encashment is negligible.

reserves is written as a multiple of total banking sector deposits:

$$R_e = e(i_e, \pi_1^b)(D + T) \qquad (2\text{-}8)$$

$$e_1 < 0, \; e_2 < 0$$

where:

e_j = the first order partial derivative of function e with respect to the j^{th} argument

i_e = an index of interest rates on banking sector earning assets (referred to as the credit market rate)

π_1^b = a vector of non price variables reflecting quality changes in earning assets (liquidity, risk, transactions costs).

The quantity of statutory reserves held by the banking sector depends upon the statutory reserve requirements on demand and time deposits and on the ratios of demand and time deposits to total deposits. In general form, the statutory reserves equation is:

$$R_s = b_{11}(r^{d'}, r^{t'}, \gamma, 1-\gamma)(D + T) \qquad (2\text{-}9)$$

$$b_{11.j} > 0; \; j = 1...3, \; b_{11.4} > 0$$

where:

$b_{11.j}$ = the first order partial derivative of function b_{11} with respect to the j^{th} argument

$r^{d'}$ = statutory reserve requirement on demand deposits

$r^{t'}$ = statutory reserve requirement on time deposits

γ = ratio of demand to total deposits

$1 - \gamma$ = ratio of time to total deposits.[14]

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[14]. We introduce Greek notation for mathematical convenience. The explicit form of Equation 2-9 (see Equation 2-14) is more easily differentiable using this notation (see Appendix A.6).

Since the distribution of banking sector deposits between demand and time deposits depends upon a vector of interest rates, real wealth, the price level, income distribution and a tastes variable (Section 4), γ is written as a functional relationship:

$$\gamma = \gamma(i, W/P_w, P, YDIS, \pi_1^p) \qquad (2\text{-}10)$$

where:

i = a vector of interest rates

W/P_w = real wealth

P = price level

YDIS = income distribution

π_1^p = tastes variable.

Aggregate banking sector reserves may now be expressed in terms of the credit market rate, statutory reserve requirements and the distribution of private sector wealth between demand and time deposits:[15, 16]

$$R = [b_{11} (r^{d'}, r^{t'}, \gamma, 1 - \gamma) + e(i_e, \pi_1^b)] \quad (D + T) \qquad (2\text{-}11)$$

$$= b_1 \; (D + T) \qquad (2\text{-}12)$$

where:

$$b_1 = b_1(r^{d'}, r^{t'}, \gamma, 1 - \gamma, i_e, \pi_1^b) \qquad (2\text{-}13)$$

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15. Equation 2-11 is written in general form to obtain the general form of the aggregate reserve ratio demand function (Equation 2-13).

16. This expression, which specifies that the desired portfolio magnitude R is the product of the desired allocation ratio b_1 and total deposits (D + T) may be derived from an conventional demand function which is homogeneous of degree one in D + T ([14], p.81).

Equation 2-9 can be written in explicit form as:

$$R_s = [r^{d'}\gamma + r^{t'}(1 - \gamma)]\ (D + T) \tag{2-14}$$

where:

$$r^{t'} = r^{s'}\delta + r^{f'}(1 - \delta) \tag{2-15}$$

$$r^{f'} = r^{fst'}\alpha + r^{fm\ell t'}(1 - \alpha) \tag{2-16}$$

and

$$b_{11} = r^{d'}\gamma + r^{t'}(1 - \gamma). \tag{2-17}$$

The statutory reserve ratio (b_{11}) is a weighted sum of the statutory reserve requirement on demand and time deposits with the ratios of demand and time deposits to total deposits as the weights.[17] Thus, the explicit form of the aggregate reserves equation is:

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[17] Equations 2-14 to 2-17 are derived in Appendix A.2. The statutory reserve requirement on time deposits is a weighted sum of the statutory reserve requirement on savings deposits ($r^{s'}$) and fixed deposits ($r^{f'}$) with the ratio of savings deposits and fixed deposits to total deposits as weights (δ , $1 - \delta$, resp.). Similarly, the statutory reserve requirement on fixed deposits ($r^{f'}$) is the weighted sum of the statutory reserve requirement on short-term fixed deposits ($r^{fst'}$) and medium plus long term fixed deposits ($r^{fm\ell t'}$) with α and $1 - \alpha$ as weights where α = the ratio of short term fixed deposits to total fixed deposits. See Appendix A.2 for a discussion of Equations 2-15, 2-16.

$$R = [r^{d'}\gamma + r^{t'}(1 - \gamma) + e](D + T) \qquad (2\text{-}18)$$

from which:[18]

$$b_1 = r^{d'}\gamma + r^{t'}(1-\gamma) + e \qquad (2\text{-}19)$$

Substituting the appropriate equations into the definition for aggregate reserves (Equation 2-7), we obtain the aggregate reserve ratio defined as the sum of the statutory and excess reserve ratios:[19]

$$b_1 = b_{11} + e \qquad (2\text{-}20)$$

The aggregate reserve ratio (b_1) is determined by policy variables, the public's desired distribution of wealth over various classes of deposits, the credit market rate and a shift variable.[20]

Before turning to the private sector, we discuss briefly the magnitude AFI^b, defined in Section 2 as the supply of commercial bank earning assets to the South African Reserve Bank. In the absence of a developed money market in South Africa, the commercial banks obtained direct lender of last resort facilities from the Reserve Bank in exchange for commercial paper eligible for rediscounting, or government debt. With the development of the South African money market in the post war period, along English lines, Reserve Bank lending to the banking sector declined in favour of last resort facilities to the new money market.

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18. Recall that $\gamma=\gamma(i, W/P_w, P, YDIS, \pi)$ so that $b_1 = r^{d'}\gamma(i, W/P_w,...) + r^{t'} - r^{t'}\gamma(i, W/P_w...) + e$

19. See Equations 2-7, 2-8, 2-11, 2-12, 2-14, 2-17. Thus, $b_1 = R/D + T$; $b_{11} = R_s/D + T$; $e = R_e/D + T$.

20. See Smith [86] for an analysis of the effects of a redistribution of wealth between deposits having different reserve requirement ratios.

In our analysis, we are concerned with the aggregate effect of Reserve Bank lending to both the banking and the private sectors (the private sector contains the new money market). Accordingly, we delay discussion of the AFI^b variable to Section 5.

4. THE PRIVATE SECTOR

4.1 The Environment of the Private Sector

The private sector is defined as private households and financial and non financial firms (excluding the commercial banks, the South African Reserve Bank and the Government). Underlying the equations used to describe the behaviour of the private sector, is an implicit notion about the economic environment. This viewpoint is elaborated on in the next paragraph and is followed by supporting arguments.

We view the South African financial structure as a sophisticated system of inter related financial markets, served by financial institutions which mobilise credit for the expansion of industrial development. The members of the private sector confront a variety of financial assets which serve as instruments of liquid wealth-holding, and a similar variety of channels for the creation of debt. The South African Government has played an extensive part in the establishment of various financial institutions which, in turn have provided the catalyst for private industrial development and the development of a private domestic money market. The most notable of these Government institutions, for the purpose of this study, are the National Finance Corporation, the Land Bank, and the Public Debt Commissioners. Their special significance as members of the private sector, will be described in Sections 5.2.1, 5.2.6 and 6.2 respectively. At present, we provide below, substantive information in support of our view of the private sector.[21]

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21. J.A.Marlin [73] is the main source of reference used in this section.

Prior to the Second World War, gold mining constituted the leading industrial sector in South Africa. However, continued ancitipations of a decline in gold output, in the post war period, led to the concentration of industrial activity in export based industries, the output of which would ultimately replace gold as an export commodity.[22]

In the period 1945 to 1966, the average annual growth rate in real gross domestic product was 5 per cent while in the decade 1956 to 1966 real gross domestic product grew at a compound rate of over 4 per cent with an average increase in prices per annum of less than 3 per cent.

An average annual growth in population of about 2.5 per cent ensured an annual increase in per capita gross domestic product of over 2 per cent.[23]

Manufacturing industry led the post war industrial development in South Africa, becoming the largest component of all non gold exports by 1966.[24] Of the 15 main manufacturing industries, those which had

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22. Foreign trade constitutes an average of 34 per cent of gross national product in South Africa. Similar figures for other countries are: Great Britain and Canada 29 per cent; Germany, 25 per cent; Australia, 22 per cent; France, 19 per cent; Japan, 14 per cent; America, 6 per cent. These figures are for the period 1962 - 1964 (Marlin, ibid.).

23. We should point out that per capita figures are suspect measures of individual welfare due to the probable skewness of the income distribution in favour of the white section of the population. This skewness is likely to be accentuated by the Government's policy of "job reservations", which prohibits non white labour from performing certain jobs, and by artificial wage differentials for the same job based on discrimination by colour.

24. Prior to the Second World War, manufacturing constituted 13 per cent of gross national product, rising to 25 per cent by 1964 and 50 per cent by 1967.

received special Government attention faired best in increasing output per annum.[25]

Government assistance was provided in cases where establishment of the industry was considered socially desirable but where the initial costs or risks involved were high, making the industry unattractive to private enterprise e.g. : farming, housing, hydro-electric, transport, communications. We review briefly the main channels of Government aid.

The Industrial Development Corporation was established in 1940 to finance industrial expansion in the face of an expected decline in gold mining. Finance from the Industrial Development Corporation helped, inter alia, the development of the manufacturing of chemicals, textiles, transport equipment and paper. The Small Industrials Division of the Industrial Development Corporation, provided finance to small enterprise, and the Border Areas Development Scheme helped the decentralization and relocation of industries towards the underdeveloped border areas.
A private financial institution, the Industrial Finance Corporation, was established on the initiative of the Industrial Development Corporation to supplement the latter's activities. It finances large enterprise by underwriting share issues, purchasing shares, and making loans. In 1944, the Fisheries Development Corporation was established to provide finance to the fishing industry.

Two other Government sponsored institutions worthy of special mention are, the Land Bank and the Public Debt Commissioners. In 1912, the Land Bank was established to provide finance for agriculture and the Public

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25. These industries include textiles, paper, transport equipment, and chemicals, whose output more than doubled in the period 1956 - 1965 with the aid of the Government sponsored Industrial Development Corporation. Other industries receiving Government sponsored finance are Sasol (producing petroleum products and oil from coal) and Phoscor (producing phosphates).

Debt Commissioners administered the trust funds and deposits of Government departments and Public bodies. As mentioned previously, the significance of these two institutions will be discussed below.

As is to be expected, industrial growth in South Africa has been accompanied by a dramatic expansion and development of financial markets and private financial institutions outside the banking sector. These institutions consist of the discount houses, the merchant banks, the building societies, insurance companies, and pension funds.[26] A group of near banks, comprised of hire purchase finance houses and savings and general banks, grew at a compound rate of 30 per cent per annum in the period 1956 to 1966 and their market share as a group increased from 3 per cent in 1956 to 11 per cent in 1966.[27] The unit trust movement was initiated in South Africa in 1965, and flourished immediately. Coexistent with these developments was the growth and maturation of the South African money market which reduced traditional dependence on London. All these financial institutions accepted claims against themselves in order to hold claims against others.

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26. In the period 1956-1966, the compound rates of growth of these institutions were: discount houses, less than 7 per cent; building societies, 7.5 per cent; insurance companies, 8 per cent; merchant banks, 10 per cent. Similar figures for the commercial banks, the Industrial Development Corporation and the Land Bank were: 8.5 per cent, 9 per cent and 7.5 per cent, respectively. Note that the compound growth rate of gross national product was 7 per cent per annum.

27. In 1964, the Government saw fit to pass legislation which gave the Reserve Bank control over these financial institutions, by imposing the same statutory cash reserve ratios and liquid asset ratios on them as were laid down for the commercial banks.

Private capital needs were met by the Mining Finance Houses (specialists in financing mining operations) and Investment Banks (specialists in share issues and underwriting). And lastly, the South African Stock Exchange provided a well organized market in industrial, mining and financial shares.

From the above exposition, the private sector is viewed as a set of inter related financial markets wherein private households and firms allocate their wealth between financial assets, and incur debt. Each economic unit is assumed to allocate his wealth in such a way as to achieve an optimum portfolio of financial assets. This optimising procedure is assumed to conform to the standard models of portfolio selection.[28]

4.2 Behaviour Equations of the Private Sector

We commence with an accounting framework for the private sector which takes the form of a balance sheet identity.

$$Cp + T + D + OA = EA^{p} + AFI^{p} \qquad (2\text{-}21)$$

where:

- Cp =demand for currency by the private sector
- D = demand for demand deposits in the banking sector
- T = demand for time deposits in the banking sector
- OA = demand for other financial assets
- EA^{p} = earning assets supplied by the private sector to the banking sector
- AFI^{p} = earning assets supplied by the private sector to the South African Reserve Bank.

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28. J.Tobin [93].

The private sector is assumed to allocate its financial wealth between currency, demand and time deposits and other assets (in this study, the demand for other assets is not specified). On the liability side of the balance sheet, the private sector is assumed to supply earning assets to the banking sector. These earning assets may be either Government or private sector debt. In addition, earning assets are supplied to the South African Reserve Bank. Net worth is assumed constant and is omitted from the balance sheet identity.

The demand functions for currency, demand, and time deposits are now specified. The earning asset supply function (EA^p) dealt with in Section 4.4, and the functions determining the supply of earning assets to the Reserve Bank by the private sector (AFI^p) and by the banking sector (AFI^b) are specified in Section 5.

The private sector's demand functions are:

$$Cp = Cp\ (i,\ W/P_w,\ P,\ YDIS,\ \pi_1^p) \qquad (2\text{-}22)$$

$$Cp_1 < 0 < Cp_2,\ Cp_3 > 0,\ Cp_4 < 0$$

$$D = D\ (i,\ W/P_w,\ P,\ YDIS,\ \pi_1^p) \qquad (2\text{-}23)$$

$$D_2 > 0,\ D_3 > 0,\ D_4 < 0$$

$$T = T\ (i,\ W/P_w,\ P,\ YDIS,\ \pi_1^p) \qquad (2\text{-}24)$$

$$T_2 > 0,\ T_3 > 0,\ T_4 < 0$$

where:

A_j = first order partial derivative of function A, A = Cp, D, T, with respect to the j^{th} argument

i = vector of interest rates relevant to private sector portfolio allocation decision and includes

i_e = an index of interest rates paid on banking sector earning assets, referred to as the credit market rate (index)

i_d = rate on demand deposits (set = 0)

i_t = rate on time deposits

i_o = rate on non banking sector earning assets

W/P_w = real wealth

P = price level

YDIS = income distribution

π_1^p = tastes variable.

In accordance with general theoretical principles and empirical evidence, Equations 2-22 to 2-24 indicate that the nominal demand for currency, demand deposits and time deposits depend upon a vector of interest rates (i), real wealth (W/P_w), the price level (P), income distribution (YDIS), and a tastes variable (π_1^p), with sign patterns on the partial derivatives as indicated.[29] All demand functions respond positively to

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29. An extensive survey of demand for money theories together with relevant empirical evidence for the United States may be found in D.Laidler [70], while empirical work on the demand for money in South Africa has been carried out by H.R.Heller [51] and T.Maxwell [74].
Whether wealth (including or excluding human wealth) or income should be included in the demand functions as a proxy for the volume of transactions remains a moot point. The American evidence suggests that wealth rather than income is the appropriate budget constraint (Laidler, op.cit., p.111). While for South Africa, permanent income as a proxy for human and non human wealth gives the best results, followed by gross national product (Maxwell, op.cit., p.21). Heller's results (op.cit., p.340) show that gross national product is the most significant budget restraint. Since our period of study overlaps that of Maxwell by ten years and to avoid a charge of "inelegant redundancy", we include real wealth and exclude income as the budget constraint on the demand functions since they are both closely related (Johnson [59], p.33). Real wealth and the price level are

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included as separate arguments in the interests of generality, no assumption being made about the linear homogeneity properties of the functions with respect to money prices. Some American and South African empirical evidence suggests that the demand for money functions are homogeneous of degree one in prices (Laidler, op.cit., p.104; Maxwell, op.cit., p.19), while other results for South Africa suggest otherwise (Heller, op.cit., p.337). In general we include all independent variables in all the demand functions, since the sum of all responses to the change in any independent variable over the whole balance sheet is equal to zero. For example, an increase in the time deposit rate raises the demand for time deposits and lowers the demand for all other assets, since the sum of all cross effects must be equal to the "own" effect. If the time deposit rate is dropped from some equations, this implies that any residual adjustment takes place in the unspecified equation. Similarly if real wealth and the price level are excluded from the time deposit equation, this implies that an increase in wealth or prices will cause an increase in the demand for currency and demand deposits at the expense of the residual equation (Brainard-Tobin [9], p.103).

changes in the level of real wealth and the price level. Currency, demand and time deposits are assumed to be gross substitutes so that a rise in the yield on any one of these assets raises the demand for that asset and lowers or leaves unchanged the demand for the other assets.

Contrary to conventional procedures, we include as an argument in the demand functions, the distribution of income (YDIS). Since this variable appears to be particularly relevant for the currency demand function in South Africa, we relegate the discussion to a separate sub-section (Section 4.3).

Several remarks about the currency demand function are appropriate here. The elasticity of demand for currency with respect to the interest rate vector i is negative, where i is a measure of the opportunity costs of holding currency.[30]

Several authors have suggested a list of variables that may influence the demand for currency. Following the Tobin-Baumol approach ([7], [91]), currency balances may depend inversely on the transactions cost of converting financial assets into currency and vice versa. Cagan [20] found that real income dominated the long-run demand for currency in the United States while the rate of personal income tax explained the rise in currency demand during war years, being a proxy for tax evasion and black market transactions. Brunner and Crouch ([14], [27]), have proposed

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30. See Cagan [20[, p.305. Brunner-Meltzer [17] point out that no adequate explanation for the demand for currency in the short-run exists and there is no evidence that the currency demand should depend on credit market rates. Hence they assume that the currency ratio is exogenously determined (ibid., p.155; and [15], [18]).

that the demand for currency may depend positively upon the price index of goods and services usually purchased with currency relative to the price index of goods and services purchased with other media of exchange.[31] Currency demand may also be affected by the incidental services offered by commercial banks to lure customers and by service charges incurred in the use of demand deposits as a means of payment. These charges are avoided by using currency in transactions.

4.3 Income Distribution and the Behaviour Equations

One implication of the Tobin-Baumol inventory approach to the transactions demand for money [7], is the existence of economies of scale in money holdings, which means that the aggregate demand for money function depends not only on the level of income but also on its distribution (assuming that income or wealth is proportionately related to the volume of transactions). D.Laidler points out that, for a given level of income, the more that income is concentrated in a few hands, the lower is the demand for money since "... one man carrying out a given volume of transactions will hold less than would two men carrying out half that volume each".[32] D.Laidler [70],p.66.

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31. If the demand for commodities purchased with currency is elastic with respect to the price of these commodities, then the demand for currency will increase if the increase in the price of these commodities is due to a fall in supply. Expenditures will rise and vice versa. If the rise in the price of these commodities is due to an increase in the demand for these commodities, then the demand for currency will increase similarly. This is discussed in detail by Weber [97], p.21.

32. See also D.Laidler [70], pp.65, 67.

The existence of economies of scale adds power to monetary policy. Under the proportionality approach of the Classical Quantity Theory, a doubling of the money supply will, ceteris paribus, double the nominal income level. Under the Tobin-Baumol approach, if the aggregate demand for money function abides by the square root formula, the level of nominal income will more than double. Economists have not investigated the full theoretical and empirical implications of income distribution. We attempt to remove some of this neglect, below.[33]

The American empirical evidence, while suggestive of the existence of economies of scale in money holdings, leaves the point moot. Although the marked decline in the wealth elasticity of the demand for money, which has been observed in the post Second World War era, is suggestive of the existence of economies of scale, it is scant evidence to refute their non existence in the previous fifty years. Laidler suggests that the pre war lack of evidence may be due to the offsetting influences of a redistribution of income in favour of lower income groups.[34]

The empirical evidence for South Africa is strongly suggestive. Heller attributes a low price elasticity of the demand for money to the presence of money illusion or "... a conscious effort on the part of the holders of money balances to economise in their use". H.R.Heller [51], p.337. Estimations of separate demand functions for coin and notes, yields a relatively higher income elasticity of demand for coin indicating the existence of economies of scale in the demand for coin but not in the case

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33. Ibid., p.84

34. Ibid., p.107

of notes.[35] While the long-run demand function (1918 to 1955) proved stable, a short run demand for money function for the post war period (1947 to 1955) exhibited a non significant negative income elasticity.

Questioning the stability results of Heller, T.Maxwell [74] tested data for the period 1918 to 1960 and found a distinctly unstable long run demand function for idle balances characterised by a secular shift between pre and post war periods.

For the post war period in particular, the wealth elasticity of money demand was often significantly negative, indicating a secular decline in the demand for coin, notes and demand deposits. Attributing this decline to the post war growth of near money substitutes and a change in tastes, Maxwell suggests that economies of scale may have been a factor contributing to the negative wealth elasticity. Indeed the addition of a simple time trend variable reverses the negative sign on wealth.[36]

In spite of suggestive evidence, the empirical work on the demand for money in South Africa, like its counterpart in America, has failed to account for the effects of income distribution on the demand for money

This study is primarily concerned with the money supply and offers no exhaustive investigation on the demand side. However, certain distinctive characteristics of the distribution of income in South Africa provide a fundamental and compelling argument for including this variable in the demand functions of the private sector.

Basically, the distribution of income between low and high income groups coincide almost exactly with the division of income sources between

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35. H.R.Heller [51], p.339.

36. T.Maxwell [74], p.18.

wage and non wage earners, and with an observed differential in payments habits between these two classes; suggesting that the former have a relatively higher marginal propensity to hold currency than the latter. A transfer of income from non wage to wage earners, for a given level of aggregate demand, will raise the demand for currency and thereby, affect the credit market rate and the money supply. Our empirical test of this hypothesis is discussed in Chapter 4 (Section 11).

4.4 Portfolio Allocation Ratios of the Private Sector, and the Supply of Earning Assets to the Banking Sector

Following general money supply theory, we define two portfolio allocation parameters, P_1 and P_2, which completely describe the private sector's demand for currency, demand and time deposits. These ratio demand functions are, themselves, dependent on the arguments of the non ratio demand functions (Equations 2-22, 2-24).

$$\frac{Cp}{D} = P_1\ (i,\ W/P_w,\ P,\ YDIS,\ \pi_1^P) \qquad (2\text{-}25)$$

$$P_{12} < 0,\ P_{13} < 0,\ P_{14} > 0$$

$$\frac{T}{D} = P_2\ (i,\ W/P_w,\ P,\ YDIS,\ \pi_1^P) \qquad (2\text{-}26)$$

$$P_{22} > 0,\ P_{23} > 0,\ P_{24} > 0$$

where:

P_{ij} = first order partial derivative of function P_i, $i = 1,2$ with respect to the j^{th} argument.

The ratio parameters P_1 and P_2 have been given a sign pattern used by several authors.[37] These sign patterns imply a set of order conditions on the partial derivatives of the non ratio demand functions. In particular, $P_{12} < 0$ implies that demand deposits are more responsive to changes in wealth than is the demand for currency, and $P_{22} > 0$ implies that time deposits are more responsive to changes in wealth than is the demand for demand deposits. These conditions may be written as:

$$0 < e(C_p,W) < e(D,W) < e(T,W)$$

where:

$$e(x,y) = \text{elasticity of } x \text{ with respect to } y.$$[38]

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37. Brunner-Meltzer [15], p.250 and [18]; Brunner-Crouch [14]; Fratianni [38], p.47, n.8; Crouch [27], p.151.

38. G.I.Weber (op.cit., p.23) finds that no response pattern can be placed on the time deposit ratio with respect to wealth, a priori. Brunner and Meltzer ([15], p.250 and [17], p.156) assign a positive response pattern which implies that the elasticity of demand for time deposits with respect to wealth is greater than the elasticity of demand deposits with respect to wealth. In Brunner-Crouch (ibid., p.83), preliminary investigations for the United States indicate an ascending order of wealth elasticities. This implies that the response of the currency ratio is negative with respect to wealth and the responses of all other allocation ratios with respect to wealth are positive.

4.5 The Relationship Between the Time Deposit Ratio and Interest Rates

The simple relationship between the private sector's time deposit allocation ratio and interest rates discussed above, conceals a set of more complicated interdependent behaviour relationships. We discuss these relationships in this section, in anticipation of Chapter 3, where they will be used to assess the impact of the credit market rate on the money and credit market multipliers and the money supply.

From Equation 2-26 we obtain Equation 2-27 below. Equation 2-28 postulates that the time deposit rate (i_t) depends on the interest rate on non banking sector earning assets (i_o) and on the credit market rate (i_e), and the signs on the partial derivatives are positive.

$$P_2 = P_2(i_t, i_o, \ldots\ldots,) \qquad (2\text{-}27)$$

$$i_t = i_t(i_o, i_e, \ldots\ldots,) \qquad (2\text{-}28)$$

Differentiating Equations2-27, 2-28 and with suitable substitutions, the response patterns of P_2 with respect to i_e and i_o are obtained in elasticity form (see Appendix A.3 for derivations).

$$e(P_2, i_e) = e(P_2, i_t)\, e(i_t, i_e) > 0 \qquad (2\text{-}29)$$

$$e(P_2, i_o) = e(P_2, i_t) e(i_t, i_o) + e(P_2, i_o) \qquad (2\text{-}30)$$

In Equation 2-29, $e(P_2, i_t) > 0$ expresses the direct interest elasticity of the time deposit ratio withrespect to the rate on time deposits. The $e(i_t, i_e)$ term is the relationship between the time deposit rate and the credit market rate on banking sector earning assets, determined by the profit maximising behaviour of the banking sector. Assume that an initial balance sheet equilibrium is disturbed by an exogenous increase in the supply of earning assets to the banking sector. An upward pressure is exerted on the credit market rate, creating a discrepancy between the marginal cost of time deposit acquisition and the marginal revenue gained by acquiring additional time deposits. The banking sector will raise the rate on time deposits accordingly and $e(i_t, i_e)$ is positive. Thus, the interest response of the time deposit ratio, $e(P_2, i_e)$ is unambiguously positive.

Similar considerations apply to Equation 2-30 but additional assumptions are required. As above, the direct price elasticity of P_2 with respect to i_t is positive. The relationship between the time deposit rate and the rate on non banking sector earning assets is postulated as positive due to competitive forces between the banking sector, non banking financial intermediaries and other financial market. In the short-run, an increase in i_o causes a transfer of funds from the banking sector to competing non bank financial intermediaries. They in turn, being unfettered by constraining statutory reserve requirements, are able to expand their holdings of earning assets in competition with the banking sector. Even though these funds are redeposited with the commercial banks in the long-run, in the form of non bank financial intermediary cash reserves, and as transactions balances held by individuals who obtain loans from the non bank financial intermediaries, the banking sector is likely to guard its short-run profit position by raising the deposit rate. This is especially likely if non bank financial intermediaries issue near money liquid assets which are held widely as transactions balances, or grant limited transfer facilities to depositors. In this instance, the return flow of funds to the banking sector will be reduced and there is further cause for the time deposit rate to follow the increase in i_o.[39]

The second term in Equation 2-30, the cross elasticity of the time deposit ratio with respect to the interest rates on alternative financial assets, is postulated as being negative, implying that the response of time deposits is lower vis a vis demand deposits.[40] Consequently, the response of the elasticity of the time deposit ratio with respect to the interest rate on non banking sector earning assets is, mutatis mutandis positive, if the sum of the elasticities is positive. This is equivalent to assuming that the direct elasticity is greater than the cross elasticity, where, in the long-run, $e(i_t, i_o)$ approximates unity; i.e. the first product term must exceed the second term in absolute value.[41]

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39. D.Shelby ([84]) provides an excellent theoretical analysis of the effects of the growth of non bank financial intermediaries on the supply of credit and commercial bank deposits. The effects on the commercial banks of the growth of non bank financial intermediaries in South Africa during the fifties and early sixties is discussed in Marlin ([73]). The importance of non bank financial intermediary growth in the South African financial sector was given explicit recognition by the passing of the new bank act in 1965, which, inter alia, imposed statutory cash reserve requirements on these near banks.

40. Brunner and Meltzer ([18]), cite the following empirical studies for the United States in support of the postulates that $e(P_2, i_t)$ is positive and $e(P_2, i_o)$ is negative: Christ [21]; Feige [37]; Brunner-Meltzer [15], and [18], p.20 and n.27.

41. Brunner-Meltzer ([18], p.20 and esp. 3rd para. of n.28) state that these assumptions are suggested by standard economic theory.

Any market rigidities which reduce the responsiveness of the time deposit rate to changes in the credit market rate and other interest rates will alter the sign patterns assigned to Equations 2-29, 2-30.[42] As the time deposit rate approaches a pre determined ceiling, $e(i_t, i_e)$ and $e(i_t, i_o)$ [Equations 2-29, 2-30 respectively] approach zero. The elasticity of the time deposit ratio, with respect to the credit market rate, approaches zero and in the case of the rate on other financial assets, the elasticity is negative.

4.6 The Supply of Private Sector Earning Assets to the Banking Sector

The nominal stock of earning assets supplied to the banking sector (EA^P) by the private sector consists of loans obtained from the banking sector and government debt sold to the banking sector. This stock depends upon a vector of interest rates relevant to private sector portfolio decisions (i), real wealth (W/P_w), the price level (P), and the stock of outstanding government debt (F^o).[43]

$$EA^P = h(i, W/P_w, P, F^o) \qquad (2\text{-}31)$$

$$h_2 > 0,\ h_3 > 0,\ h_4 > 0$$

where:

h_j, $j = 2,3,4$ is the first order partial derivative of function h with respect to the j^{th} argument.

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42. Such rigidities may take the form of a ceiling on the time deposit rate imposed by the monetary authorities or an oligopolistic cartel agreement.

43. Inclusion of these variables, for the most part, follows the principles pertaining to the assets demand functions (see Sec. 4.2 and esp. n.29). In Brunner-Meltzer ([18], p.6 and n.11; and Fratianni [38]), wealth and the price level are written separately while in Brunner-Meltzer ([17], p.160 and esp. n.9) the price level is submerged in a nominal wealth proxy and the ratio of current income to permanent income is included as a transitory income proxy.

In particular it is assumed that earning assets respond negatively to the credit market rate (i_e) and positively to the interest rate on non banking sector earning assets (i_o).

Before turning to the role of the discount market in South Africa, we require several assumptions about the supply of currency, demand and time deposits. No explicit function exists for the supply of currency. It is assumed that currency demand is always accommodated by the South African Reserve Bank via the banking sector. Since the convertibility of banking sector deposits into currency is the mainstay of the commercial banks, the supply curve for currency is infinitely elastic. Similarly, no separate supply functions for demand deposits and time deposits are specified. If ceiling rates on deposits exist or if rates are set by inter bank agreement, then the banking sector must be willing to accept demand and time deposits in whatever quantity the public wishes to hold.[44]

The h function responds positively to an increase in the stock of oustanding government debt, reflecting the portfolio absorption of government debt by the banking sector and the private sector in response to an exogenous increase in supply.[45]

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44. See W.Brainard and J.Tobin [9], p.102.

45. The mechanism whereby new issues of government debt are fed into the "secondary market" (the banking and private sectors excluding the Public Debt Commissioners) by the Public Debt Commissioners will be discussed in Sec.6.2.

5. THE SUPPLY OF EARNING ASSETS TO THE RESERVE BANK - THE AFI VARIABLE

5.1 A Perspective

In Section 2, we define the adjusted monetary base (B^a) as the difference between the monetary base (B) and the supply of earning assets to the Reserve Bank by the banking and private sectors (AFI). In other words, AFI represents last resort lending by the Reserve Bank to the banking and private sectors, as a source of base money.[46] As an endogenous variable, AFI is deducted from the monetary base to yield the adjusted monetary base as the measure of monetary policy. The influence of AFI on the money supply is then reflected in the money multiplier, to be derived in Section 7.

One major justification for this procedure arises from an extended debate in Britain in the last fifteen years, that control of the money supply is impossible in a situation in which lender of last resort facilities are available to offset policy induced changes in the monetary base.[47] This situation is special for Britain in view of the institutional

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46. Essentially, AFI constitutes a source of reserves to the banking sector alone, since base money acquired by the private sector will ultimately be returned to the banking sector as deposits, to the extent that it is not retained as currency balances by the private sector, or used to purchase government debt.

47. The argument may be summarised by the following propositions: 1. the monetary base cannot be controlled because the discount market has an automatic right to lender of last resort facilities from the Bank of England and the commercial banks have direct access to the discount market; 2. interest rate stabilization implies loss of control of the monetary base and hence the money supply; 3. if the base is used to stabilize the interest rate, then the supply of Treasury bills must be used to control the money supply. The major works dealing with the debate are: Newlyn [79], pp.19-41; Coppock and Gibson [28], pp.203-222; Crouch [25], p.916, and [26], pp.81-94; Karaken [66], pp.97-103. These articles are reprinted with a useful introduction by J.M.Parkin, in Johnson, et al. [63], pp.203-277.

relationship between the Bank of England, the London discount market and the banking sector, and for South Africa as well, since the recently developed money market has been modelled on that of its London counterpart.

A further justification rests with the method of monetary analysis used in South Africa, which, by virtue of the balance sheet consolidation procedure employed by the Reserve Bank (see Section 2), precludes analysis of the effects of Reserve Bank lending on the money supply process. To remedy this omission, the institutional working of the South African money market and other financial institutions are investigated below, and a supply function for banking and private sector earning assets supplied to the Reserve Bank, is formulated.[48]

5.2 The Institutional Relationship Between the Banking Sector, the Private Sector and the Reserve Bank

Analytically, the supply of earning assets to the Reserve Bank by the banking and private sectors is endogenously determined by interest rates and exogenous variables, the latter depicting liquidity conditions in the economy. In the section that follows, we outline the institutional relationship between the Reserve Bank and the banking and private sectors, and derive an aggregate supply function for both sectors.[49] In the course

48. One major point of departure from the British institutional structure is that the South African Reserve Bank extends lender of last resort facilities not only to the South African discount market, but also to other financial institutions including commercial banks. The Bank of England extends these facilities to the London discount market alone.

49. The development of the South African money market is fully discussed in Palmer [80], Palmer and Dickman [81], and Dickman [34].

of this specification, the following topics are discussed:

a brief description of the South African money market

the nature of the lender of last resort facilities

the role of the discount houses

the supply equation for the money market

the supply equation for the commercial banks

the equation for the Land Bank and other financial institutions

the aggregate supply equation.

5.2.1 A Brief Description of the South African Money Market. The South African money market is a post Second World War phenomenon, modelled (in principle) on the London discount market and differing from it only in degree. Generally speaking, the functions of the money market are: to accept very short-term deposits subject to withdrawal at call or short notice, and to invest these funds in short-term debt instruments comprised of Treasury bills, short-term government securities and private sector commercial bills. As such, the money market provides a supply of highly liquid interest-bearing financial assets to the banking sector, other financial intermediaries and private firms; thus, enabling them to economise on temporarily idle cash balances. These balances are loaned to the Government and private economic unit.

Three sets of financial institutions comprise the money market; the National Finance Corporation (established in 1949 on the initiative of the Government), the private discount houses and the merchant banks. The National Finance Corporation and the discount houses perform fundamentally the same function, as described above. The merchant banks accept deposits, make loans, and create private sector debt instruments by attaching their signature to commercial bills, which may then be discounted with the discount houses. These bills, known as bankers acceptances, constitute 'good' commercial paper eligible for redisoount at the Reserve Bank. The significance of the money market rests with the discount houses and the nature of the Reserve Bank's last resort facilities.

5.2.2 The Nature of the Lender of Last Resort Facilities. The South African Reserve Bank stands ready to transact with certain financial institutions by exchanging non interest bearing claims against the Government (base money) for earning assets supplied by the institutions (a loan on pledge of assets).

These transactions are concluded at a price determined by the Reserve Bank. With Bank Rate exogenously fixed in this manner, the supply of base money is demand determined. While financial institutions face an infinitely elastic supply curve for Reserve Bank claims, the quantity demanded is determined by the level of Bank Rate. In this way the Reserve Bank insures the convertibility of financial intermediary deposits and thereby confers upon these intermediaries a monopoly right to issue liquid claims against themselves. It will be seen that the interest elasticity of the above mentioned supply curve is critical to the transmission of Bank Rate policy to the credit market.

5.2.3 The Role of the Discount Houses. The discount houses earn their profits from the difference between yields on earning assets and the rate paid on call deposits issued by them. This profit margin is, however, set within tight limits by an institutional constraint, which sets a floor to the call rate paid by the discount houses, at some percentage below the market Treasury bill rate. In the long-run, this profit margin varies little.

Since the portfolios of the discount houses are confined to short-term financial assets (91-day Treasury bills, 3-month bankers acceptances and short-term government securities of 3 years or less), there exists little need for more than negligible cash balances, especially since lender of last resort facilities are available. There exists no cushion of excess cash reserves sufficient to absorb the effects of any persistent drain of call deposits from the discount houses.[50] A persistent drain affects the balance between marginal revenue and marginal cost, with a resulting adjustment of discount house balance sheets.[51] It should be stressed that call loans are held by commercial banks as highly liquid reserve assets and constitute the first line of defence when a decline in cash reserves occurs. If the discount houses are forced to borrow from the Reserve Bank at a penal

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50. A non persistent drain would be one in which, while some sectors of the financial system were withdrawing their call deposits, others were making call deposits so that the aggregate call fund was not depleted.

51. For example, the difference between the index of interest rates on discount house earning assets (marginal revenue) and the call rate paid on call deposits (marginal cost) will become negative. Consider the following. An exogenous decline in call deposits held by commercial banks will force the discount houses to adjust by (a) selling financial assets, reducing bills discounted and accumulating funds from asset maturities; resulting in an increase in short-term interest rates; (b) attempting to attract new call deposits by raising the call rate (in any case the call rate would rise if the Treasury bill rate were increased); (c) seeking lender of last resort assistance from the Reserve Bank as an alternative source of funds, at a rate determined by the Reserve Bank.

rate, losses are immediately inflicted and will continue as long as indebtedness to the Reserve Bank remains. Consequently, the discount houses will seek to restore equilibrium by reducing their indebtedness to the Reserve Bank with a resulting increase in short-term rates. It is clear that in the short-run, a reserve drain from the banking sector may be replenished by last resort lending to the discount market. However, fine profit margins combined with a penal Bank Rate policy ensures that tight money conditions in the banking sector will be reflected quickly by a rise in short-term interest rates in the credit market. The transmission mechanism is embodied in the profit maximising behaviour of the discount houses. Short-term rates rise when the discount houses attempt to expunge their indebtedness to the Reserve Bank.

It follows from these arguments, that if last resort facilities are not provided at a penalty rate, then, they in effect, remove the contractionary forces that necessitated last resort borrowing in the first place. In other words, if Bank Rate is penal, the discount houses confront a rising marginal cost schedule for the acquisition of funds, which is reflected in a continuing shortage of banking sector reserves and rising short-term interest rates. The demand for Reserve Bank accommodation is positive in the short-run but approaches zero in the long-run.

5.2.4 The Supply Equation of the Money Market. On the basis of the preceding discussion, the supply of earning assets to the Reserve Bank by the money market (A^{nh}) is specified in terms of appropriate interest rates and credit market conditions:

$$A^{nh} = A^{nh}(i, i_{br}, \pi_2^{nh}) \qquad (2\text{-}23)$$

$$A_1^{nh} > 0 > A_2^{nh}$$

where:

i = vector of interest rates in the bank credit market

i_{br} = Bank Rate

π_2^{nh} = a shift variable.

The interest rate vector reflects profit conditions in the money market by including the rate on call deposits and an index of interest rates in the banking sector credit market. A rise in the call rate represents an increase in the cost of deposit acquisition relative to the cost of borrowing from the Reserve Bank, and raises the relative demand for last resort facilities.

π_2^{nh} is a variable that reflects non price factors which influence the demand for Reserve Bank loans, such as liquidity conditions.

The National Finance Corporation, as a Government initiated money market institution, acquires call deposits by "special arrangements", i.e. funds are deposited at rates below the market call rate, a factor that tends to lower their need for last resort facilities. Furthermore, for any given change in credit market conditions, money market indebtedness to the Reserve Bank will be lower, the lower is the banking sector's elasticity of demand for call deposits, the higher is the elasticity of demand by the private sector for call deposits, and the higher is the elasticity of demand of the private sector for money market loans. Changes in the "special arrangement" and in the demand elasticities are captured by variations in π_2^{nh}.

5.2.5 The Supply Equation of the Commercial Banks. Unlike the Bank of England, the South African Reserve Bank provides rediscounting facilities to the commercial banks, despite the existence of a money market. This phenomenon is a carry over from the prewar era, when no money market existed. The supply of earning assets tothe Reserve Bank by the commercial banks depends upon cost and revenue criteria, and like the discount houses, is positive in the short-run and tends to zero in the long-run, if Bank Rate is penal. Changes in the monetary base will affect banking sector reserves, and hence the need for last resort facilities. This is especially true in the absence of a developed money market, as was the case up until the late fifties. Even with the existence of a well developed call loan market, the commercial banks may still seek to adjust reserve deficiencies via the Reserve Bank, if Bank Rate is set at or below market rates. In this instance, lender of last resort accommodation would by pass the money market.

The supply equation for the commercial banks is:

$$A^b = A^b\ (i,\ i_{br},\ \pi_2^b) \qquad (2\text{-}23)$$

Commercial banks will compare bank rate with the cost of alternative methods of balance sheet adjustment. Thus, the vector i contains an index of interest rates on earning assets (call rate, interest rates on government debt and banking sector loan rates). In addition, commercial banks are able to generate additional excess reserves by inducing the private sector to shift from demand to time deposits (due to the differential cash reserve requirement on demand and time deposits, in operation until 1965). Vector i must therefore contain the interest rate on time deposits and the implicit deposit rate on demand deposits. Adjustment by the latter means will depend on the price elasticity of demand of the private sector for demand and time deposits.

The π_2^b shift variable reflects changes in the optimum level of excess reserves, the relative demand for call deposits as liquid reserve assets, special arrangements between the commercial banks and the Reserve Bank, the quantity of eligible paper with the commercial banks, and the response of the currency ratio to credit market changes.

5.2.6. The Supply Equation of the Land Bank and other Financial Institutions. The Land Bank is a financial institution specialising in the provision of credit appropriate to the particular requirements and special risks of agriculture. The Land Bank receives "special privileges" from the Reserve Bank, the latter purchasing Land Bank bills and thereby, providing the former with finance.[52] On profit maximising criteria, the Land Bank may be expected to seek funds having the lowest marginal cost of acquisition. The sale of bills to the Reserve Bank depends upon, inter alia, competitive rates in alternative credit markets. In this instance, the sale of Land Bank bills to the Reserve Bank (A^L) is a form of reserve injection into the banking sector, differing in degree but not

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52. The Land Bank is however an autonomous body, independent of the Treasury and not a department of the State. However, all its board members are appointed by the State President [sic]. Other sources of funds are: amounts voted annually by Parliament, commercial bank overdrafts, and the acceptance of deposits. In 1959, the Land Bank was authorised to raise funds by the issue of long-term debentures in the capital market (fifteen to twenty years) (Marlin [73], p.302, 307, 308).

kind from lender of last resort facilities extended to the money market and the commercial banks. The Land Bank equation is written as:

$$A^L = A^L(i, i_{br}, \pi_2^L) \qquad (2\text{-}34)$$

The vector i contains interest rates in credit markets and reflects the profit position of the Land Bank.[53] The shift variable (π_2^L) accounts for changes in circumstances that affect the quantity of support received from the Reserve Bank. Finally, it should be noted that Land Bank indebtedness to the Reserve Bank will be part of the long-run equilibrium position of the Land Bank if Reserve Bank loans are extended at a rate below alternative sources of finance.

Similar principles determine the supply of earning assets to the Reserve Bank by other financial intermediaries, to whom the Reserve Bank extends lender of last resort facilities. Lending to these institutions constitutes an indirect injection of reserves into the banking sector to the extent that these institutions acquire additional private sector debt. If government debt is acquired, the loans accrue to the Government.

5.2.7 The Aggregate Supply Function. a) The Private Sector's Supply Function. As mentioned previously, the private sector (as defined)

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53. These rates would be: the interest rate on commercial bank overdrafts, the rate on Land Bank bills and debentures, call and other deposit rates. Since Land Bank bills compete with other short term debt instruments, the interest rates on private sector short-term debt, on Treasury bills and on short-term government securities, are relevant, as well as interest rates on deposits issued by the Land Bank and rates on deposits in other financial institutions.

includes the financial institutions comprising the money market (discount houses, National Finance Corporation, merchant banks), the Land Bank and other miscellaneous financial institutions who receive Reserve Bank aid. An aggregate supply function of earning assets by the private sector (AFI^P) is obtained by aggregating the individual supply functions.

$$AFI^P = AFI^P(i,\ i_{br},\ \pi_2^P) \qquad (2\text{-}35)$$

$$AFI_1^P > 0 > AFI_2^P$$

π_2^P typically represents some exogenous changes in the balance sheet equilibrium of the banking sector, such as a decline in demand deposits and banking sector reserves through the balance of payments. The banking sector will seek to refurbish its reserves by reducing call loans to the discount market. Ceteris paribus, the discount houses will supply earning assets to the Reserve Bank in exchange for base money, which then flows into the banking sector. Thus, AFI^P is related to the level of demand deposits. Assuming that the supply of earning assets to the Reserve Bank is homogeneous of degree one in demand deposits, we rewrite Equation 2-35 as,[54]

$$AFI^P = AFI^P(i,\ i_{br},\ \frac{\pi_2^P}{D})\ D \qquad (2\text{-}36)$$

$$= P_8'D \qquad (2\text{-}37)$$

where:

$$P_8' = AFI^P(i,\ i_{br},\ \frac{\pi_2^P}{D}) \qquad (2\text{-}38)$$

$$P_{81}' > 0 > P_{82}'$$

54. See K. Brunner and R.L.Crouch [14], p.7,8 and n.7.

Equation 2-37 expresses the supply of earning assets to the Reserve Bank as the product of a parameter P_8' and demand deposits (D) where P_8' is determined by the arguments in Equation 2-36. Equations 2-36 to 2-38 complete the system of Equations (2-21 to 2-31) describing the portfolio allocation behaviour of the private sector in Section 4.4.

b) The Banking Sector's Supply Function. Using similar arguments, the variable π_2^b in Equation 2-39 below, reflects the effect of an exogenous change in demand deposits on the equilibrium balance sheet position of the banking sector. The banking sector may by-pass the discount market and seek direct aid from the Reserve Bank in response to an exogenous fall in demand deposits.

In conformity with our previous ratio equations, we define a portfolio allocation parameter P_8^b which describes the banking sector's supply of earning assets to the Reserve Bank, and depends on the arguments in Equation 2-39.

$$AFI^b = AFI^b(i, i_{br}, \pi_2^b)D \qquad (2\text{-}39)$$

$$= P_8^b D \qquad (2\text{-}40)$$

where:

$$P_8^b = AFI^b(i, i_{br}, \pi_2^b) \qquad (2\text{-}41)$$

$$P_{81}^b > 0 > P_{82}^b$$

c) The Aggregate Supply Function for the Banking and Private Sectors. The aggregate supply function is derived from a definition for the aggregate supply of earning assets to the Reserve Bank and Equations 2-36 to 2-41.

The aggregate supply of earning assets to the Reserve Bank (AFI) is defined as the sum of earning assets supplied by the banking sector (AFI^b) and the private sector (AFI^p).

$$AFI = AFI^b + AFI^p \tag{2-42}$$

From Equations 2-37 and 2-40:

$$AFI = (P_8' + P_8^b)D \tag{2-43}$$

$$= P_8(i, i_{br}, \pi_2)D \tag{2-44}$$

where:

$$P_{81} > 0 > P_{82}$$

P_{8j} is the first order partial derivative of function P_8 with respect to the j^{th} argument and the variables i, i_{br} are defined as before. π_2 is a vector of variables which determine π_2^b and π_2^p, and P_8 is dependent on the arguments of functions 2-38 and 2-41. The ratio parameter P_8 responds positively to changes in interest rates and negatively to Bank Rate.

To summarise: P_8 reflects the profit maximising behaviour of the institutions in the money market and other institutions that obtain funds from the Reserve Bank. An exogenous fall in liquidity in the banking sector brought about by a decline in the monetary base, has immediate repercussions on liquidity conditions in the money market. The discount houses are driven to borrow from the Reserve Bank in the course of their portfolio readjustments. During this process, market rates may be expected to rise if Bank Rate is penal. Changes in market rates, ceteris paribus, induce a disequilibrium in the banking and private sectors with consequent balance sheet readjustments.

Referring back to Equation 2-2, recall that we deductedthe aggregate supply of earning assets to the Reserve Bank (AFI) from the monetary base (B) in order to obtain the adjusted monetary base (B^a) as an exogenous policy variable. It will be seen in Section 7 below, that the influence of AFI on the money supply and the credit market rate is reflected in the money multiplier (m) and the credit market multiplier (a). Bank Rate and discounting policy of the Reserve Bank will influence these multipliers via the parameter P_8, which embodies the institutional arrangements characterised by the relationship between the Reserve Bank, and the banking and private sectors.[55]

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55. Brunner-Crouch, op.cit., specify a similar aggregate demand function for the London money market. However they do not elaborate on its working. It is to be expected that the forces determining our behaviour parameter P_8 will differ significantly from those affecting a similar parameter for the London money market.

6. THE RELATIONSHIP BETWEEN THE MONETARY BASE AND THE GOVERNMENT'S BUDGET DEFICIT

6.1 An Analytical Framework Relating Monetary Policy, Fiscal Policy and Interest Rate Stabilization Policy

In this section, we derive expressions showing the interrelationship between the Government's budget deficit and the monetary base. These expressions provide an analytical framework bearing on two related issues. The first is the implication for monetary policy of stabilizing the interest rate on government debt. The second related issue is the independence of monetary policy from fiscal policy. Our attention is next directed towards the special role played by the Public Debt Commissioners in financing the Government's budget, and hence in the determination of the money supply and credit market rate.

In principle, a fiscal deficit may be financed in several different ways; by an issue of government debt, by an increase in the coinage through the Mint and by an increase in the Government's net indebtedness to the Reserve Bank. A balance sheet stock identity for the Treasury is written as:

$$\sum_{i}^{t}(G - T) = S + (GLOAN - REX) + C + F^{o} + FFGN \qquad (2\text{-}45)$$

where:

G = Government expenditures

T = tax revenue

$\sum_{i}^{t}(G-T)$ = the sum of past deficits from period i

S = the Reserve Bank's portfolio of government debt

$GLOAN$ = Reserve Bank lending to the Treasury

REX = the Exchequer (and Pay Master General) account at the Reserve Bank

C = total minted coin

F^o = the outstanding stock of government debt held by the banking and private sectors

FFGN = government debt issued abroad.

The Treasury balance sheet and derivation of Equation 2-45 are presented in Appendix A.4. Rewriting Equation 2-45 in flow terms defines the Government budget for the period t, in terms of changes in the stock of outstanding government debts, net indebtedness to the Reserve Bank and so on (see Appendix A.4).

$$(G - T)_t - \Delta F^o = \Delta [S + (GLOAN - REX) + C + FFGN] \qquad (2\text{-}46)$$

We demonstrate that the extent to which monetary policy becomes subservient to fiscal policy, depends, inter alia, upon the interest rate stabilization policy pursued by the monetary authorities.

Assume that the Government sets the size of the deficit and the ceiling rate on government debt. The latter fixes the demand for government debt by the private and banking sectors and hence the value of ΔF^o. If the new issue of government debt does not cover the deficit, $(G - T)_t > \Delta F^o$, and the difference must be met by an increase in one or all of the terms on the right hand side of Equation 2-46. These terms, being source components of the monetary base, may imply an increase in the monetary base. In order to maintain a desired ceiling rate on government debt, given the Government's budget deficit, the monetary base must be expanded to meet residual deficit finance requirements in the case where the total deficit cannot be financed by the banking and private sectors alone.

It appears that the interest rate ceiling together with the deficit negates the independent determination of the monetary base and hence, the independence of monetary policy. We noted in Section 2.2.1, that the Reserve Bank's portfolio of government debt is, in principle, independently determined so that open market operations can be used to set the level of the adjusted monetary base. If the component S in Equation 2-46 varies inversely with the deficit, this implies that the remaining components on the right hand side of the equation must offset the decline in S, which means that open market operations are not being used to independently determine the adjusted monetary base, but rather the adjusted base is being varied to maintain a ceiling rate on government debt. Open market purchases (an increase in S), combined with a Government deficit, implies that open market operations are being used to stabilize the ceiling rate by an appropriate adjustment of the adjusted monetary base. Conversely, a decline in S must be mirrored by an increase in the outstanding stock of national debt (F^o) held by the banking and private sector's, which means that open market operations are being used to independently determine the base and the budget deficit is shifted from the Reserve Bank to the banking and private sectors.

The independence of the monetary base from fiscal policy rests on two empirical issues; firstly, the extent to which components on the right hand side of Equation 2-46 dominate movements in the base, and the Reserve Bank cooperates in maintaining the interest rate ceiling on government debt; secondly, the extent to which the Treasury is able to shift the burden of deficit finance from the Reserve Bank to the banking and private sectors. These issues will be dealt with in the discussion in Chapter 3 (Section 5) concerning the implications of monetary policy, which is subservient to National Debt management. We turn now to a discussion of the Public Debt Commissioners.

6.2 The Role of the Public Debt Commissioners

The Public Debt Commissioners are introduced in order to assess their role in the determination of the money supply. Since they exercise their economic significance in the market for government debt, the Commissioners influence the money supply through the interest rate mechanism, and variations in the money multiplier. A brief description of the activities of the Public Debt Commissioners is in order.[56]

The markets for government debt in South Africa have been historically thin and inactive. Prior to the maturation of the money market (late fifties), Treasury bills were issued to particular holders on pre arranged terms, which had little to do with market demand and supply conditions, while short and long-term securities were issued almost exclusively to the Public Debt Commissioners. The Commissioners constitute a curious hybrid. On the one hand, they act as a profit maximising financial intermediary, and on the other, they perform the function of a government broker. Funds are received in the form of deposits from public agencies and Government

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56. The major source of information on the Public Debt Commissioners is C.J. de Swart and G.Steenkamp [32].

departments, and are invested exclusively in Treasury bills, and short and long-term government securities.[57] The purpose of such investments is to maximise returns for depositors, and in this capacity, the Commissioners act as investment nominees in government debt. However, the other function of the Commissioners is to meet the needs of the secondary market for government debt, and in this respect, they act as government brokers. Since deposits are not subject to frequent withdrawal, liquidity considerations are minimal.[58] As such, constantly maturing long-term debt is fed into the private (secondary) market as it reaches the shorter end of the debt spectrum. The private market is composed of institutional and other investors who require new supplies of short-term debt as their outstanding stocks reach redemption date. By this means, the Commissioners maintain the longer end of their portfolio structure intact in the interest of yield maximisation, and are net sellers of short-term debt to the secondary market. The Commissioners obtain additional supplies of national debt directly from the Government through new subscriptions and "tap" Treasury bills.[59] Since a continuous stream of new deposits accrue to the Commissioners, the latter deposits provide the Government with a major source

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57. The public agencies are typically the Post Office Savings Bank, the South African Railways, the Provincial Administrations and Public Corporations. Government department accounts such as the social securities fund, the sinking fund and pension and provident fund are held with the Public Debt Commissioners.

58. Since the advent of the weekly Treasury bill tender in 1958, the Public Debt Commissioners have been an active participant in order to obtain Treasury bills to support the shorter end of their deposit liability structure.

59. Tap Treasury bills are bills issued at market price so as not to disturb the market rate of interest. In Britain, dealing in tap Treasury bills with the Bank of England is known as dealing through the open back door.

of fiscal finance in excess of revenues. Indeed, this is necessary in view of the thin secondary market. It may be concluded that the Public Debt Commissioners are predominantly monopoly holders of government debt, working within a Government defined legal framework, but also, seek to maximise profits with some independence of decision making.

Flows of funds between the private sector and the Public Debt Commissioners will affect the adjusted base. Assuming that depositors with the Commissioners hold transactions balances with the banking sector, a transfer of funds from the banking sector to the Public Debt Commissioners will be initially reflected by an increase in the deposits of the Commissioners with the banking sector (assuming that the Commissioners hold transactions balances with the banking sector). However, the Commissioners immediately invest the additional funds in government debt. To the extent that these purchases constitute new issues there is a transfer of funds from the banking sector to the Government. Base money with the banking sector declines and Government deposits with the Reserve Bank increase. In the long-run, however, fiscal deficit expenditures reflate the base and a new long-run equilibrium position exists in which interest rates are higher with an increased stock of outstanding government debt, ceteris paribus.

In conclusion, it may be noted that as Government agents, the Public Debt Commissioners are in a position to stabilize the interest rate on government debt by meeting the excess demands of and absorbing excess supplies from the secondary markets, at the going rate. Since the Commissioners constitute the dominant vehicle of government debt supply to the banking and private sectors, they emerge as a crucial force in the determination of market rates of interest and hence, the money multiplier and the money supply.

7. STATIC EQUILIBRIUM SOLUTION FUNCTIONS FOR THE MONEY SUPPLY, THE STOCK OF EARNING ASSETS AND THE BANK CREDIT MARKET RATE

Having set out equations describing the banking and private sectors' portfolio behaviour and two identities expressing balance sheet equilibrium in both sectors, we establish the equilibrium condition in the bank credit market, and formulate solution functions for the equilibrium volume of earning assets, the credit market rate and the money stock.

7.1 Equilibrium in the Bank Credit Market; The Credit Market Multiplier and the Solution Function

Equilibrium in the credit market is established by the interaction of the banking and private sectors and requires that the nominal value of earning assets supplied to the banking sector by the private sector (EA^p) be equal to the demand for earning assets by the banking (EA^b).

$$EA^p = EA^b \qquad (2\text{-}47)$$

The supply of earning assets to the banking sector is comprised of private sector loans received from the banking sector plus the stock of government debt sold by the private sector to the banking sector. The path towards equilibrium is characterised by portfolio adjustments by the banking and private sectors; the outstanding stock of government debt is absorbed into financial asset portfolios, bank loans are extended by the banking sector or are repaid by the private sector and interest rates on government debt and bank loans are adjusted.

Using the definition for earning assets in the banking sector (Equation 2-6), the adjusted monetary base definition (Equation 2-4), and the behaviour equations for the banking and private sectors, we obtain an expression for banking sector earning assets in terms of a multiplier coefficient (a) and the adjusted monetary base:

$$EA^b = aB^a \qquad (2\text{-}48)$$

where:

$$a = \frac{(1 + P_1)\ (1 - b_1)}{P_1 + b_1(1+P_2) - P_8} \qquad (2\text{-}49)$$

A complete derivation is furnished in Appendix A.5.[60] Notice that a is not a constant, being functionally dependent upon the arguments of the constituent parameters (P_1, P_2, P_8, b_1). Thus, the stock of earning assets in the banking sector is dependent on the adjusted monetary base and the interacting portfolio behaviour of the banking and private sectors, embodied in the above mentioned parameters.

Writing the multiplier coefficient in general form, in terms of an interest rate vector i containing the credit market rate (i_e) and exogenous variables, we obtain:

$$a = a\ (i,\ r^{d'},\ r^{t'},\ i_{br},\ W/P_w,\ P,\ YDIS,\ \pi) \qquad (2\text{-}50)$$

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[60] Note that the multiplier coefficient a is defined in terms of the total reserve ratio b_1, where b_1 was defined in Section 3 as the sum of the statutory reserve requirement ratio (b_{11}) and the demand for excess reserves (e). Since excess reserves have remained relatively stable over the sample period, b_1 reflects variations in b_{11}. Similarly, the money multiplier (m) is defined in terms of b_1 (see Equation 2-55).

All the arguments have been defined previously and π represents the general shift variables appearing in the asset demand functions of both sectors.

The credit market equilibrium condition may now be restated in terms of multiplier coefficient a and the adjusted monetary base, by substituting Equations 2-50 and 2-48 and the earning assets supply equation for the private sector (Equation 2-31) into the equilibrium solution equation (Equation 2-47).

$$h(i, W/P_w, P, F^o) = a(i, r^{d'}, r^{t'}, i_{br}, W/P_w, P, YDIS, \pi)B^a \qquad (2\text{-}51)$$

Function $h(i, W/P_w, \ldots)$ summarises the private sector's behaviour in the bank credit market, while function $a(i, r^{d'}, \ldots)$ accounts for the joint portfolio allocation behaviour of the two sectors, which includes the supply of loans received from the Reserve Bank.

Solving Equation 2-51 yields the equilibrium stock of earning assets in the credit market (E) and the equilibrium interest rate (i_e) in terms of policy variables B^a, $r^{d'}$, $r^{t'}$, i_{br}, and exogenous variables, W/P_w, P, YDIS, F^o.

The solution function for the credit market rate is:

$$i_e = i_e(i_o, r^{d'}, r^{t'}, i_{br}, W/P_w, P, YDIS, F^o, B^a, \pi) \qquad (2\text{-}52)$$

(an explicit expression for Equation 2-52 is derived in Chapter 3, Section 3).

7.2 The Money Supply Semi-Reduced Form and the Solution Function

By an analogous procedure, we obtain an expression for the money supply in terms of money multiplier m and the exogenous policy variable B^a.

Defining the money supply (M_2) in the usually accepted broad sense as the sum of currency plus demand and time deposits:

$$M_2 = C_p + D + T \qquad (2\text{-}53)$$

where:

C_p = currency held by the private sector

D = banking sector demand deposits

T = banking sector time deposits

the semi-reduced form for the money supply is:

$$M_2 = mB^a \qquad (2\text{-}54)$$

where:

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1+P_2) - P_8} \qquad (2\text{-}55)$$

(the multiplier expression is derived in Appendix A.5).

Writing m in general form as:

$$m = m\ (i,\ r^{d'}\ r^{t'},\ i_{br},\ W/P_w,\ P,\ YDIS,\ \pi) \qquad (2\text{-}56)$$

we see that the multiplier coefficient is determined by the arguments of its constituent portfolio allocation ratios (P_1, P_2, P_8, b_1).

It must be emphasized that the multiplier is not a simple multiplicative constant but a functional relation determined by credit market rates, and exogenous variables. Substituting the solution function for the credit market rate (Equation 2-52) into Equation 2-56 and substituting into Equation 2-54, we obtain the solution function for the equilibrium money stock, written in general form as:

$$M_2 = M_2(i_o, r^{d'}, r^{t'}, i_{br}, W/P_w, P, YDIS, F^o, B^a, \pi) \qquad (2\text{-}57)$$

The equilibrium money stock is determined by a vector of interest rates on non banking sector earning assets (i_o), the reserve requirements on demand and time deposits ($r^{d'}$, $r^{t'}$, resp.), Bank Rate (i_{br}), the adjusted monetary base (B^a), the outstanding stock of government debt (F^o), and other exogenous variables (wealth, income distribution and the price level).

8. SUMMARY OF THE MONEY SUPPLY MODEL FOR SOUTH AFRICA

The purpose of the theoretical model is to explain observed movements in the money stock (defined in the broad sense) and to clarify the role of interest rates in the money supply determination process. The model is constructed by defining the adjusted monetary base and balance sheet identities for the banking and private sectors. Behaviour equations are constructed for these two sectors to explain their portfolio allocation decisions, the supply of earning assets to the banking sector, and the supply of earning assets to the South African Reserve Bank. These functions are dependent upon a vector of relevant interest rates and exogenous variables.

The credit market rate (i_e), the stock of earning assets (E) and the money stock (M_2) are endogenously determined in the model. Using the definition for the adjusted monetary base (Equation 2-4) and the money supply definition (Equation 2-53) and by appropriate substitutions using the portfolio behaviour equations, the model reduces to two semi-reduced form equations in terms of the portfolio allocation ratios (P_1, P_2, P_8, b_1) and the policy variable (B^a) as follows:

$$M_2 = mB^a \qquad (2\text{-}54)$$

$$h(i, W/P_w \ldots) = aB^a \qquad (2\text{-}51)$$

where:

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1+P_2) - P_8} \qquad (2\text{-}55)$$

$$a = \frac{(1 + P_1)(1 - b_1)}{P_1 + b_1(1+P_2) - P_8} \qquad (2\text{-}49)$$

Derivations may be found in Appendix A.5.

The equilibrium rate in the credit market defines the equilibrium stock of earning assets, obtained by solving Equations 2-51 and 2-47. The solution function for the credit market rate index (i_e), so derived, is:

$$i_e = i_e(i_o,\ r^{d'},\ r^{t'},\ i_{br},\ W/P_w\ P,\ YDIS,\ F^o,\ B^a,\ \pi) \qquad (2\text{-}52)$$

Exogenous and policy variables determine the credit market rate index.[61] Inserting Equation 2-52 into the money supply semi-reduced form (Equation 2-54) yields the solution function for the equilibrium money stock in terms of the same exogenous and policy variables:

$$M_2 = M_2(i_o,\ r^{d'},\ r^{t'},\ i_{br},\ W/P_w,\ P,\ YDIS,\ F^o,\ B^a,\ \pi) \qquad (2\text{-}57)$$

Solution functions 2-52 and 2-57 are used in Chapter 3 to establish the relationship between the credit market rate and the money stock in terms of the policy and exogenous variables, while the semi-reduced Equation 2-54 will facilitate an examination of the relative contributions of the adjusted monetary base and the money multiplier to changes in the money supply. In turn, the relative contributions of the behaviour parameters to variations in the multiplier and hence the money supply are calculated.

In the following chapter, the comparative static implications of the model are investigated.

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61. The model here described is aggregative and determines an index of credit market rates, not the term structure of interest rates on government debt nor the rate on banking sector loans. Solutions for individual interest rates are determined by additional relations not here specified. See Meiselman [77], Malkiel [72], and Hester [52].

CHAPTER 3

THE COMPARATIVE STATIC IMPLICATIONS OF THE MONEY SUPPLY MODEL

1. INTRODUCTION

The theoretical structure developed in Chapter 2, provides a set of equations which describe the operations of the South African financial system. Three endogenous variables are determined bythe model; the equilibrium money stock (M_2), the credit market rate index (i_e) and the equilibrium stock of earning assets (E) in the bank credit market. The endogenous variables are determined by nine exogenous variables; a vector of interest rate on non banking sector earning assets (i_o), real wealth (W/P_w), the price level (P), the distribution of income (YDIS), the stock of outstanding government debt net of the Reserve Bank's portfolio (F^o), the adjusted monetary base (B^a), reserve requirements on demand deposits ($r^{d'}$) and time deposits ($r^{t'}$), and Bank Rate (i_{br}). The four latter variables are policy variables determined by the Monetary Authorities and F^o is dependent upon the fiscal actions of the Treasury.

Two theoretical multiplier coefficients (the credit market multiplier and the money multiplier) summarise the influence of the exogenous variables. We have defined four ratio parameters; P_1, P_2, P_8, b_1, in terms of which the multipliers are written. These ratio parameters, being determined by the exogenous variables, transmit variations in the exogenous variables to the multiplier coefficients.

The first purpose of this chapter is to derive the comparative static properties implied by the model, in terms of precisely defined elasticity expressions. The assumptions of the model are used to allocate a priori sign patterns to these expressions, and the hypotheses resulting in consequence, are subjected to empirical investigation in Chapter 4.

The second purpose of this chapter is to clarify the economic significance of the formal elasticity expressions by elaborating the underlying economic processes which are characterised by the behaviour of economic agents in financial markets. It is necessary to emphasise that the money supply model for South Africa constitutes a static simultaneous system so that our exposition of the underlying processes contains no time ordering of causal events. To incorporate time dimensions. would require hypotheses involving lagged adjustment processes. Since the discussion is complex, proofs of the propositions asserted in the text are relegated to the appendices and textual cross-references are provided for convenience.

In Sections 2.1 and 2.2, we analyse the response of the banking sector's aggregate reserve ratio (b_1) to changes in policy determined statutory reserve requirements and to changes in the allocation of private sector wealth between demand and time deposits. The aggregate reserve ratio exerts its influence on the money supply and credit market rate through the money and credit market multipliers. In Section 2.3, an hypothesis is formulated; that, due to the development of the South African money market, excess reserves may be assumed constant, so that variations in b_1 are dominated by variations in the statutory reserve ratio (b_{11}).

The explicit solution function for the credit market rate is derived in Section 3 and the elasticity expressions describing the responses of the credit market rate to changes in the exogenous variables are obtained from the solution function. In general, the transmission mechanism linking the credit market rate to the exogenous variables is comprised of variations in the credit market multiplier and the supply of earning assets to the banking sector (function h).

In Section 4, the explicit solution function for the equilibrium money stock is formally derived followed by an explanation of the money supply response to changes in the exogenous variables. The interest rate elasticities, obtained in Section 3, are used to assess the pattern of money supply responses to changes in exogenous variables (where variations in the money and credit market multipliers transmit changes in the exogenous variables to the money stock).

Having constructed a theoretical framework for analysing the relationship between the adjusted monetary base and the Government's budget deficit in Section 6 of Chapter 2, Section 5 of this chapter, deals with the implications for monetary policy of an interest rate stabilization scheme, and Section 6 examines the relative impact of open market operations, changes in the adjusted monetary base and changes in the method of Government deficit finance, on the credit market rate.

Concluding each section is a summary of the hypotheses deduced, and the chapter terminates with an overall summary and conclusion.

2. ANALYSIS OF THE BANKING SECTOR RESERVES EQUATION

The money multiplier (m) and credit market multiplier (a) transmit changes in the aggregate reserve ratio (b_1) to the money stock and credit market rate through variations in the statutory and excess reserve ratios (b_{11}, e, resp.). The precise nature of this transmission mechanism is elaborated below. In Section 2.1, we discuss the responses of the statutory reserve ratio (b_{11}) to changes in statutory reserve requirements and to exogenous changes in the ratio of demand to total deposits. The distribution of deposits between demand and time deposits depends on the portfolio allocation behaviour of the private sector, and consequently, the statutory reserve ratio varies with changes in interest rates, real wealth, thé price level and income distribution. Section 2.2 deals with these relationships.

Finally, in Section 2.3, we postulate that variations in the total reserve ratio (b_1) are likely to be dominated by variations in the statutory reserve ratio (b_{11}) since the excess reserve ratio (e) is expected to have a small variation relative to that of b_{11}, due to institutional developments in the financial system.

2.1 <u>Responses of the Statutory Reserve Ratio to Changes in Statutory Reserve Requirements and to Changes in Private Sector Holdings of Demand and Time Deposits</u>

The statutory reserves equation was defined in Chapter 2 (Equation 2-17) as:

$$b_{11} = r^{d'}\gamma + r^{t'}(1 - \gamma)$$
$$= r^{d'}\gamma + r^{t'} - r^{t'}\gamma$$

Differentiating with respect to $r^{d'}$ and $r^{t'}$ we obtain the responses of the statutory reserve ratio to changes in statutory reserve requirements on demand and time deposits.[1]

$$\frac{\partial b_{11}}{\partial r^{d'}} = \gamma = \frac{D}{D+T} > 0 \qquad (3\text{-}1)$$

$$\frac{\partial b_{11}}{\partial r^{t'}} = 1 - \gamma = \frac{T}{D+T} > 0 \qquad (3\text{-}2)$$

The statutory reserve ratio rises with an increase in the reserve requirements on demand and time deposits, proportionately to the distribution of total banking sector deposits between demand and time deposits respectively.

Differentiating b_{11} with respect to γ and $1 - \gamma$ yields:

$$\frac{\partial b_{11}}{\partial \gamma} = r^{d'} - r^{t'} > 0 \quad \text{if } r^{d'} > r^{t'} \qquad (3\text{-}3)$$

$$\frac{\partial b_{11}}{\partial (1-\gamma)} = -(r^{d'} - r^{t'}) < 0 \quad \text{if } r^{d'} > r^{t'} \qquad (3\text{-}4)$$

where $\gamma = D/D + T$ and $1 - \gamma = T/D + T$.[2]

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1. See Appendix A.6.1 and A.6.4.

2. Appendix 6.2 provides the derivations of Equations 3-3 and 3-4, together with further derivations with respect to the savings deposit ratio (δ) the fixed deposit ratio ($1-\delta$) the short-term fixed deposit ratio (α) and the medium plus long-term fixed deposit ratio ($1-\alpha$), where time deposits are defined as the sum of savings and fixed deposits, and the latter is defined as the sum of fixed short-term, medium-term, and long-term deposits. In conformity with the remaining analysis in this chapter, equivalent elasticity expressions are derived in Appendix A.6.4.

Dividing the numerator and denominator of γ by D, we obtain $\gamma = \frac{1}{1 + T/D}$. γ may rise either due to an exogenous increase in D (T is constant and therefore D + T rises), or due to a redistribution of deposits in favour of demand deposits (T falls and D + T remains constant). In either case, the statutory reserve ratio (b_{11}) rises, if the cash reserve requirement on demand deposits is greater than on time deposits ($r^{d'} > r^{t'}$).

However, the response of γ to a change in the quantity of demand deposits held, differs, depending on whether T is varied or held constant. Differentiating γ with respect to D holding T constant, yields Equation 3-5, and with respect to D holding D + T constant, yields Equation 3-6.

$$\frac{\partial\gamma}{\partial D} = \frac{T}{(D+T)^2} = (1 - \gamma)\ \frac{1}{D+T} > 0 \qquad (3\text{-}5)$$

$$\frac{\partial\gamma}{\partial D} = \frac{1}{D+T} > 0 \qquad (3\text{-}6)$$

where:

$$\frac{1}{D+T} > (1 - \gamma)\ \frac{1}{D+T}$$

A reallocation of deposits between demand and time deposits (for a given level of total deposits) raises γ by more than an exogenous increase in demand deposits which also raises the level of total deposits. This result holds equally for the effect of an increase in demand deposits on the statutory reserve ratio parameter (b_{11}). Using Equations 3-3, 3-5 and 3-6, we obtain the response of b_{11} to a change in D, holding T constant (Equation

3-7) and allowing T to vary (Equation 3-8).[3]

$$\frac{\partial b_{11}}{\partial D} = (r^{d'} - r^{t'})(1 - \gamma) \frac{1}{D+T} > 0 \qquad (3\text{-}7)$$

if $r^{d'} > r^{t}$

$$\frac{\partial b_{11}}{\partial D} = (r^{d'} - r^{t'}) \frac{1}{D+T} > 0 \qquad (3\text{-}8)$$

if $r^{d'} > r^{t'}$

where:

$$(r^{d'} - r^{t'}) \frac{1}{D+T} > (r^{d'} - r^{t'}) (1 - \gamma) \frac{1}{D+T}$$

To summarise: firstly, the statutory reserve ratio varies positively with changes in reserve requirements on demand and time deposits in proportion to the private sector's desired ratio of demand and time deposits; secondly, the statutory reserve ratio varies positively with changes in the ratio of demand to total deposits if the statutory reserve requirement on demand deposits is greater than on time deposits. This ensures that $|r^{d'}\gamma| > |r^{t'}\gamma|$ where $b_{11} = r^{d'}\gamma + r^{t'} - r^{t'}\gamma$.[4]

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3. See Appendix A.6.3 for derivations. Equivalent expressions are derived for $\partial\gamma/\partial T$.

4. Appendix A.6.3 provides equivalent expressions for a redistribution of time deposits between demand, savings and fixed deposits, holding time deposits constant, where time deposits equal the sum of fixed and savings deposits. The response of b_{11} depends on the empirical relation between statutory reserve requirements on demand, savings and fixed deposits.

2.2 Responses of the Statutory Rèserve Ratio to Changes in Exogenous Variables

As a consequence of a differential reserve requirement on demand and time deposits in the banking sector, the distribution of private sector wealth between these two categories of deposits will influence the banking sector's statutory reserve. Since private sector portfolio allocation depends on the credit market rate and exogenous variables of the model, we assess below, the responses of the statutory reserve ratio to changes in these variables.

From the statutory reserves equation in Section 2.1 above, the responses of b_{11} to changes in exogenous variables and the credit market rate depend on the product of two elasticities; the elasticity of b_{11} with respect to γ and the elasticity of γ with respect to interest rates and the exogenous variables.

$$e(b_{11},x) = e(b_{11}, \gamma)\ e(\gamma , x) \qquad (3\text{-}9)$$

for

$$x = i_e, i_o, W/P_w, P, YDIS \qquad (3\text{-}10)$$

Having dealt with the first product term in Section 2.1 above, we turn to the second term by writing the statutory reserve ratio (b_{11}) in terms of the ratio of demand to total deposits (see Chapter 2, Equations 2-9 to 2-11, 2-17).

$$b_{11} = r^{d'} \gamma\ (i....) + r^{t'} - r^{t'}\ \gamma\ (i...) \qquad (3\text{-}10a)$$

where,

$$\gamma = \gamma(i, W/P_w, P, YDIS, \pi) \qquad (3\text{-}10b)$$

$$\gamma_j < 0 \text{ for } j = i, W/P_w, P, YDIS$$

i = vector of interest rates containing the time deposit rate (i_t), the credit market rate (i_e) and the rate on non banking sector earning assets (i_o). All other variables are as previously defined.

The sign pattern on Equation 3-10b is inferred from the private sector's time deposit ratio function (P_2) [Chapter 2, Equation 2-26], where changes in wealth, the price level and income distribution are postulated to have a positive effect on P_2. This implies that time deposits are more responsive than demand deposits to changes in these variables. Since $\gamma = \frac{D}{D+T}$, γ responds negatively to these same variables. From Chapter 2, Section 4.5, the P_2 ratio was shown to respond positively to the credit market rate (Equation 2-29) and to the rate on non banking sector earning assets (Equation 2-30), mutatis mutandis, giving γ a negative response to these rates. Finally a positive response of P_2 to the interest rate on time deposits implies a negative response of γ. The elasticities of b_{11} with respect to its various arguments, are given in Table 3.I, and are derived in Appendices A.6.4 and A.6.5. The signs in the table are evident from Expression 3-9 above. Since $e(b_{11}, \gamma) > 0$ and $e(\gamma, x) < 0$, we conclude that an increase in the reserve requirements on demand and time deposits raises b_{11}, depending on the relative values of D and T. An increase in wealth, the price level and interest rates will raise D and lower γ. Similarly, a redistribution of income in favour of a high income

TABLE 3.I

THE ELASTICITIES OF THE STATUTORY RESERVE RATIO

1.	$e(b_{11},i_e) = \frac{(r^{d'} - r^{t'})D}{r^{d'}D + r^{t'}T}\, e(\gamma,i_e)$		< 0
2.	$e(b_{11},i_o) = \frac{(r^{d'} - r^{t'})D}{r^{d'}D + r^{t'}T}\, e(\gamma,i_o)$		< 0
3.	$e(b_{11},W/P_w) = \frac{(r^{d'} - r^{t'})D}{r^{d'}D + r^{t'}T}\, e(\gamma,W/P_w)$		< 0
4.	$e(b_{11},P) = \frac{(r^{d'} - r^{t'})D}{r^{d'}D + r^{t'}T}\, e(\gamma,P)$		< 0
5.	$e(b_{11},YDIS) = \frac{(r^{d'} - r^{t'})D}{r^{d'}D + r^{t'}T}\, e(\gamma,YDIS)$		< 0
6.	$e(b_{11},r^{d'}) = \frac{r^{d'}D}{r^{d'}D + r^{t'}T}$		> 0
7.	$e(b_{11},r^{t'}) = \frac{r^{t'}T}{r^{d'}D + r^{t'}T}$		> 0

NOTES: Derivations are provided in Appendices A.6.4 and A.6.5. The ratio parameter b_1 may be substituted for b_{11} in the above expressions to obtain elasticity expressions for the aggregate reserve ratio (see note to Appendix A.6).

group who economise on cash balances as income rises, raises the P_2 ratio, causing a decline in γ.

2.3 The Excess Reserves Hypothesis

In Chapter 2 (Equation 2-8), the excess reserve ratio depends upon the credit market rate index (i_e), and a shift variable (π_1^b) which measures the growth of highly liquid financial assets in the money market. We postulate in the argument below, that the initiation of a money market induces the banking sector to lower its optimum excess reserve ratio and that the existence of the money market enables the banking sector to maintain a relatively stable excess reserve ratio in the face of cyclical fluctuations in income and international reserves. In consequence, we conclude that it is the statutory reserve ratio (b_{11}) that dominates variations in the aggregate reserve ratio (b_1), and that the excess reserve ratio (e), for the purpose of our study, may be assumed constant.

The theoretical analysis of excess reserves in America, stresses the dependence of excess reserves on interest rates. Moreover, money supply theory is formulated in terms of free reserves defined as excess minus borrowed reserves.[5] No such concept is used in the money supply model for South Africa, since banking sector borrowing from the Reserve Bank, forms part of the aggregate Reserve Bank lending ratio (P_8) (see Chapter 2, Section 2 and n.3; and Section 5.2.7).

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[5] Cf. Brunner-Meltzer [15], [17] and [18]; and Meigs [76].

We postulate, following Brunner-Meltzer, that the transactions demand for excess reserves is stably related to the institutional payments habits of bank customers which change slowly over time.[6] These authors indicate further that changes in income exert no influence on excess reserves with the existence of banking sector earning assets which have very low transactions and information costs.[7]

Now the initiation of a money market in South Africa in the immediate post war period, and its subsequent growth, is expected to lower the banking sector's optimum excess reserve ratio and to dampen variations in response to changes in income and international reserves.

Low transactions costs enable the banking sector to absorb fluctuations in income and international reserves by varying their money market earning assets. In this way, the money market performs its function of allocating otherwise idle resources to productive uses and money market earning assets replace excess cash reserves as the banking sector's first line of defence following a cash reserve drain or inflow.[8,9]

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6. Brunner and Meltzer point out that the demand for vault cash may be related to specific costs and yields which depend on a comparatively stable institutional environment and bear a tenuous relationship to interest rates([15], pp.249-50).

7. Brunner-Meltzer [17], pp.159-60.

8. The South African Monetary Authorities gave tacit recognition to the substitution of money market claims for excess reserves by: (a) temporarily lowering the legal minimum on cash reserves to permit banks to hold money market claims (deposits of the National Finance Corporation) in 1949 and (b) entitling banks to hold supplementary statutory reserves in the form of certain approved liquid assets (which included money market call deposits) as per the 1956 legislative amendment (M.L. Truu [96], p.123).

9. Brunner and Crouch, accept a similar hypothesis for Britain, given the supply of call deposits from the London Discount market to the London Clearing Banks ([14], p.82 and [27], p.144).

On the basis of these arguments, it appears justifiable to treat the transactions demand for excess reserves as exogenous and to assume that the speculative demand is small and stable. This facilitates a convenient analytical simplification in our comparative static analysis, whereby the statutory reserve ratio (b_{11}) constitutes the major source of variation in the aggregate reserve ratio (b_1). Empirical evidence is provided in Chapter 4 to support the view that this analytical formulation is appropriate for South Africa.

2.4 Summary and Conclusions

The statutory reserve ratio (b_{11}) influences the money stock and credit market rate through the money and credit market multipliers. The determinants of b_{11} are the differential statutory reserve requirements on demand and time deposits and the quantity of demand and time deposits held by the private sector. The latter are determined in turn by interest rates, real wealth, the price level and income distribution.

Changes in statutory reserve requirements influence b_{11} in direct proportion to the ratio of demand to total banking sector deposits. Variations in the ratio of demand to total deposits, ceterisparibus, influence b_{11} positively, and by a greater amount, if time deposits vary inversely with demand deposits by an equal absolute amount.

The statutory reserve ratio varies inversely with interest rates, real wealth, the price level and income distribution.

Due to the development of the South African money market, excess reserves are assumed constant and variations in b_{11} dominate variations in the banking sector's aggregate reserve ratio (b_1).

3. SOLUTION FUNCTION FOR THE BANK CREDIT MARKET RATE (i_e) AND THE RESPONSES OF THE CREDIT MARKET MULTIPLIER (a) AND THE CREDIT MARKET RATE TO CHANGES IN THE EXOGENOUS VARIABLES

In this section, we derive the solution function for the credit market rate (i_e) and associated responses to changes in the monetary base, statutory reserve requirements and other exogenous variables. These responses will then be used in Section 4, to assess the influence of the exogenous variables on the equilibrium money stock. In this way, we are able to dissect the determinants of the money stock into two categories, viz., those influences that operate directly through the money multiplier (m), and those that influence the money stock through the working of the interest rate mechanism, via the credit market.

We commence by rewriting the general form of the credit market equilibrium condition (Chapter2, Section 7).[10]

$$h(i, W/P_w, P, F^o) = a(i, r^{d'}, r^{t'}, i_{br}, W/P_w, P, \text{YDIS})B^a \qquad (3\text{-}11)$$

Assuming that the elasticities of the credit market multiplier (a) with respect to its various arguments can be approximated by constants and that function h is linear in logarithmic form, then solving for log i_e from the logarithmic form of Equation 3-11, yields the solution for the credit market rate in terms of the log of the exogenous variables and

[10]. The left-hand side is the equation for the private sector's supply of earning assets to the banking sector and the right-hand side is the demand for earning assets by the banking sector. The arguments of these functions are as defined in Chap. 2.

associated elasticities:[11]

$$\log i_e = e(i_e, x)\log x + e(i_e, B^a)\log B^a \qquad (3\text{-}12)$$

where $e(i_e, x)$ is the elasticity of the credit market rate (i_e) with respect to x; x being a vector containing the arguments of the functions in Equation 3-11.

The expanded version of Equation 3-12 is derived in Appendix A.9.1 (Equation A.9.1-4). From this derivation, the appropriate elasticities of the credit market rate with respect to the exogenous variables are obtained by suitable differentiation (see Appendix A.9.2, Equations A.9.2-1 to A.9.2-7). These elasticities are given in Table 3.II of the text and summarise the role of the credit market multiplier (a) in determining the credit market rate. We discuss their characteristics as follows.

The denominator of each elasticity in Table 3.II contains the expression $e(a, i_e) - e(h, i_e)$, which is the difference between the interest elasticity of the credit market multiplier (a) and the private sector's earning asset supply function (h). The first term is defined as:[12]

$$e(a, i_e) = e(a, P_2)\, e(P_2, i_e) + e(a, P_8)\, e(P_8, i_e) + e(a, b_1)\, e(b_1 \gamma)\, e(\gamma, i_e) > 0 \qquad (3\text{-}13)$$

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11. See K.Brunner [18], p.33.

12. Some doubt exists about the relevance of interest rates in determining the demand for currency. Hence, P_1 is excluded from Equation 3-13. See Chap.2, Sec.4-4, and esp. n.39.

Inspection of Equation 3-13 reveals the dependence of $e(a, i_e)$ on a combination of interest elasticities. The elasticities of multiplier a with respect to the ratio parameters P_2, P_8, b_1 are explicit expressions, derived in Appendix A.7.1 with appropriate signs, and listed in Table 3.III of the text. $e(b_1, \gamma)$ is also an explicit expression with a determinate sign, derived in Appendix A.6.4. The remaining terms of Equation 3-13 are the interest elasticities of the portfolio allocation ratios of the model. In Appendix A.9.2 (Equations A.9.2-15, A.9.2-16) we demonstrate that the interest elasticity of the credit market multiplier is positive if the currency ratio (P_1) is greater than the P_8 ratio and if the statutory reserve requirement on demand deposits is greater than on time deposits ($r^{d'} > r^{t'}$). $e(h, i_e)$ is the interest elasticity of supply of earning assets to the banking sector by the private sector and is negative a priori. Thus, the denominators of each expression in Table 3.II are positive (if the empirical conditions are satisfied that $P_1 > P_8$ and $r^{d'} > r^{t'}$), and formally summarise the behaviour of the banking and private sectors in the bank credit market.

The numerators reflect the direct responses of multiplier a to changes in exogenous variables, modified by a similar response pattern for the h function. A change in exogenous variables exerts a direct influence (through the numerators) on multiplier a, through variations in the portfolio allocation ratios, and on function h. These initial variations in the behaviour parameters, induce a change in credit market rates, which in turn, cause a secondary or indirect variation in the behaviour parameters, the credit market multiplier and the h function, thereby modifying the initial direct effect. The denominators reflect this pattern of secondary responses. The net effect of changes in exogenous variables on the credit market rate is a combination of the direct and secondary influences, formalised by the elasticity expressions in Table 3.II.

In order to obtain information on the sign patterns of the interest rate elasticities, we begin by observing in Table 3.II, that the elasticity of the credit market rate with respect to the adjusted monetary base is negative. A change in the base disturbs the balance sheet equilibria of the banking and private sectors, and the ensuing portfolio adjustments change the credit market rate, and hence, multiplier a and the h function. Inserting the expression for $e(i_e, B^a)$ into the remaining elasticities, we obtain in Table 3.IV, a set of interest elasticities in terms of the adjusted monetary base, multiplier a and function h.[13]

Four unambiguous sign patterns are derived for the policy variables; the adjusted monetary base, statutory reserve requirements on demand and time deposits, and Bank Rate (Table 3.IV, Equations 1-4). The interest rate effects of changes in reserve requirements and Bank Rate are positive, since $e(a,i_e) - e(h,i_e)$ is positive, and the second multiplicative term is unambiguously positive.[14] An increase in statutory reserve requirements

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13. Appendix A.7.2 provides detailed derivations (see Equations A.9.2-8 to A.9.2-14), together with the sign patterns and inequality conditions. A convenient summary is provided at the end of the appendix.

14. $e(a,i_{br}) = e(a,P_8)e(P_8,i_{br}) < 0$, since $e(a,P_8) > 0$ and $e(P_8,i_{br}) < 0$ *a priori* (see Appendix A.7.2, Equation A.7.2-2). Expressions for the statutory reserve requirement elasticities are; $e(a,r^{d'}) = e(a,b_1)e(b_1,r^{d'})$ and $e(a,r^{t'}) = e(a,b_1)e(b_1,r^{t'})$. The terms on the right-hand side of these expressions are defined explicitly in Tables 3.I and 3.III of the text and are derived in Appendices A.7.1 and A.6.4.

on demand or time deposits will raise the credit market rate by an amount dependent upon the relative demands of the private sector for time and demand deposits, where $e(a, r^{d'})$, $e(a, r^{t'})$ are negative -- (see Table 3.III, Equations 5 and 6). Similarly, an increase in Bank Rate has a positive influence on the credit market rate depending on the negative responsiveness of multiplier a to changes in Bank Rate, which makes the numerator of Equation 4 in Table 3.II, negative. However, the interest rate response to changes in reserve requirements is less in absolute value, than the response of the credit market rate to changes in the adjusted monetary base.

This result emerges as follows. As we mentioned above, the numerators reflect the direct or impact effect of a change in policy variables. In the case of the adjusted monetary base, the numerator is unity, and is less than unity for the reserve requirement elasticities.[15]

The direct or impact effect of changes in the adjusted monetary base is greater than for changes in statutory reserve requirements, while the secondary effect, working through the denominators is the same. Intuitively, this result is appealing. Assume that the Reserve Bank raises the adjusted monetary base by an open market purchase of government securities. The outstanding stock of interest-bearing government debt is reduced and the supply of non interest-bearing claims on the Government is increased, which raises the relative price of interest bearing government debt and interest rates fall. There is no such initial fall of interest rates when reserve

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15. See Expressions 5 and 6 in Table 3.III of text. In Chap. 4, we evaluate the reserve requirement elasticity expressions and confirm their signs.

requirements are lowered. Excess reserves are created in the banking sector without an accompanying decline in interest rates; whereas an increase in the base creates excess reserves in the banking sector with an accompanying fall in interest rates. Hence, changes in the base exert a greater influence on the credit market rate than do changes in reserve requirements. Similar conclusions hold for changes in Bank Rate, if $e(a, i_{br})$ is less than unity (cf. Equations 1,4 in Table 3.II).

Following similar lines of reasoning, the credit market rate responds positively to changes in the stock of outstanding government debt (F^o) net of the Reserve Bank's portfolio. By hypothesis, the direct response of function h to changes in F^o is positive, modified by the secondary interest rate effects in the denominator of the elasticity expression.

The influences of real wealth (W/P_w), the price level (P) and income distribution (YDIS) on the credit market rate exhibit the same causal patterns (see Table 3.II).

In the absence of private sector debt responses, an increase in real wealth exerts a downward pressure on interest rates through a reallocation of asset portfolios away from currency and in favour of time and demand deposits. As hypothesised, the currency ratio falls and the time deposit ratio rises, both causing an increase in multiplier a.[16] The consequent decline in interest rates causes a secondary adjustment of portfolios with a further change in multiplier a. However, the net effect on the credit market rate will be modified by the private sector's supply of earning

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16. From Table 3.III, $e(a, P_1)$ is negative and $e(a, P_2)$ is positive, hence, $e(a, W/P_w)$ is positive. See Equation A.7.2-3 in Appendix A.7.2.

assets to the banking sector (the h'function), which responds positively to changes in real wealth and negatively to changes in credit market rates.[17] The increase in real wealth not only raises the demand for financial assets, but also the demand for increased indebtedness, which raises the private sector's supply of earning assets to the banking sector and exerts an upward pressure on interest rates, thereby, modifying the downward pressure exerted by the initial portfolio reallocation. From Tables 3.II and 3.IV, the influence of real wealth on the credit market rate is positive, if the debt effect (function h) exceeds the portfolio reallocation effect (multiplier a), i.e. $e(h,W/P_w) > e(a,W/P_w)$. Analogous considerations apply to the price level.

A redistribution of income in favour of wage earners, affects the credit market rate by inducing an initial decline in demand and time deposits, and an increase in the demand for currency. A currency drain from the banking sector exerts an upward pressure on interest rates, reflected by an increase in the credit market multiplier and a decline in the private sector's earning asset supply function (h). The combined change in P_1, P_2, b_1 portfolio allocation ratios, generates an initial negative change in multiplier a in the numerator, if the response of the P_1 ratio to changes in income distribution dominates movements in multiplier a. If

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17. See Table 3.II, Equation 6. $e(i_e, W/P_w)$ is a combination of the direct and secondary influences on the credit market multiplier and function h.

so, income distribution exerts a positive influence on the credit market rate (Equation 8, Table 3.IV).[18]

We turn finally, to the relationship between the interest rate on non banking sector earning assets (i_o) and the credit market rate (i_e). As discussed in Chapter 2, Section 4.5, the time deposit ratio is, mutatis mutandis, positively related to i_o, so that $e(a, i_o)$ is positive.[19] As before, changes in i_o will induce primary and secondary reactions in multiplier a and the earning asset supply function h -- (Table 3.II, Expression 5). Although $e(a, i_o)$ is positive (Appendix A.7.2, Equation A.7.2-1), the elasticity of the credit market rate with respect to i_o is not determined unambiguously. The latter elasticity is positive only if the response of the h function exceeds the response of multiplier a, to changes in i_o. The debt effect must outweigh the portfolio reallocation effect of a change in i_o (see Equation 5 in Tables 3.II and 3.IV).

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18. From Appendix A.7.2, Equation A.7.2-3, $e(a,YDIS) = e(a,P_1)e(P_1,YDIS) + e(a,P_2)\,e(P_2,YDIS) + e(a,b_1)e(b_1,YDIS)$. The first product term is negative and the remaining terms are positive. Hence $e(a,YDIS) < 0$ if $|e(a,P_1)e(P_1,YDIS)| > |e(a,P_2)e(P_2,YDIS) + e(a,b_1)e(b_1,YDIS)|$, in which case, $e(i_e,YDIS) > 0$.

19. In Chap. 2, Equation 2-30, it was pointed out that this conclusion rests on the assumption that the direct elasticity of P_2 with respect to the time deposit rate, is greater than the cross elasticity of P_2 with respect to i_o in absolute value, i.e. $|e(P_2,i_t)e(i_t,i_o)|>|e(P_2,i_o)|$. If $e(P_2,i_o)$ is positive, then $e(a,i_o)$ is positive (see Equation A.7.2-1 in Appendix A.7.2).

TABLE 3.II

THE ELASTICITIES OF THE CREDIT MARKET RATE INDEX
WITH RESPECT TO THE EXOGENOUS VARIABLES

1.	$e(i_e,B^a) = -\dfrac{1}{e(a,i_e) - e(h,i_e)}$		< 0
2.	$e(i_e,r^{d'}) = -\dfrac{e(a,r^{d'})}{e(a,i_e) - e(h,i_e)}$		> 0
3.	$e(i_e,r^{t'}) = -\dfrac{e(a,r^{t'})}{e(a,i_e) - e(h,i_e)}$		> 0
4.	$e(i_e,i_{br}) = -\dfrac{e(a,i_{br})}{e(a,i_e) - e(h,i_e)}$		> 0
5.	$e(i_e,i_o) = \dfrac{e(h,i_o) - e(a,i_o)}{e(a,i_e) - e(h,i_e)}$		> 0
6.	$e(i_e,W/P_w) = \dfrac{e(h,W/P_w) - e(a,W/P_w)}{e(a,i_e) - e(h,i_e)}$		> 0
7.	$e(i_e,P) = \dfrac{e(h,P) - e(a,P)}{e(a,i_e) - e(h,i_e)}$		> 0
8.	$e(i_e,YDIS) = -\dfrac{e(a,YDIS)}{e(a,i_e) - e(h,i_e)}$		> 0
9.	$e(i_e,F^o) = \dfrac{e(h,F^o)}{e(a,i_e) - e(h,i_e)}$		> 0

NOTES: Derivations are provided in Appendix A.9.2.

TABLE 3.III

THE ELASTICITIES OF THE CREDIT MARKET MULTIPLIER WITH RESPECT TO THE RATIO PARAMETERS AND THE EXOGENOUS VARIABLES

1. $e(a,P_1) = -\frac{P_1}{\Delta_2}$ < 0

2. $e(a,P_2) = \frac{(P_1 - P_8)P_2}{\Delta_2(1 + P_2)}$ > 0

3. $e(a,P_8) = \frac{P_8}{\Delta_2}$ > 0

4. $e(a,b_1) = -\frac{(1 + P_1 + P_2 - P_8)b_1}{\Delta_2(1 - b_1)}$ < 0

5. $e(a,r^{d'}) = -\frac{(1 + P_1 + P_2 - P_8)r^{d'}D}{\Delta_2(1 - b_1)(D + T)}$ < 0

6. $e(a,r^{t'}) = -\frac{(1 + P_1 + P_2 - P_8)r^{t'}T}{\Delta_2(1 - b_1)(D + T)}$ < 0

7. $e(a,i_{br}) = \frac{P_8}{\Delta_2} e(P_8,i_{br})$ < 0

8. $$e(a,i_o) = \frac{1}{\Delta_2}\left[\frac{(P_1 - P_8)P_2}{1 + P_2} e(P_2,i_o) + P_8 e(P_8,i_o) - \frac{(1 + P_1 + P_2 - P_8)b_1}{1 - b_1} \cdot \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,i_o)\right] > 0$$

9. $$e(a,x) = \frac{1}{\Delta_2}\left[- P_1 e(P_1,x) + \frac{(P_1 - P_8)P_2}{1 + P_2} e(P_2,x) - \frac{(1 + P_1 + P_2 - P_8)b_1}{1 - b_1} \cdot \frac{(r^{d'} - r^{t'})}{\Delta_1} e(\gamma,x)\right] > 0$$

for $x = W/P_w$, P; and for $x = YDIS$ < 0

where: $\Delta_1 = r^{d'}D + r^{t'}T$, $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$

NOTES: Derivations are provided in Appendix A.7.

TABLE 3.IV

THE ELASTICITIES OF THE CREDIT MARKET RATE INDEX
WITH RESPECT TO THE EXOGENOUS VARIABLES
IN TERMS OF THE ADJUSTED MONETARY BASE

1.	$e(i_e,B^a)$	$= -\dfrac{1}{e(a,i_e) - e(h,i_e)}$	< 0
2.	$e(i_e,r^{d'})$	$= e(i_e,B^a)e(a,r^{d'})$	> 0
3.	$e(i_e,r^{t'})$	$= e(i_e,B^a)e(a,r^{t'})$	> 0
4.	$e(i_e,i_{br})$	$= e(i_e,B^a)e(a,i_{br})$	> 0
5.	$e(i_e,i_o)$	$= - e(i_e,B^a)[e(h,i_o) - e(a,i_o)]$	> 0
6.	$e(i_e,W/P_w)$	$= - e(i_e,B^a)[e(h,W/P_w) - e(a,W/P_w)]$	> 0
7.	$e(i_e,P)$	$= - e(i_e,B^a)[e(h,P) - e(a,P)]$	> 0
8.	$e(i_e,YDIS)$	$= e(i_e,B^a)e(a,YDIS)$	> 0
9.	$e(i_e,F^o)$	$= - e(i_e,B^a)e(h,F^o)$	> 0

NOTES: Derivations are provided in Appendix A.9.2.

3.1 Summary and Conclusions

A summary of the major hypotheses concerning the influence of policy and exogenous variables on the credit market rate (i_e) is provided below.

The response of the credit market rate to changes in exogenous variables depends on the initial direct effect, summarised by the numerators of the elasticity expression. This effect embodies a reallocation of financial assets and debt in the balance sheets of economic units, at a given level of interest rates. The demand curves for financial assets and debt shift, creating excess demands or supplies in the credit market. Interest rates change, causing a secondary portfolio reallocation process, reflected in the denominators of the elasticity expressions. In several instances, the net effect on the credit market rate depends upon the relative strength of the asset and debt reallocations in financial balance sheets, during the initial reallocation process. The major interest rate hypotheses are.

1. The credit market multiplier (a) responds positively to changes in the credit market rate (i_e). From Equation 3-13, $e(a, i_e) > 0$.

2. The elasticity of supply of earning assets to the banking sector by the private sector (function h), with respect to the credit market rate, is negative by hypothesis. The difference between the interest elasticity of multiplier a and function h constitutes the common denominator for all elasticity expressions in Table 3.II. The denominator is positive and represents the secondary interest rate effect of a change in exogenous variables.

3. Changes in the adjusted monetary base cause an inverse change in the credit market rate.

4. An increase in the statutory reserve requirement on demand and time deposits, and in Bank Rate, causes an increase in the credit market rate.

5. The credit market rate responds less to changes in statutory reserve requirements than to changes in the adjusted monetary base. This conclusion applies also to changes in Bank Rate, if the response of the credit market multiplier to Bank Rate changes, is less than unity.

6. The response of the credit market rate to changes in the stock of outstanding government debt (net of Reserve Bank holdings), is positive.

7. Changes in the credit market rate are positively related to changes in real wealth and the price level provided that the wealth and price elasticities of the h function exceeds that of multiplier a.

8. Income distribution affects the credit market rate positively if the credit market multiplier is dominated by an associated change in the behaviour ratio P_1, i.e. $e(a, YDIS) < 0$.

9. The elasticity of the credit market rate with respect to the interest rate on non banking sector earning assets is positive, only if the interest response of the h function exceeds that of multiplier a.

A complete mathematical derivation of the elasticity expressions in Table 3.II, is provided in Appendix A.9.2, together with a convenient summary. All the signs in Table 3.II depend on the empirical inequalities that the currency ratio (P_1) is greater than the Reserve Bank lending ratio (P_8) and that the statutory reserve requirement on demand deposits is greater than on time deposits ($r^{d'} > r^{t'}$). In addition, $e(i_e, YDIS) > 0$ requires that changes in the credit market multiplier are dominated by variations in P_1, resulting from changes in income distribution. The signs on the elasticities with respect to the interest rate on non banking sector earning assets, real wealth and the price level, require that the response of the h function to changes in these variables (the debt effect) is greater than the associated response of the credit market multiplier (the asset effect), i.e. $e(h, x) > e(a, x)$ for $x = i_o, W/P_w, P$.

In the following section we derive the responses of the money supply with respect to the exogenous variables, making use of the sign patterns on the credit market rate elasticities.

4. SOLUTION FUNCTION FOR THE MONEY STOCK AND THE RESPONSES OF THE MONEY MULTIPLIER (m) AND THE MONEY STOCK TO CHANGES IN THE EXOGENOUS VARIABLES

In this section, we derive the solution function for the equilibrium money stock and the response patterns of the money stock to changes in exogenous variables. These responses are decomposed into three avenues of influence, viz., a direct or impact effect on money multiplier m, an interest rate response, and a secondary or feedback response on m resulting from changes in interest rates. Tables 3.V to 3.VIII in the text, summarise formally these response patterns. Detailed derivations are provided in Appendices A.8 and A.10.

We proceed to derive the money supply solution function and associated elasticities. In Appendix A.5, the semi-reduced form for the money supply is derived in terms of money multiplier (m) and the adjusted monetary base (B^a), where m is defined as a non linear combination of the four portfolio allocation ratios, P_1, P_2, P_8, b_1. Thus, rewriting these equations:

$$M_2 = mB^a \qquad (3\text{-}14)$$

where

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_8} \qquad (3\text{-}15)$$

Since m depends upon the arguments of its constituent ratio parameters, its general form is given by:

$$m = m\,(i,\ r^{d'},\ r^{t'},\ i_{br},\ W/P_w,\ P,\ YDIS) \quad (3\text{-}16)$$

where the variables in Equation 3-16 are as defined previously.[20] The logarithmic forms of Equation 3-14 and 3-16 are, respectively:

$$\log M_2 = \log m + \log B^a \qquad (3\text{-}17)$$

$$\log m = e(m, i_e) \log i_e + \Sigma\, e(m, y) \log y \qquad (3\text{-}18)$$

where y is a vector containing the arguments of Equation 3-16 excluding the credit market rate index (i_e).

Substituting for log i_e from the credit market rate solution function (Equation 3-12), the solution function for the equilibrium money stock is:

$$\begin{aligned} \log M_2 &= e(m, i_e)\ [\ \Sigma\, e(i_e,x) \log x + e(i_e,B^a) \log B^a] + \\ &\quad \Sigma\ \ e(m, y) \log y + \log B^a \\ &= e(m, i_e)\ \Sigma\, e(i_e,x) \log x + \Sigma\, e(m, y) \log y + \\ &\quad [1 + e(m, i_e)\ e(i_e, B^a)] \log B^a \end{aligned} \qquad (3\text{-}19)$$

The fully expanded function is given in Appendix A.10.1. Differentiation of this function yields elasticity expressions for the money stock with respect to each exogenous variable. These elasticities are listed in Table 3.V of the text where it is seen that the money supply responses depend upon the direct response of the money multiplier (m) to changes in the credit market rate (i_e), direct and secondary responses of the credit market multiplier (a) with respect to the same variables, and the responses of the earning asset supply function (h).

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20. i = vector of interest rates containing the credit market rate index (i_e), the time deposit rate (i_t) and the rate on non banking sector earning assets (i_o).

Since the credit market elasticities have been fully analysed in Section 3, Table 3.VI presents a more general statement of the expressions in Table 3.V.[21] In Table 3.V, all the money supply elasticities are defined as a configuration of the responses of the money and credit market multipliers and the earning asset supply function (h), while in Table 3.VI, the money supply elasticities are reformulated in terms of three response patterns; the response of m to changes in the credit market rate, $e(m, i_e)$, the response of the credit market rate to changes in exogenous variables, $e(i_e, x)$ [where x is a vector containing the exogenous variables], and the response of m to changes in the exogenous variables, $e(\bar{m}, \bar{x})$. The purpose of this reformulation is to subsume the interest rate effects of changes in the credit market multiplier and the earning asset supply function in a single, surrogate term, representing the overall effect on the credit market rate of a change in the exogenous variables. From our reformulation, we are able to dichotomise clearly the determinants of the money supply elasticities into two basic channels of influence; the first, working through the money multiplier and the second, working through the credit market. This process is represented by two convenient expressions below, which summarise the elasticities in Table 3.VI, and facilitate some general observations.

$$e(M_2, B^a) = 1 + e(m, i_e)\, e(i_e, B^a) \qquad (3\text{-}20)$$

$$e(m, x) = e(m, i_e)\, e(i_e, x) + e(m, x) \qquad (3\text{-}21)$$

where,

x = vector of exogenous variables in the model.

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21. Table 3.VI is derived by substituting the credit market rate elasticities in Table 3.II into the money supply elasticities in Table 3.V. This procedure is elaborated in Appendix A.10.2.

Equations 3-20 and 3-21, reveal the two-path transmission mechanism linking changes in exogenous variables to changes in the money supply. In Equation 3-20, the first term (unity), expresses the direct or impact effect on the money supply of a change in the adjusted monetary base, while the second term demonstrates the secondary feedback effect on multiplier m through the interest rate mechanism, which serves to modify the direct effect. The same causal pattern is discernible in Equation 3-21, where e(m, x) is the direct effect on m of a change in x, which disturbs portfolio equilibria in balance sheets, resulting in adjustments at the existing set of interest rates. The adjustment process towards a new equilibrium position alters the credit market rate, $e(i_e, x)$, which induces a second round of portfolio adjustment and a further change in m, given by $e(m, i_e)$. The direct effect on m is modified by the feedback response of m due to changes in the credit market rate. In both equations, multiplier m and the rate of interest mechanism constitute the two-path mechanism linking the money stock to the exogenous variables.

Our analysis requires a more detailed explanation of the interest response of multiplier m -- term $e(m, i_e)$, which is common to all the elasticities in Tables 3.V and 3.VI.[22]

Analogous with Equation 3-13, $e(m, i_e)$ is a combination of interest elasticities and portfolio allocation ratios.

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22. In Table 3.V, this term appears in the numerator, the significance of which, is dealt with below.

$$e(m, i_e) = e(m, P_2)\, e(P_2, i_e) + e(m, P_8)\, e(P_8, i_e)$$
$$+ e(m, b_1)\, e(b_1, \gamma)\, e(\gamma, i_e) > 0 \qquad (3\text{-}22)$$

The interest rate response of m depends on the interest rate responses of P_2, P_8, and γ and the consequent response of m to changes in these parameters. Table 3.VII lists the explicit expressions for $e(m, P_2)$, $e(m, P_8)$ and $e(m, b_1)$ - complete derivations and sign patterns are provided in Appendix 8.1. $e(b_1, \gamma)$ is an explicit expression with a determinate sign, derived in Appendix A.6.4. The remaining terms are the interest elasticities of the behaviour equations discussed in Chapter 2, and Chapter 3, Section 2.3. In Appendix A.10.2, Equation A.10.2-17, we demonstrate that the interest elasticity of m is positive if $P_1 > P_8$, $b_1 < 1$ and if the statutory reserve requirement on demand deposit is greater than on time deposit ($r^{d'} > r^{t'}$). As mentioned above, the product $e(m, i_e)\, e(i_e, x)$ formalises the secondary or feedback effect on m due to changes in interest rates.

In order to discern the significance of the interest rate mechanism, we must turn to the more detailed expressions in Table 3.V. Combining $e(m, i_e)$ with the denominators of the expressions in Table 3.V, a new variable K is introduced, defined as the feedback operator and is given by:

$$K = \frac{e(m, i_e)}{e(a, i_e) - e(h, i_e)} \qquad (3\text{-}23)$$

Variable K is composed of a non linear combination of elasticities where the denominator embodies the working of the credit market through multiplier a and function h. The total interest rate effect is determined by the relative magnitudes of the numerator and denominator, a matter to which we now turn.

We have seen that $e(a, i_e) > 0$, and since $e(h, i_e) < 0$ a priori, $[e(a, i_e) - e(h, i_e)] > 0$ (Section 3 of this chapter). Given that $e(m, i_e) > 0$, we are able to derive a constraint for K, by demonstrating that since

$$0 < e(m, i_e) < [e(a, i_e) - e(h, i_e)] \qquad (3\text{-}24)$$

then $0 < K < 1$. Proof of this inequality is provided in Appendix A.12.

Since K is a component of all the money supply elasticities in Table 3.V, the direct effect of changes in exogenous variables will be modified by the interest rate effect by a factor K lying in the interval $0 < K < 1$.

We conclude our general remarks with several observations, which refer specifically to Table 3.V and are implied in Table 3.VI. The expressions in Table 3.V may be summarised by a general expression $e(M_2, x) = Kc + d$ for x = exogenous variables; where c is the second multiplicative term in the numerators, reflecting the direct effect of changes in exogenous variables on multiplier a, and function h where applicable, and d is the second additive term reflecting the direct effect on m (see esp. Table 3.IX). Since $0 < K < 1$, the interest rate effect attenuates the direct effect (c), of a change in exogenous variables, in all cases. An increase in K lowers this attenuating effect and vice versa. It should be stressed that the attenuating influence of K is due directly to the positive interest elasticity of multiplier m. If $e(m, i_e)$ tends to zero, changes in exogenous variables are confined to the direct effects (d, defined above) operating through the money multiplier. An increase in $e(m, i_e)$ raises K and lowers its attenuating influence in cases where K enters the elasticity expressions multiplicatively. Similarly, a higher interest rate response of multiplier a, and of function h in absolute value, lowers K and raises its attenuating influence. We turn now to a consideration of the separate expressions in Tables 3.V and 3.VI and commence with the adjusted monetary base.

Since the monetary base is a crucial policy variable in this study, its causal links with the money stock are elaborated on in detail (at the expense of some repetition). This linkage applies with little modification, to the remaining elasticity expressions. Initially, the direct effect of an increase in the adjusted monetary base is to raise the money supply (by increasing deposits in the banking sector, and currency with the public) and to generate excess reserves in the banking sector. Balance sheet equilibria in the banking and private sectors are disturbed due to an increase in portfolio allocation ratios P_1, P_2, and b_1, above their equilibrium values. An excess supply is created in the money market due to a rightward shift of the supply curves. This excess of actual over desired ratios stimulates efforts to restore the initial ratios at the existing set of interest rates by transactions in the credit market, which exert a downward pressure on interest rates, and set in motion a secondary round of portfolio adjustments (movements along the new supply curve). The money and credit market multipliers respond to the fall in the credit market rate.

From Table 3.VI, Equation 1, this mechanism is immediately apparent. Assume that the adjusted monetary base is increased by an open market purchase of government securities. The interest rate falls and economic units alter their equilibrium portfolio allocation ratios. Since $e\ (i_e, B^a) < 0$, and as we have seen $e(m, i_e) > 0$, the product term is negative. The initial increase in the base raises the money supply simultaneously by an equal amount. If the interest rate mechanism were inoperative, or interest rates adjusted slowly (due to low interest elasticities of the structural equations), $e(M_2, B^a)$ would approach unity. The rate of interest mechanism, therefore, attenuates the positive influence of a change in the base on the money supply. In particular, the degree of attenuation is greater the higher is the interest response of multiplier m and the lower is the interest response of multiplier a and the h function (Table 3.V, Equation 1). Since K does not enter Equation 1 of Table 3.V multiplicatively, a higher value of K lowers the efficacy of monetary policy exercised through the adjusted monetary base relative to changes in statutory reserve requirements and Bank Rate (Equations 2-4, Table 3.V). We conclude that $0 < e(M_2, B^a) < 1$. The money supply responds positively to changes in the adjusted monetary base but less than proportionately.

The remaining elasticities in Table 3.V exhibit similar causal sequences. An inflexible interest rate mechanism which lowers K will reduce the magnitude of the first terms. The effects of a change in the exogenous variables will be confined to the direct effect working through multiplier m, where portfolios are adjusted without inducing secondary interest rate responses.

Before discussing the individual elasticities in Table 3.VI (Equations 2 to 9), we refer back to Equation 3-21 of the text, which summarises this table, and recall that the common term $e(m, i_e) > 0$. The term $e(i_e, x)$

has been fully dealt with in Section 3 of this chapter and its components are listed in Tables 3.II and 3.IV. Full derivations are provided in Appendix A.10.2, which also contains a convenient summary. The product $e(m, i_e)\ e(i_e, x)$ represents, as previously, the secondary interest rate effects.

The remaining term in Equation 3-21 is $e(m, x)$ which represents the direct effect on multiplier m of a change in exogenous variables. In general,

$$e(m, x) = e(m, y)\ e(y, x) \tag{3-25}$$

where, y is a vector containing the portfolio allocation ratios P_1, P_2, P_8, b_1 and x is a vector of exogenous variables. $e(m, y)$ consists of a set of explicit expressions, fully derived together with sign patterns and inequality conditions in Appendix A.8.1, and listed in Table 3.VIII. The elasticities of the ratio parameters, with respect to the exogenous variables, $e(y, x)$, take the a priori signs discussed in Chapter 2. The composite expressions for the product $e(m, y)\ e(y, x)$ together with signs and inequality conditions are provided in Appendix A.8.2 and these are listed in Tables 3.VII and 3.VIII. Finally, Appendix A.10.2 contains complete derivations of the expressions in Tables 3.V and 3.VI. The remaining elasticity expressions in Table 3.VI (Equations 2-9) are now clarified below, by reiterating the main elements in the transmission mechanism and synthesising the direct and secondary effects determining the money supply elasticities.

An increase in the statutory reserve requirement on demand and time deposits raises the value of the banking sector's reserve ratio (b_1) and lowers the money multiplier (m), $e(m, b_1) < 0$. This negative relationship is unambiguous and its value depends, inter alia, on the distribution of total banking sector deposits between demand and time deposits (Table 3.VII). Portfolio adjustments in the banking sector raise the credit market rate $[e(i_e, r^{d'}) > 0, e(i_e, r^{t'}) > 0]$ which attenuates the negative direct effect. The money supply response to changes in statutory reserve requirements depends on the relative absolute values of the direct and secondary effects and is, therefore, not unambiguous. The money stock responds negatively to an increase in reserve requirements if the negative direct effect outweighs the positive secondary interest rate effect.

On the basis of these preceding arguments, a formal assessment of the relative efficacy of monetary policy exercised through the adjusted monetary base as opposed to changes in statutory reserve requirements, is now possible. Referring to Table 3.V, Equation 1 is written as:

$$e(M_2, B^a) - 1 = - \frac{e(m, i_e)}{e(a, i_e) - e(h, i_e)} \qquad (3\text{-}26)$$

Substituting into the statutory reserve elasticities, we obtain the general expression:

$$e(M_2, x) = [e(M_2, B^a) - 1]\ e(a, x) + e(m, x) \qquad (3\text{-}27)$$

where $x = r^{d'}, r^{t'}$

Since $0 < e(M_2, B^a) < 1$, the term in square brackets in Equation 3-27 is also less than unity, and since $e(a, x) < 1$, the elasticity of the money supply with respect to the base exceeds the first product term. Provided that $e(m, x)$ is not too large in absolute value, the base will have a larger influence on the money supply than will a change in statutory reserve requirements. This is clearly seen in Table 3.V, Equations 2 and 3, where the term containing multiplier a lowers K so that the final response of the money supply to changes in statutory reserve requirements depends on the absolute value of the additive term.

An increase in Bank Rate lowers multiplier m directly, by lowering the P_8 ratio [$e(m, i_{br}) < 0$ - Table 3.VIII]. The credit market rate rises, inducing a secondary offsetting increase in m [$e(m, i_e)\ e(i_e, i_{br}) > 0$]. The net effect on the money supply is negative if the direct effect is not outweighed by the secondary interest rate effect.

In the case of a change in the stock of net outstanding government debt (F^o), the initial direct effect does not operate on the money multiplier but on the h function, and hence on the credit market rate directly (Tables 3.V and 3.VI, Equation 9). An increase in F^o exerts an upward pressure on credit market rates, which raises m. Hence, the money supply response is unambiguously positive.[23]

An increase in real wealth induces portfolio reallocations involving both the demand for financial assets (the portfolio allocation ratios P_1 and P_2) and the demand for debt (function h). The multiplier m rises [$e(m, W/P_w) > 0$ - Table 3.VIII] as well as the credit market rate [$e(i_e, W/P_w) > 0$]. The influence of real wealth on the credit market rate depends on the condition that $|e(h, W/P_w)| > |e(a, W/P_w)|$ which means

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[23] Cf. Brunner-Meltzer [17], pp.163, 164.

that the asset effect must not outweigh the debt effect, i.e. the increase in interest rates due to an increase in the demand for debt must not be offset by the fall in interest rates due to an increase in the demand for banking sector deposits [see $e(i_e, W/P_w)$ in Appendix A.9.2]. The money supply response to an increase in real wealth is positive if this inequality is satisfied. If this is true, then in Table 3.VI, the interest rate effect reinforces the direct effect $e(m, i_e)\ e(i_e, W/P_w) > 0$ and $e(m, W/P_w) > 0$.

Similar conclusions apply, in general, to increases in the price level and the rate on non banking sector earning assets (i_o). The direct and secondary effects reinforce each other and the money supply response is positive provided that the elasticity of the h function with respect to changes in these exogenous variables is greater than the response of multiplier a (Appendix A.9.2). The effect of changes in the rate on non banking sector earning assets on the P_2 ratio is worthy of mention. As discussed in Chapter 2, Section 4.5 (Equation 2-30), this relation is, mutatis mutandis, positive when we account for the substitutability between banking sector deposits and other financial assets. An increase in i_o also raises the supply of earning assets to the Reserve Bank (P_8) since reserve bank credit becomes relatively cheaper. Multiplier m responds positively to the combined changes in P_2 and P_8, resulting from the direct effect of a change in i_o. It follows that an increase in the price level and the interest rate on non banking sector earning assets, will raise the money supply if the inequality above is satisfied.

TABLE 3.V

THE ELASTICITIES OF THE MONEY SUPPLY WITH RESPECT TO THE EXOGENOUS VARIABLES

1.	$e(M_2,B^a)$	$= 1 - \dfrac{e(m,i_e)}{e(a,i_e) - e(h,i_e)}$		> 0
2.	$e(M_2,r^{d'})$	$= -\dfrac{e(m,i_e)e(a,r^{d'})}{e(a,i_e) - e(h,i_e)}$	$+ e(m,r^{d'})$	< 0
3.	$e(M_2,r^{t'})$	$= -\dfrac{e(m,i_e)e(a,r^{t'})}{e(a,i_e) - e(h,i_e)}$	$+ e(m,r^{t'})$	< 0
4.	$e(M_2,i_{br})$	$= -\dfrac{e(m,i_e)e(a,i_{br})}{e(a,i_e) - e(h,i_e)}$	$+ e(m,i_{br})$	< 0
5.	$e(M_2,i_o)$	$= \dfrac{e(m,i_e)[e(h,i_o) - e(a,i_o)]}{e(a,i_e) - e(h,i_e)}$	$+ e(m,i_o)$	> 0
6.	$e(M_2,W/P_w)$	$= \dfrac{e(m,i_e)[e(h,W/P_w) - e(a,W/P_w)]}{e(a,i_e) - e(h,i_e)}$	$+ e(m,W/P_w)$	> 0
7.	$e(M_2,P)$	$= \dfrac{e(m,i_e)[e(h,P) - e(a,P)]}{e(a,i_e) - e(h,i_e)}$	$+ e(m,P)$	> 0
8.	$e(M_2,YDIS)$	$= -\dfrac{e(m,i_e)e(a,YDIS)}{e(a,i_e) - e(h,i_e)}$	$+ e(m,YDIS)$	> 0
9.	$e(M_2,F^o)$	$= \dfrac{e(m,i_e)e(h,F^o)}{e(a,i_e) - e(h,i_e)}$		> 0

NOTES: Derivations are provided in Appendix A.10.2.

TABLE 3.VI

THE ELASTICITIES OF THE MONEY SUPPLY WITH RESPECT TO THE EXOGENOUS VARIABLES IN TERMS OF THE CREDIT MARKET RATE INDEX ELASTICITIES

1.	$e(M_2,B^a)$	$= 1 + e(m,i_e)e(i_e,B^a)$		> 0
2.	$e(M_2,r^{d'})$	$= e(m,i_e)e(i_e,r^{d'})$	$+ e(m,r^{d'})$	< 0
3.	$e(M_2,r^{t'})$	$= e(m,i_e)e(i_e,r^{t'})$	$+ e(m,r^{t'})$	< 0
4.	$e(M,i_{br})$	$= e(m,i_e)e(i_e,i_{br})$	$+ e(m,i_{br})$	< 0
5.	$e(M_2,i_o)$	$= e(m,i_e)e(i_e,i_o)$	$+ e(m,i_o)$	> 0
6.	$e(M_2,W/P_w)$	$= e(m,i_e)e(i_e,W/P_w)$	$+ e(m,W/P_w)$	> 0
7.	$e(M_2,P)$	$= e(m,i_e)e(i_e,P)$	$+ e(m,P)$	> 0
8.	$e(M_2,YDIS)$	$= e(m,i_e)e(i_e,YDIS)$	$+ e(m,YDIS)$	> 0
9.	$e(M_2,F^o)$	$= e(m,i_e)e(i_e,F^o)$		> 0

NOTES: Derivations are provided in Appendix A.10.2.

TABLE 3.VII

THE ELASTICITIES OF THE MONEY MULTIPLIER
WITH RESPECT TO THE RATIO PARAMETERS
AND STATUTORY RESERVE REQUIREMENTS

1.	$e(m,P_1) = P_1\left(\frac{1}{1 + P_1 + P_2} - \frac{1}{\Delta_2}\right)$	< 0
2.	$e(m,P_2) = P_2\left(\frac{1}{1 + P_1 + P_2} - \frac{b_1}{\Delta_2}\right)$	> 0
3.	$e(m,P_8) = \frac{P_8}{\Delta_2}$	> 0
4.	$e(m,b_1) = -\frac{(1 + P_2)b_1}{\Delta_2}$	< 0
5.	$e(m,r^{d'}) = -\frac{(1 + P_2)r^{d'}D}{\Delta_2(D + T)}$	< 0
6.	$e(m,r^{t'}) = -\frac{(1 + P_2)r^{t'}T}{\Delta_2(D + T)}$	< 0

where $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$

NOTES: Derivations are provided in Appendix A8.1.

TABLE 3.VIII

THE ELASTICITIES OF THE MONEY MULTIPLIER WITH RESPECT TO THE EXOGENOUS VARIABLES

$$e(m,i_{br}) = \frac{P_8}{\Delta_2} e(P_8,i_{br}) \qquad < 0$$

$$e(m,i_o) = \frac{1}{\Delta_2} \left\{ \frac{[\Delta_2 - b_1(1+P_1+P_2)]P_2}{1 + P_1 + P_2} e(P_2,i_o) + P_8 e(P_8,i_o) - [(1+P_2)b_1] \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,i_o) \right\} \qquad > 0$$

$$e(m,x) = \frac{1}{\Delta_2} \left\{ \frac{[\Delta_2 - b_1(1+P_1+P_2]P_1}{1 + P_1 + P_2} e(P_1,x) + \frac{[\Delta_2 - b_1(1+P_1+P_2)]P_2}{1 + P_1 + P_2} e(P_2,x) - [(1+P_2)b_1] \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,x) \right\} \qquad > 0$$

for $x = W/P_w$, P; and for $x = YDIS$ $\qquad < 0$

where $\Delta_1 = r^{d'}D + r^{t'}T$, $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$

NOTES: Derivations are provided in Appendix A.8.2.

A redistribution of income in favour of low income wage earners, raises the portfolio allocation ratios P_1, P_2 and lowers b_1. However, the associated negative response of multiplier m [e(m, YDIS) < 0], is not unambiguous and depends on an inequality condition being satisfied (see Appendix A.8.2, Equation A.8.2-3 and summary and Table 3.VIII). A similar inequality holds for e(i_e, YDIS)> 0 (see Appendix A.9.2, Equation A.9.2-6 and summary). Consequently, e(m, i_e) e(i_e, YDIS) > 0 and e(m, YDIS)< 0 only if the above mentioned inequalities are satisfied. The inequalities imply that the response of the currency ratio to changes in income distribution (hypothesised as positive) is sufficiently high in absolute value so as to outweigh the corresponding responses of P_2 and b_1, such that variations in multiplier m and multiplier a are dominated by the response of P_1 to changes in income distribution (see Appendix A.10.2 and summary in particular). A change in income distribution will raise the money supply if the inequalities above are satisfied.

4.1 Summary and Conclusions

Provided below is an overall summary of the multiplier and credit market mechanisms that transmit changes in exogenous variables to the money stock, followed by a summary of the main hypotheses generated in this section.

The elasticities in Table 3.V are rewritten in terms of the feedback operator K and listed in Table 3.IX. Scrutiny of these expressions reveals that the money supply elasticities are dependent on the secondary interest rate or feedback mechanism (summarised by K), and the direct effect of changes in the exogenous variables on multiplier a, multiplier m and the h function. The sign patterns are implied by the expressions in Table 3.X

TABLE 3.IX

MONEY SUPPLY ELASTICITIES WITH RESPECT TO THE EXOGENOUS VARIABLES IN TERMS OF VARIABLE K

1.	$e(M_2,B^a)$	$= 1 - K$	> 0
2.	$e(M_2,r^{d'})$	$= - Ke(a,r^{d'}) + e(m,r^{d'})$	< 0
3.	$e(M_2,r^{t'})$	$= - Ke(a,r^{t'}) + e(m,r^{t'})$	< 0
4.	$e(M_2,i_{br})$	$= - Ke(a,i_{br}) + e(m,i_{br})$	< 0
5.	$e(M_2,i_o)$	$= K[e(h,i_o) - e(a,i_o)] + e(m,i_o)$	> 0
6.	$e(M_2,W/P_w)$	$= K[e(h,W/P_w) - e(a,W/P_w)] + e(m,W/P_w)$	> 0
7.	$e(M_2,P)$	$= K[e(h,P) - e(a,P)] + e(m,P)$	> 0
8.	$e(M_2,YDIS)$	$= - Ke(a,YDIS) + e(m,YDIS)$	> 0
9.	$e(M_2,F^o)$	$= Ke(h,F^o)$	> 0

TABLE 3.X

SUMMARY OF SIGN PATTERNS RELEVENT TO THE MONEY SUPPLY ELASTICITIES IN TABLE 3.IX

	SIGNS	SOURCES
1.	$0 < K < 1$	Equation 3-24
2.	$e(a,r^{d'}) < 0$	Table 3.III and Appendix A.7.1
3.	$e(a,r^{t'}) < 0$	" "
4.	$e(a,i_{br}) < 0$	" " A.7.2
5.	$e(a,i_o) > 0$	" "
6.	$e(a,W/P_w) > 0$	" "
7.	$e(a,P) > 0$	" "
8.	$e(a,YDIS) < 0$	" "
9.	$e(h,i_o) > 0$	Equation 2.31
10.	$e(h,W/P_w) > 0$	"
11.	$e(h,P) > 0$	"
12.	$e(h,F^o) > 0$	"
13.	$e(m,r^{d'}) < 0$	Table 3.VII and Appendix A.8.1
14.	$e(m,r^{t'}) < 0$	" "
15.	$e(m,i_{br}) < 0$	" 3.VIII " A.8.2
16.	$e(m,i_o) > 0$	" "
17.	$e(m,W/P_w) > 0$	" "
18.	$e(m,P) > 0$	" "
19.	$e(m,YDIS) < 0$	" "

The postulated signs on all the money supply elasticities in Table 3.IX require that

$$P_1 > P_8 \tag{3-28a}$$

$$r^{d'} > r^{t'} \tag{3-28b}$$

$$b_1 > 1 \tag{3-28c}$$

In addition, Equations 2 to 4 require that

$$| -K\ e(a, x)| < |e(m, x)| \tag{3-29}$$

for $x = r^{d'}, r^{t'}, i_{br}$, which is equivalent to

$$| e(m, i_e)\ e(i_e, x)| < |e(m, x)| \tag{3-30}$$

in Table 3.VI. This means that the direct effect must exceed the secondary effect in absolute value.

Equations 5 to 7 in Table 3.IX require the additional inequality that

$$e(h, x) > e(a, x) \tag{3-31}$$

for $x = i_o, W/P_w, P$, implying that the debt effect must outweigh the asset effect. If this inequality is satisfied, then in Table 3.VI

$$e(i_e, x) > 0 \tag{3-32}$$

for $x = i_o, W/P_w, P$.

Equation 8 in Table 3.IX requires two additional inequalities:

$$|e(a, P_1)\, e(P_1, YDIS)| \quad > \quad |e(a,P_2)\, e(P_2, YDIS) + e(a, b_1)\, e(b_1, \gamma)\, e(\gamma, YDIS)| \qquad (3\text{-}33)$$

and

$$|e(m, P_1)\, e(P_1, YDIS)| \quad > \quad |e(m, P_2)\, e(P_2, YDIS) + e(m, b_1)\, e(b_1, \gamma)\, e(\gamma, YDIS)| \qquad (3\text{-}34)$$

These inequalities ensure that

$$e(a, YDIS) < 0 \qquad (3\text{-}34a)$$

$$e(m, YDIS) < 0 \qquad (3\text{-}34b)$$

which means that multipliers a and m are dominated by ratio parameter P_1, for changes in income distribution.

The comparative static implications of the model are as follows.

1. The feedback operator K measures the secondary interest rate effect on the money supply and is constrained to lying in the interval $0 < K < 1$.

2. The constraint on K depends on $e(m, i_e) > 0$ and implies that the interest rate effect attenuates the direct effect of changes in all the exogenous variables on the money supply. An increase in $e(m, i_e)$ lowers the attenuating effect of K while an increase in $e(a, i_e) - e(h, i_e)$ raises this influence for all exogenous variables other than the adjusted monetary base.

3. An increase in the adjusted monetary base raises the money supply less than proportionately due to the attenuating influence of K. In this instance an increase in $e(m, i_e)$ and a fall in $e(a, i_e) - e(h, i_e)$ raises K and lowers $e(M_2, B^a)$.

4. If interest rates are slow to adjust, K approaches zero and $e(M_2, B^a)$ approaches unity. Since the elasticities of multiplier m with respect to statutory reserve requirements and Bank Rate are less than unity, monetary policy exercised through the adjusted monetary base has a greater effect on the money supply than through changes in statutory reserve requirements and Bank Rate. In the case of the latter policy variables, the transmission mechanism is confined to the direct effect working through m.

5. Changes in reserve requirements and Bank Rate are related inversely to the money supply if the direct effect outweighs the secondary effect. Changes in the adjusted monetary base will have a stronger effect on the money supply than will changes in statutory reserve requirements, if the response of the money multiplier to changes in statutory reserve requirements is low.

6. The effect on the money supply of a change in the outstanding stock of government debt is unambiguously positive, with the interest rate mechanism, working through K, attenuating the positive effect exerted by the h function.

7. Changes in real wealth, the price level and the interest rate on non banking sector earning assets, affect the money supply positively if the interest rate effect of changes in the demand for banking sector deposits outweighs the interest rate effects of changes in the supply of financial assets to the banking sector.

8. A redistribution of income in favour of wage earners, raises the money supply if the responses of multipliers m and a are dominated by changes in the currency ratio (P_1).

These hypotheses will be subjected to empirical investigation in Chapter 4.

5. INTEREST RATE STABILIZATION POLICY

In Chapter 2, Section 6, we concluded that fiscal policy dominated monetary policy only if the Reserve Bank agreed to stabilize the interest rate on government debt. In this section, we elaborate on the formal implications of this hypothesis in terms of the relationships between the adjusted monetary base, the money multiplier, the money stock and the stock of outstanding government debt.

The credit market rate may be stabilized by Reserve Bank control of the adjusted monetary base or the money multiplier, through open market operations, variations in statutory reserve requirements, Bank Rate and open back door lending.[24] An interest rate stabilization policy implies that the monetary base is not an independently determined policy variable. It must respond appropriately to exogenous changes in the balance of payments and to fiscal policy, in order to maintain a desired credit market rate.

To illustrate an interest rate stabilization policy which is exercised through the monetary base, we write the general form of the credit market rate solution function (Equation 2-52) in terms of the policy variables controlled by the Monetary Authorities: statutory reserve requirements ($r^{d'}$, $r^{t'}$), Bank Rate (i_{br}), the adjusted monetary base (B^a) and the outstanding stock of government debt (F^o).

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24. Open back door operations by the Reserve Bank refer to situations in which the Reserve Bank lends to the banking and private sectors at market rates (while maintaining Bank Rate at its penal level) in order not to disturb market rates of interest.

$$\bar{i}_e = i_e(i,\ r^{d'},\ r^{t'},\ i_{br},\ W/P_w,\ P,\ YDIS,\ F^o,\ B^a) \qquad (3\text{-}35)$$

where:

$\bar{i}_e$ = the predetermined credit market ceiling rate.

An interest rate stabilization policy requires that the monetary base be continuously adjusted in response to changes in the interest rate vector i, real wealth, the price level, the distribution of income and the stock of government debt (determined by the Treasury's deficit).[25] Under these conditions the credit market rate becomes exogenous, while the adjusted monetary base and the money supply are endogenously determined. Equations 3-36 and 3-37 below (from Chapter 2, Sections 6, 7), illustrate this point.

$$h(\bar{i}_e \ldots F^o) = a(\bar{i}_e \ldots)\ B^a \qquad (3\text{-}36)$$

$$M_2 = m(\bar{i}_e \ldots)\ B^a \qquad (3\text{-}37)$$

Since the response of the credit market rate to changes in the adjusted monetary base and the money stock is negative, maintenance of the ceiling rate requires that the money stock and the base respond positively to changes in exogenous variables, which exert upward pressures on the credit market interest rate ceiling ($\bar{i}_e$). It follows that an increase in the ceiling rate requires a lower money stock and adjusted monetary base. Alternatively, if the adjusted monetary base (B^a) and hence the money supply (M_2) are not controlled by the Monetary Authorities, then $\bar{i}_e$ is maintained by offsetting variations in statutory reserve requirements and Bank Rate which operate through the money and credit market multipliers.

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25. Use of the remaining policy variables for the purpose of interest rate stabilization, will be discussed below.

The responses of the money supply and the adjusted monetary base to changes in the ceiling rate are obtained from Equation 3-36 and 3-37 by suitable logarithmic differentiation and substitution (see Appendix A.13, Equations A.13-10, A.13-12).

$$e(M_2, \bar{i}_e) = e(m, \bar{i}_e) - [e(a, \bar{i}_e) - e(h, \bar{i}_e)] < 0 \qquad (3\text{-}38)$$

$$e(B^a, \bar{i}_e) = - [e(a, \bar{i}_e) - e(h, \bar{i}_e)] \quad < \quad 0 \qquad (3\text{-}39)$$

Both the money and credit market multipliers respond positively, and the h function negatively, to upward pressures on the ceiling rate. Maintenance of a higher policy-determined ceiling rate, is compatible with a fall in the adjusted monetary base and the money stock. Equation 3-38 is negative if:

$$0 < e(m, \bar{i}_e) < [e(a, \bar{i}_e) - e(h, \bar{i}_e)] \qquad (3\text{-}39a)$$

(see Appendix A.12.)

and Equation 3-39 is unambiguously negative (see Appendix A.12).

The response of the adjusted monetary base to a change in the stock of outstanding government debt, for a given ceiling rate, is unambiguously positive and depends upon the response of function h to changes in the stock of outstanding government debt.

$$e(B^a, F^o) = e(h, F^o) > 0 \qquad (3\text{-}40)$$

(see Appendix A.13, Equation A.13-8).

We conclude that upward pressures on the credit market rate ceiling caused by changes in exogenous variables and the stock of government debt, requires an increase in the money supply and the adjusted monetary base, if the policy-determined ceiling rate is to be maintained. Increases in the ceiling rate are compatible with a fall in the adjusted monetary base and the money supply.

An alternative set of circumstances may exist which requires that stabilization policy be exercised through money multiplier m. Consider the situation where the adjusted monetary base cannot be controlled by the Reserve Bank for institutional reasons, and is therefore no longer a policy variable, being determined exogenously by the balance of payments and the Government's budget deficit.[26] From Equation 3.37 it is clear that maintenance of the ceiling rate requires control of money multiplier m. Writing the general form of the money multiplier function (Chapter 2, Equation 2-56):

$$m = m(\overline{i_e}, i_o, r^{d'}, r^{t'}, i_{br}, W/P_w, P, YDIS) \qquad (3\text{-}41)$$

$$m_j < o \text{ for } j = r^{d'}, r^{t'}, i_{br}$$

where:

m_j = first order partial derivative of function m.

The Monetary Authorities may offset exogenous upward pressures on the ceiling rate by lowering the statutory reserve requirements on demand and

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[26] For instance, lack of a resilient market in government debt in South Africa, negated control of the monetary base through open market operations.

time deposits and reducing Bank Rate. The former lowers the portfolio allocation ratio b_1, thereby raising m, while a fall in Bank Rate raises P_8 which raises m.[27] In this instance, the money stock varies positively with upward pressures on the ceiling rate.

The full range of options available to the Monetary Authorities are revealed in the general form for the equilibrium money stock (Chapter 2, Equation 2-57):

$$M_2 = M_2(i_o, r^{d'}, r^{t'}, i_{br}, W/P_w, P, YDIS, F^o, B^a, \pi) \qquad (3\text{-}42$$

With the adjusted monetary base determined exogenously by the balance of payments and fiscal finance, and with infrequent variation in statutory resérve requirements, the only variables available to control the money supply are Bank Rate and Reserve Bank lending through the open back door (contained in vector π). Note, that if open back door operations are used to stabilize interest rates, the Reserve Bank's lending Ratio (P_8) varies inversely with changes in the adjusted monetary base, and directly with changes in the stock of outstanding government debt; and money supply control is negated.

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27. The elasticities $e(m, r^{d'})$, $e(m, r^{t'})$, $e(m, i_{br})$ are negative. See Tables 3.VII and 3.VIII.

5.1 Summary and Conclusions

In the above analysis, we derive the following hypotheses. An interest rate stabilization policy may be executed by the Reserve Bank either through its control of the adjusted monetary base or through control of the money multiplier, or both. Assume that the Treasury fixes the size of the Government's deficit and the ceiling rate on government debt. Then, the ceiling rate is maintained only if the monetary base is appropriately adjusted through open market operations by the Reserve Bank, in response to changes in the stock of outstanding government debt and other exogenous variables. In particular, the base and the money stock respond positively to exogenous upward pressures on the ceiling rate and the base responds positively to increases in the stock of government debt. In this case, an interest rate stabilization programme does not remove the efficacy of open market operations or the causal connection between the adjusted monetary base and the money supply -- it merely negates the use of the base as an independently determined policy variable since both the base and the money supply become endogenous.[28]

On the other hand, the monetary base is exogenously determined if the Reserve Bank is unable to exercise its control through open market operations, and the money supply remains endogenous through Reserve Bank control of the money multiplier. Since variations in statutory reserves may occur infrequently, control of the money multiplier may be exercised through

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[28] See Brunner-Crouch [14], pp.91, 108.

open back door lending by the Reserve Bank, whereby, additional reserves are supplied to the banking sector at market rates. This implies that the portfolio allocation parameter P_8 varies directly with an increase in the stock of outstanding government debt, inversely with the exogenously determined monetary base, and inversely with the remaining exogenous variables (real wealth, the price level, the rate on non banking sector earning assets, and income distribution) which may exert upward pressures on the ceiling rate.

6. OPEN MARKET OPERATIONS, GOVERNMENT DEFICIT FINANCE AND THE CREDIT MARKET RATE[29]

It has been established in Chapter 2, Section 6, that the monetary base is determined in part by the fiscal action of the Treasury and that the monetary base may be used independently to determine the size of the money stock, only if the Reserve Bank does not stabilize the credit market rate. We proceed to investigate in this section, the relative effects on the credit market rate of: a change in the monetary base through open market operations; a change in the monetary base by other means; and a shift in the sources of deficit finance between the banking and private sectors, and the Reserve Bank.

Assume that the source of deficit finance is shifted from the banking and private sectors to the Reserve Bank by a reduction in the stock of outstanding government debt (F^o) and an equal absolute increase in Treasury indebtedness to the Reserve Bank, which inflates the adjusted monetary base correspondingly. Formally, we represent this situation by the condition:

$$\Delta B^a = - \Delta F^o \qquad (3\text{-}43)$$

Equation 3-43 is also equivalent to an increase in the monetary base from an open market purchase of government debt by the Reserve Bank. The thrust of either of these two actions on the credit market rate is given by Equation 3-44 below (see derivation in Appendix A.14).

$$\frac{\Delta i_e}{i_e} = e(i_e, B^a) \left[1 + e(h, F^o) \frac{B^a}{F^o}\right] \frac{\Delta B^a}{B^a} < 0 \qquad (3\text{-}44)$$

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29. This section is based on Brunner-Meltzer [17], p.161.

The total credit market rate response is comprised of three elements; the interest rate response to a change in the base $e(i_e, B^a)$, the response of function h to a change in the stock of outstanding government debt $[e(h, F^o)]$, and a scale factor given by the ratio of the base to the stock of outstanding government debt $(\frac{B^a}{F^o})$, where $e(i_e, B^a) < 0$ and $e(h, F^o) > 0$, and the term in square brackets is greater than unity. From Equation 3-44, the composite response of the credit market rate to open market operations or a shift in Treasury finance from the banking and private sectors to the Reserve Bank, is unambiguously negative and is not constant, being positively dependent in absolute value on the ratio of the adjusted monetary base to the stock of outstanding government debt.

Consider the case of a change in the adjusted monetary base not by means of an open market operation but by a change in some other source component. The outstanding stock of government debt remains constant, the $e(h, F^o)$ term in Equation 3-44 is zero and the impact on the credit market rate is confined to the adjusted base component.

$$\frac{\Delta i_e}{i_e} = e(i_e, B^a) \frac{\Delta B^a}{B^a} < 0 \qquad (3\text{-}45)$$

It is clear, that the credit market rate response in Equation 3-45 is less than in Equation 3-44. In the case of the open market purchase or a shift in deficit finance, a two-pronged thrust from a simultaneous increase in the base and a decline in the stock of outstanding government debt, causes a greater fall in the credit market rate than does the single thrust exerted by an increase in the monetary base due to changes in source components other than the Reserve Bank portfolio of government debt.

An open market purchase or a shift in deficit finance simultaneously raises the adjusted monetary base (B^a) and hence the banking sector's demand for earning assets, and lowers the private sector's supply of earning assets to the banking sector (the h function); whereas, the impact effect of an increase in the base from other sources does not affect the h function directly.

Analogous arguments apply, *ceteris paribus*, to the issue or retirement by the Treasury, of government debt held by the banking and private sectors. The credit market rate responds positively to variations in the stock of outstanding government debt.

We conclude that the interest rate effect of either an open market operation, or a shift in Treasury deficit finance (from the banking and private sectors to the Reserve Bank), will have a greater effect on the credit market rate, than will either a change in the adjusted monetary base, due to variations in sources other than the Reserve Bank's portfolio of government debt, or, *ceteris paribus*, the issue or retirement of outstanding government deby by the Treasury.

7. SUMMARY AND MAIN CONCLUSIONS

Two solution functions and the credit market equilibrium condition enable us to solve for the equilibrium money stock, the equilibrium credit market rate and the equilibrium stock of earning assets in the bank credit market, in terms of the exogenous variables. From the solution functions, we obtain elasticity expressions describing the responses of the credit market rate and the money supply to changes in the exogenous variables. In general, the responses of the credit market rate and the money supply, depend upon a configuration of credit market and money multiplier elasticities, and the response of the banking sector's earning asset supply function.

The signs attached to the elasticity expressions are deduced from the a priori signs on the structural portfolio allocation functions and the responses of the multipliers to variations in the portfolio allocation ratios. In most cases, the responses of the credit market rate and the money supply, require that inequality constraints be satisfied.

Underlying the comparative static elasticity expressions, is a two-path process of economic behaviour, in which, changes in exogenous variables are transmitted to the credit market rate and the money supply. On the one hand, changes in the exogenous variables induce a direct shift in the demand and supply functions in financial markets, thus creating excess demands for and supplies of financial assets and debt at existing rates of interest. This direct effect is captured by an initial change in the credit market and money multiplier coefficients, and the banking sector's earning asset supply function. Adjustment towards a new equilibrium position causes a change in interest rates and a secondary reallocation of financial assets and debt in the balance sheets of economic agents. This secondary adjustment, along the new demand and supply curves, is captured by secondary variations in the multiplier coefficients and the private sector's earning asset supply function. The net effect on the endogenous variables of a change in the exogenous variables depends upon the relative strengths of the direct and secondary effects. Thus, the money supply is not a simple multiplicative relationship between the adjusted monetary base and a multiplier coefficient, (as was the case with money supply models in the early post war era). Rather, it is the outcome of interrelated financial behaviour in financial markets where the direct effect of a change in the policy variables, controlled by the Reserve Bank, is modified by the secondary interest rate effect resulting from endogenously induced portfolio readjustments in the bank credit market.

Since a summary of the deduced hypotheses is provided at the end of each section, we summarise the major implications of the model, as follows:

1. Changes in reserve requirements influence the multiplier coefficients through the statutory reserve ratio (b_{11}) and hence the banking sector's aggregate reserve ratio (b_1). An increase in the statutory reserve requirement on demand and time deposits, raises b_{11} proportionately to the ratio of demand to total deposits.

2. <u>Ceteris paribus,</u> an increase in the ratio of demand to total deposits, raises b_{11}, if the statutory reserve requirement on demand deposits is greater than the statutory reserve requirement on time deposits. The increase in b_{11} will be greater if demand deposits increase at the expense of time deposits, than if demand deposits increase exogenously with time

deposits constant.

3. The excess reserve ratio is assumed constant in the money supply model for South Africa, since the development of the South African money market provides the banking sector with highly liquid interest-bearing call deposits, which are close substitutes for excess reserves. Evidence suggests that these deposits are used by the banking sector as a first line of defence, implying that the marginal transactions cost on call deposits is less than their marginal yield. Thus, variations in the aggregate reserve ratio (b_1) are dominated by changes in the statutory reserve ratio (b_{11}).

4. Changes in the policy variables exert the expected influence on the credit market rate: the credit market rate varies inversely with the adjusted monetary base and directly with statutory reserve requirements on demand and time deposits, and Bank Rate. However, the adjusted monetary base exerts a stronger influence on the credit market rate than do variations in statutory reserve requirements or Bank Rate.

5. The credit market rate varies directly with the stock of outstanding government debt, real wealth, the interest rate on non banking sector earning assets, and income distribution. In the case of real wealth, the price level and the interest rate on non banking sector earning assets, an additional inequality constraint that the wealth, price and interest rate elasticities of the h function exceed that of multiplier a, is required. With respect to changes in income distribution, the influence of the currency ratio (P_1) must dominate variations in multiplier a.

6. The secondary interest rate effect attenuates the direct effect of a change in exogenous variables on the money supply. This effect is weaker, the greater is the interest elasticity of multiplier m and the lower are the interest elasticities of multiplier a and the banking sector's earning asset supply function h, for changes in all exogenous variables <u>other than</u> the adjusted monetary base.

7. The secondary interest rate effect is measured by variable K (the feedback operator) which is constrained to lie in the interval $0 \leq K \leq 1$.

8. An increase in the adjusted monetary base raises the money supply less than proportionately if $0 < K < 1$ and K attenuates the direct effect of an increase in the adjusted monetary base.

9. A relatively inflexible interest rate mechanism, reduces the attenuating influence of K and raises the response of the money supply to changes in the adjusted monetary base.

10. Changes in the adjusted monetary base, exert a stronger influence on the money supply than do changes in statutory reserve requirements and Bank Rate. Thus, the efficacy of monetary policy is greater when the Reserve Bank exercises its control through variations in the base. This conclusion is true in particular if interest rates are slow to adjust (in which case K approaches zero).

11. The money supply responds negatively to an increase in statutory reserve requirements and Bank Rate if the direct effect outweighs the secondary interest rate effect.

12. Variations in the stock of outstanding government debt, real wealth, the price level and the interest rate on non banking sector earning assets, induce a positive money supply response. In the case of the three latter exogenous variables, the money supply response is positive if debt adjustments outweigh asset adjustments.

13. A redistribution of income in favour of wage earners, raises the money supply if the multiplier coefficients are dominated by associated variations in the ratio parameter P_1.

14. If the Reserve Bank agrees to stabilize the interest rate on government debt, then the credit market rate is exogenously determined and the money supply and adjusted monetary base must respond positively to exogenous upward pressures on the ceiling rate and to changes in the stock of outstanding government debt. The adjusted monetary base is no longer an independently determined policy variable.

15. If the adjusted monetary base is determined exogenously of the Reserve Bank, then the ceiling rate is maintained by policy-induced variation in the multiplier coefficient. Since variations in statutory reserve requirements occur infrequently, the Reserve Bank may control the multiplier

coefficients through open back door operations. Thus, the portfolio allocation ratio P_8 must vary directly with the stock of outstanding government debt, inversely with the adjusted monetary base and inversely with the remaining exogenous variables.

16. The interest rate effect of either an open market operation, or a shift in Treasury deficit finance in favour of the Reserve Bank, will have a greater effect on the credit market rate, than will either a change in the adjusted monetary base due to exogenous factors, or, *ceteris paribus*, due to the issue or retirement of government debt by the Treasury.

In Chapter 4, we investigate the hypotheses derived in this chapter, for the South African financial system, for the period 1950 to 1971.

CHAPTER 4

EMPIRICAL EVIDENCE ON THE MONEY SUPPLY AND INTEREST RATE DETERMINATION PROCESS IN SOUTH AFRICA

1. INTRODUCTION

Having derived the comparative static implications of the money supply model in Chapter 3, we turn to a systematic investigation of the processes determining the money supply and the credit market rate in South Africa. It is of fundamental importance that the empirical results be related to the course of monetary policy and the path of financial evolution that has occurred over the time period of this study. In this regard, we direct attention to those details of financial history that seem relevant to the hypotheses in question.

Broadly, our empirical evidence supports the theoretical structure of the money supply model and is consistent with the comparative static implications.

Certain features of the empirical results pertaining particularly to the South African financial system are worthy of special mention.

1. In accordance with numerous money supply studies for other countries, the adjusted monetary base is indispensable for an understanding of the processes that determine the money supply and credit market rate in South Africa. That the South African Monetary Authorities have chosen to ignore the influence of the adjusted base appears to be a serious analytical omission.

2. The South African money market is of crucial relevence to the money supply process. Its modus opperandi relegates the banking sector's excess

reserve ratio to the position of an unimportant constant, thereby facilitating a useful analytical simplification. The behaviour of the banking sector may be synthesized by the aggregate reserve ratio (or the statuatory reserve ratio); a single parameter which enters the monetary process as a component of the money and credit market multipliers. The importance of the Reserve Bank's lending ratio (P_8) is supported by the evidence, suggesting that the money market must be incorporated into a money supply model for South Africa.

3. Analysis of the money multiplier reveals that, unlike the money supply process for Canada and Italy, the multiplier is of lesser importance in shorter time periods as opposed to longer time periods. We find that, in contrast to the studies for Canada and Great Britain, the currency ratio (as a component of the money multiplier) is relatively unimportant in explaining the money supply. Cyclical variations in the multiplier are assymetric due to the unique inter-relationship between the policy actions of the Monetary Authorities and movements in the balance of payments over the course of the business cycle. The operation of the South African financial system typifies a Classical Gold Standard system, and the Keynesian dilemma between internal and external balance in a world of fixed exchange rates emerges in the contraction phase of the cycle.

4. Income distribution appears relevant to the money supply process and should not be ignored when policy is formulated. Economies of scale in money holdings appear to exist in South Africa.

5. We find that the actions of the Public Debt Commissioners serve to stabilize the credit market rate, as expected, and also to influence the

money supply process.

Our empirical investigation proceeds as follows. In Section 2, we review the goals of monetary policy pursued by the Monetary Authorities and the policy instruments used to achieve them. Many of our empirical results in succeeding sections rationalize the character of monetary policy in South Africa. In Section 3, we test the banking sector's portfolio allocation ratios, in order to determine whether or not our excess reserves hypothesis is valid. A detailed discussion of financial events in the period is provided in order to formulate empirically testable hypotheses. The role of the money market is central to the empirical conclusions.

In Sections 4, 5 and 6, three related issues are dealt with: these prepare the ground for the final test of the comparative static hypotheses (Section 7) and an explanation of the observed cyclical behaviour of the money supply and credit market rate (Section 8). Section 4, is concerned with the source components of the monetary base, and in Section 5, we examine the relative contributions of the money multiplier and the monetary base to the growth rate of the money stock. In Section 6, observed variations in the money multiplier are explained in terms of its constituent ratio parameters and we examine the determinants of the ratio parameters themselves. Various aspects of Reserve Bank lending policy emerge, and we consider the behaviour of interest rates over time.

We estimate the credit market rate solution function and the money supply function for South Africa in Section 7, and obtain estimates for all the elasticity expressions derived in Sections 3 and 4, of Chapter 3. In addition, estimates of the money multiplier elasticities with respect to the exogenous variables of the model and the credit market rate are deduced, as well as for the components of the transmission mechanism (the direct and secondary interest rate effects) linking the exogenous variables to the money supply and credit market rate. These results supply us with a comprehensive view of the money supply process operating through the interest rate mechanism in the credit market.

Section 8, may be considered to be the high point of our study. We synthesize the information from Sections 2 to 6 and the empirical relationships from Section 7, to explain the observed cyclical behaviour of the money supply and credit market rate in terms of the theoretical variables; the money multiplier and its constituent ratio parameters, and the adjusted monetary base. The policy actions of the Monetary Authorities are also assessed in terms of our theoretical framework.

The remaining three analytical sections of this chapter, deal with side issues. In Section 9, we show that the credit market rate is influenced most strongly by open market operations, and in Section 10, the role of the Public Debt Commissioners in the money supply process is investigated. That income distribution is a relevant variable in the money supply and credit market rate determination process is demonstrated in Section 11.

Finally, we provide an overall summary of the empirical evidence in Section 12. Several of the longer sections in this chapter are concluded with a more detailed summary of the evidence contained therein.

2. THE INSTRUMENTS OF MONETARY POLICY: 1950 to 1971.

During the period of this study, the Monetary Authorities in South Africa used a variety of policy instruments to achieve their goals. Many of the empirical results in this chapter only make sense when the policy actions of the Monetary Authorities are taken into consideration. We use a set of conventional categories in our theoretical money supply model to describe various policy instruments, such as open market operations, Bank Rate policy and variable statutory reserve requirements. Often, however, a very special usage is implied when empirical investigation begins. It is our purpose in this section to make this specific usage explicit, in the context of South African monetary policy. In this respect, this section is an important prelude to our empirical analysis and must be borne in mind when examining the conclusions of our empirical investigation.

The Monetary Authorities are concerned basically with three magnitudes; the rate of change of interest rates, the supply of banking sector credit and the balance of payments. During the period 1950 to 1971, seven complete cycles (peak to peak) in economic activity are identifiable and are closely associated with the balance of payments.[1]

The course of monetary policy is conveniently divisible into two sub-periods: 1950-1965, 1965-1971. In the first sub-period, successive periods of inflationary pressures followed by deficits in the balance of payments were accompanied by monetary policy exercised through changes in interest rates, Bank Rate and discounting policy of the Reserve Bank, variations in statutory reserve requirements, and moral suasion. Import and exchange controls were

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1. In our empirical work, we employ the cycles identified by Smit and van der Walt [85]. Since their study terminates in 1968, we add three half-cycles for the period 1968 to 1971, based on analysis of our own data.

consistently employed for balance of payments purposes. Of constant concern to the Monetary Authorities was the development and growth of the South African money market. Another important feature of this period was the tremendous proliferation of near banks. During the second sub-period, commencing in 1965, the relatively passive policy actions of the Monetary Authorities (in the earlier period) were abandoned, in the wake of rising inflationary pressures caused by a generally favourable balance of payments. New financial legislation was passed, empowering the Monetary Authorities to exert control over the near banks, and expanding the scope of variable liquid asset ratios, which were adopted in favour of variable statutory cash reserve ratios. The maturation of the money market permitted a more comprehensive interest rate policy, and moral suasion was replaced by direct credit control on the banking sector. In addition, National Debt management was specifically geared to influencing monetary conditions. The characteristics of the aforementioned policy instruments are discussed below.

The preoccupation of the Monetary Authorities with stabilizing interest rates on government debt precluded control of the money supply. Interest rate policy differed between short-term and long-term interest rates. In the years following the Second World War, the Monetary Authorities sought to stabilize the rates on both short and long-term government debt by quoting a pattern of rates at which the Reserve Bank stood prepared to deal; so that market rates and the yield on new issues of government debt reflected the quoted pattern. It was not intended that interest rates should be pegged, but only stabilized for some time. Periodically, the quoted pattern was changed in response to evolving demand and supply conditions in the market.[2]

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2. In the immediate post war period, a persistent rise in interest rates from the low levels existing during the war, created uncertainty in the market for government debt, discouraging investors from holding government debt. The method of "quoting a pattern of rates" was initiated as an experiment to dampen interest rate fluctuations, and became official policy in July, 1952. The object was not to peg interest rates, but to follow market pressure, allowing rates to adjust in an "orderly" manner ([87], 1950, p. 14, and 1953, pp. 5, 6; [33], p. 22).

Thus, open market operations were used to stabilize interest rates and not for the purpose of controlling the adjusted monetary base.[3]

In consequence, the market for long-term debt remains thin, being dominated by the Reserve Bank and the Public Debt Commissioners.[4]

The market for short-term government debt evolved along a different route, becoming broad and active through the development of the money market, and the short-term rate on government debt ceased to be part of the quoted pattern in 1960.[5]

Bank Rate and discounting policies of the Reserve Bank were almost entirely devoted to the encouragement of the development of the money market in the period to 1960, and thereafter, to the efficient functioning of the money market. This policy, implied essentially that the Treasury bill rate was stabilized in the former period, and less so in the latter (with exceptions). In general, short-term rates were more flexible than long-term rates, and by 1960 interest rates on Treasury bills and short-term government debt were determined by market forces.[6]

In the period 1950 to 1960, Bank Rate was not a penalty rate and discounting policy was designed to stabilize the Treasury bill rate in order to protect the new money market institutions (the National Finance Corporation and private discount houses) from undue losses. To this end, open back door operations were used to alleviate stringent liquidity conditions

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3. Evidence submitted by the Governor of the South African Reserve Bank to the Radcliffe Committee in Great Britain ([48], vol. 1, para. 16, p.289).

4. See Chap. 2, Sec. 6.2. The role of the Public Debt Commissioners is examined in Sec. 10 of this chapter.

5. See Chap. 2, Sec. 5.

6. [81], pp. 365-358.

in the market.[7] Open back door operations worked as follows. Treasury bills could be discounted (by the banking sector, discount houses and other financail institutions) at preferential discount rates, well below Bank Rate and repurchase agreements were concluded, whereby, previously discounted Treasury bills could be repurchased from the Reserve Bank at a predetermined rate prior to maturity. In June 1958, the weekly tender on 91-day Treasury bills was established to broaden the Treasury bill market, and the Treasury bill rate became subject to market forces.[8] Penalty rates on Treasury bills discounted were then related to the tender rate and the National Finance Corporation's call deposit rate.

By 1960, the money market was functioning well, the Treasury bill formed the backbone of the market and short-term interest rates were free of direct administration. Reserve Bank policy acquired a new dimension when Bank Rate was declared to be the penalty rate on all last resort lending by the Reserve Bank to the banking sector and the money market.[9] Conventional Bank Rate policy could now be applied (or so it seemed).

After 1960 recurrent deficits on the balance of payments, required continuous stabilization of the Treasury bill rate, by means of open back door operations. This time, the Reserve Bank relieved market stringency by open market purchases of Treasury bills at market rates, and by periodic transfer of funds from the Government's deposit at the Reserve Bank to the discount

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7. Prior to 1949, no money market existed in South Africa. In 1949, the National Finance Corporation was established by the Government to promote a market in short-term government debt and Treasury bills. Bank Rate was not enforced as a penalty rate, to stimulate confidence in the new institution. But the rediscounting of commercial bills by the banking sector, and later by the discount houses, was always subject to the Bank Rate penalty ([80], p.246 and [81], p. 356).

8. [80], pp. 250-252; [81], p. 356; [34], p. 234. After the establishment of the tender, the banking sector obtained Treasury bills from the Reserve Bank at tender rates; a mere extension of open back door operations.

9. [81], pp. 357-358.

houses and the banking sector (more will be said about this when we discuss the use of National Debt management for the purpose of monetary policy). Bank Rate was not universally applied as a penalty rate on Treasury bill discounts.[10]

The period 1965 to 1971 differed in degree but not kind from the previous period. Continuous inflation induced a more restrictive attitude by the Reserve Bank to discounting policy, and open back door operations of one sort or another were used to relieve market stringency during a deficit in the balance of payments.[11]

In the case of South Africa, variable statutory reserves do not necessarily mean variable cash reserves. During the period 1958 to 1965, the Reserve Bank imposed supplementary reserve requirements on the banking sector, to be held either as cash reserve at the Reserve Bank or in the form of certain specified liquid assets.[12] Thus, supplementary reserve requirements contained an element of liquid asset reserve requirements. Consistently over phases of the business cycle, supplementary reserve requirements were varied contracyclically to influence banking sector reserves.[13] In 1965, in accordance with the Banks Act No. 23 of 1965, the cash reserve ratio in the banking sector

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10. [34], p. 214, 215, 227, 231. In May 1962, rather than lower Bank Rate during a balance of payments surplus, the Reserve Bank quoted a separate discount rate on Treasury bills equal to 2 per cent above the Treasury bill rate. In May 1964, the above penalty was dispensed with, and the Reserve Bank imposed quantitative restrictions on discounting.

11. We show in Secs. 8.2 and 8.4, that Bank Rate had in fact been assigned to controlling the balance of payments, and that open back door operations were used as an instrument for fine turning short-term interest rates. In the period 1967 to 1971, however, a penalty rate was applied for anti-inflationary purposes, accompanied by a balance of payments deficit.

12. In 1956, an amendment to the Banks Act No. 38 of 1942, empowered the Reserve Bank to impose supplementary reserve requirements on the banking sector. These powers were first used in 1958 ([88], June 1958).

13. See [85].

was lowered and a new set of liquid asset ratios imposed.[14] Hencefort, variable liquid asset ratios were used as a tool of contra-cyclical policy, with no variation in the cash reserve ratio being permitted by the Act.[15]

In the period to 1965, moral suasion took the form of requests by the Reserve Bank to the banking sector, that the supply of credit to the private sector should be restricted. These requests were also varied contra-cyclically.[16]

From 1965-1971, the advent of a period of accelerated inflation caused the Monetary Authorities to adopt a more aggressive and stringent set of policy instruments. We have noted that discounting policy was tightened in the money market. By June 1965, liquid asset ratios in the banking sector had been raised to their legal maximum. Two new instruments of monetary policy were created to combat inflation: firstly, the Reserve Bank was empowered to impose a ceiling on the supply of banking sector credit to the private sector (replacing moral suasion, a more gentle version of the same thing); and secondly, National Debt management was used for monetary control.[17]

After imposition of the credit ceiling in October 1965, the ceiling was systematically varied according to inflationary conditions over the

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14. The change in cash reserve requirements in 1965 is discussed in Appendix A.15. Cash reserves in the banking sector were lowered in 1965 in accordance with the new ligislation, in order to remove the competitive disadvantage of the banking sector <u>vis a vis</u> the near banks. See de Kock [30].

15. Cyclical variations in the liquid asset ratios are discussed in [85] for the period 1965 to 1968, and subsequent changes are discussed in the Reserve Bank's monetary analysis ([88], 1968-1971).

16. [85].

17. The credit ceiling was imposed under the Currency and Exchange Act of 1933. In March 1965, an interest rate ceiling was imposed on banking sector deposits in terms of this Act, to restrict the interest rate war that had broken out between the banking sector and the near banks, following the collapse of the commercial banks' cartel agreement. However, this ceiling was removed in July 1968 and was not a systematic policy weapon.

cycle, to control the supply of banking sector credit.[18] From 1965 onwards, the Monetary Authorities exercised their powers to borrow from the banking and private sectors, in excess of their deficit requirements, and to transfer the proceeds to the Stabilization account at the Reserve Bank.[19] Thus, Treasury borrowing in the banking and private sectors, and variations in the Treasury's account at the Reserve Bank were used to obtain non inflationary deficit finance; to maintain the structure of quoted rates; and to absorb surplus liquidity in the money market due to a balance of payments surplus; or to relieve stringency in the money market due to a balance of payments deficit.[20]

Throughout the entire period (1950-1971), import and exchange controls were varied contra-cyclically to offset pro-cyclical movements in the balance of payments.[21] In this respect, the Monetary Authorities attempted to control the balance of payments by controlling the demand for foreign exchange. But the supply of foreign exchange remained exogenous.

We have not provided an evaluation of the efficacy of these policy instruments; this is the task of the remaining sections of this chapter. In the following sections, we purposefully augment our empirical conclusions *a fortiori* with repetition of relevant details from this section.

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18. C. J. de Swart and G. Steenkamp [33].

19. Prior to 1965, National Debt management was designed to finance the Government's deficit in a manner consistent with monetary conditions, and the quoted pattern of rates on government debt (ibid., Pp. 26, 27). Under the General Loans Act of 1961, the Monetary Authorities were permitted to borrow limited amounts in excess of their loan requirements, and in 1964, unlimited borrowing powers were obtained for the purpose of regulating monetary conditions. Funds could be freely transferred between the Stabilization account at the Reserve Bank, and the Banking and private sectors, for purposes of monetary control (ibid., Pp.17, 27, 28).

20. Ibid., p. 28 and [32], p. 24.

21. See de Swart and Steenkamp; ibid.

3. THE BEHAVIOUR OF THE BANKING SECTOR

The purpose of this section, is to investigate the determinants of the banking sector's aggregate reserve ratio (b_1). The influence of b_1 is transmitted by the money and credit market multipliers to the money stock and the credit market rate. In Chapter 2, (Section 3), we formulate the behaviour of the banking sector in terms of two ratio parameters; the statutory reserve ratio (b_{11}) and the excess reserve ratio (e), and define the aggregate reserve ratio as the sum of these two ratios;

$$b_1 = b_{11} + e \qquad (4\text{-}1)$$

In Chapter 3, (Section 2.3), we postulate that the creation and subsequent development of the South African money market reduces the optimum excess reserve ratio in the banking sector, and that variations in this ratio are stabilized about that minimum level in response to changes in relative interest rates.[22] Variations in b_1 are then mirrored by variations in b_{11}, which reflect policy changes in statutory reserve requirements, and portfolio shifts between demand and time deposit by the private sector, given that a differential statutory reserve requirement is maintained between demand and time deposit.[23]

The empirical investigation that follows, appears to substantiate these postulates, and proceeds in two stages. Firstly, we provide preliminary evidence that the mean and variance of e relative to those of b_{11} is small, so that indeed b_1 is dominated by variations in b_{11};

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22. The theoretical bases for these propositions are discussed in Chap. 2, Secs. 5.2.1 - 5.2.4.

23. Due to the existence of the London discount market, the cash reserve ratio held by the London Clearing banks is less variable than that held by commercial banks in other countries, such as the United States. Brunner and Crouch ([14], p.83) assume that the cash reserve ratio for Britain is a constant and independent of interest rates. See also Crouch [27], p. 144.

and secondly, we support these results by means of regression analysis, which shows that variations in b_1' are dominated by monetary policy and private sector portfolio behaviour rather then by variations in money market interest rates.

3.1 Some Preliminary Evidence

For the purpose of empirical investigation, it is necessary to obtain an appropriate measure of excess reserved by reformulating Equation 4-1 above. A measure of excess reserves (R_e) is obtained by deducting statutory reserves (R_s) from aggregate banking sector reserves (R).[24]

$$R_e = R - R_s \qquad (4\text{-}2)$$

Since vault cash is not counted as part of statutory reserves in South Africa, excess reserves are held as vault cash (R_c) and deposits in the Reserve Bank in excess of required statutory reserves (R_e^{CB}).[25]

$$R_e = R_c + R_e^{CB} \qquad (4\text{-}3)$$

Following general practice, we treat vault cash (transactions balances) as a relatively involatile component of excess reserves, varying slowly over time in response to structural changes in the payment habits of the private sector and the institutional payments mechanism, and identify excess reserves held in the Reserve Bank (speculative balances) as the relevant magnitude for empirical study.[26] Aggregate banking sector reserves are defined as the sum of statutory reserves, excess reserves in the Reserve Bank and vault cash:

$$R = R_s + R_e^{CB} + R_c \qquad (4\text{-}4)$$

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24. Appendix A.15 provides raw data from which we calculate the banking sector's statutory and excess reserve ratios.

25. [5], p. 239.

26. See Chap. 3 Sec. 2.3 and nn. 7-9.

Dividing Equation 4-4 through by aggregate deposits (D + T) we obtain the aggregate reserve ratio (b_1), the statutory reserve ratio (b_{11}), the excess reserve ratio (e_{CB}), and the vault cast ratio (v). Equation 4-1 is reformulated as:

$$b_1 = b_{11} + e_{CB} + v \qquad (4\text{-}5)$$

In Table 4.II we provide time series data on the measured reserve ratios in Equation 4-5 for the period 1944 to 1971, and summary statistics are provided in Table 4.I. Since the relative contributions of the reserve ratios (on the right hand side of Equation 4-5) to variations in the aggregate reserve ratio depend on both their absolute size as well as their degree of variation, we make comparisons between the means and standard deviations listed in Table 4.I.

It is apparent that the mean of b_{11} constitutes 60 per cent of the mean of b_1 (the largest proportion), compared to a 5 per cent contribution by e_{CB} . In terms of relative orders of magnitude, the mean of b_1 exceeds that of b_{11} and e_{CB} by 66 per cent and 1773 per cent respectively. In terms of mean values, b_{11} is more important relative to e_{CB} in influencing b_1 .

A similar pattern prevails for comparisons of the standard deviations. The standard deviation of b_1 exceeds that of b_{11} and e_{CB} by 35 per cent and 419 per cent respectively, and the standard deviation of b_1 is almost four times larger than that of e_{CB} . When b_{11} takes a value one standard deviation away from its mean, the change in b_1 will be substantially greater than for a similar value taken by e_{CB} . Finally, the simple correlation coefficients between the ratios indicate that b_{11} has a stronger positive association with b_1 than does e_{CB}, where, $r_{b_1,b_{11}} = 0.99$ and $r_{b_1,e_{CB}} = 0.58$.

TABLE 4.I

MEANS, STANDARD DEVIATIONS AND CORRELATION COEFICIENTS OF THE AGGREGATE RESERVE RATIO

Reserve Ratio Parameters	Mean	Standard Deviation	Ratio of Means to b_I	Correlation Coefficient with respect to b_I
b_I	0.1180	0.0270	...	...
b_{II}	0.0710	0.0200	0.60	0.99
e_{CB}	0.0063	0.0052	0.05	0.58
v	0.0410	0.0052	0.35	0.77

SOURCE: Calculated from Table 4.II for the period 1950-1971.
NOTES: b_I =aggregate reserve ratio, b_{II} =statutory reserve ratio, e_{CB} =excess reserve ratio, v = vault cash ratio.

TABLE 4.II

ANNUAL VALUES OF THE AGGREGATE RESERVE RATIO EQUATION: 1944-1971

Year	b_I	b_{II}	e_{CB}	v
1944	0.610	0.093	0.490	0.029
1945	0.620	0.093	0.490	0.029
1946	0.460	0.092	0.340	0.028
1947	0.860	0.093	0.340	0.025
1948	0.280	0.095	0.160	0.028
1949	0.200	0.096	0.067	0.037
1950	0.214	0.096	0.082	0.037
1951	0.152	0.095	0.014	0.043
1952	0.161	0.092	0.023	0.043
1953	0.146	0.094	0.009	0.043
1954	0.145	0.091	0.009	0.045
1955	0.139	0.086	0.007	0.046
1956	0.136	0.083	0.005	0.049
1957	0.130	0.081	0.003	0.046
1958	0.133	0.081	0.006	0.046
1959	0.126	0.081	0.003	0.042
1960	0.133	0.082	0.004	0.047
1961	0.130	0.079	0.005	0.046
1962	0.127	0.079	0.006	0.043
1963	0.128	0.082	0.004	0.042
1964	0.121	0.079	0.005	0.037
1965	0.083	0.045	0.000	0.038
1966	0.087	0.043	0.002	0.042
1967	0.083	0.043	0.001	0.040
1968	0.087	0.044	0.007	0.037
1969	0.080	0.042	0.005	0.033
1970	0.084	0.043	0.010	0.031
1971	0.075	0.043	0.002	0.030

SOURCE: South African Reserve Bank Quarterly Bulletin. See Appendix A.15 for basic data.
NOTES: b_I =aggregate reserve ratio, b_{II} =statutory reserve ratio, e_{CB} =excess reserve ratio, v = vault cash ratio.

We conclude, that overall variations in the aggregate reserve ratio are dominated by variations in the statutory reserve ratio. These conclusions are not altered by the stronger influence of the vault cash ratio relative to that of the excess reserve ratio, using the same criteria. For the purpose of our study we focus attention on the statutory reserve and excess reserve ratios and treat the vault cash ratio as an exogenous variable (not explained by the mechanism of the model).

3.2 The Excess Reserve Ratio

Additional evidence in support of our hypothesis is provided by means of regression analysis and to this end we must translate our theoretical hypothesis about the influence of the money market, into empirically testable propositions concerning the behaviour of the excess reserve ratio over time.

Scrutiny of the e_{CB} time series for the period 1944 to 1971 in Table 4.II and Figure 4.I, reveals three broad characteristics of variation.[27] The first is a long-run downtrend; the second is a pair of discrete shifts occurring in 1958 and 1965, and the third is a set of systematic variations about a constant trend.

The equation to be tested is Equation 2-8. In order to capture the downtrend and the discrete shifts in e_{CB}, we introduce dummy variables as a proxy for the shift variable π_1^b, and the remaining interest rate variables explain the residual variation in e_{CB}, which we postulate to be systematic about a constant trend.

We commence a discussion of the e_{CB} time series in relation to financial events and monetary policy in South Africa, in order to demonstrate

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[27] Our period of analysis is 1950 - 1971. We provide data for the years 1944 - 1949 in order to observe the post war adjustment in the excess reserve ratio.

that the dummy variables are indeed meaningful proxies for structural changes in the financial system, caused by economic fluctuations, monetary policy and random events.

3.2.1 Historical Analysis. Although our period of study is from 1950 to 1971, we commence our historical survey in 1944, in order to assess the influence of the Second World War on the immediate post war years. For the period 1944 to 1971 as a whole, the downtrend in the excess reserve ratio is immediately discernible from Table 4.III (and Figure 4.I). The total period is divided into four periods of seven years each and the mean values of e_{CB} are calculated for each period.[28] The excess reserve ratio declines from an average value of 0.28 in the immediate post war period to an average of 0.037 in the period 1965 to 1971. The rate of decrease is highest between the post war period and the period 1951 to 1957 with a decline of 96.4 per cent, thereafter, decelerating between the second and third period to 51 per cent and between the third and fourth period to 24.5 per cent. The slower rates of decline in periods 3 and 4 relative to period 2, are attributable to the events that caused the structural shift at the beginning of these periods (i.e. 1958 and 1965, resp.).

We alter periods 1 and 2 in Table 4.III slightly for the purpose of more detailed historical analysis, and identify the following periods for discussion: 1944 to 1952; 1953 to 1957; 1958 to 1964; and 1965 to 1971. The reader should refer to Table 4.II and Figure 4.I, in the following analysis.

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28. Notice in Table 4.II, that starting from 1951, the beginning of the historically low post war trend in the excess reserve ratio, each seven year period to 1971 is separated by what we have identified as a discrete structural shift.

TABLE 4.III

MEAN VALUES OF THE EXCESS RESERVE RATIO FOR SELECTED PERIODS

Means	1944-1950 (1)	1951-1957 (2)	1958-1964 (3)	1965-1971 (4)
e_{CB}	0.28	0.01	0.0049	0.0037
Mean Change(%)	...	-96.4	-51.0000	-24.5000

SOURCE: South African Reserve Bank Quarterly Bulletin. See Appendix A.15 for basic data.

NOTES: Mean values of the excess reserve ratio are calculated from Table 4.II and average percentage changes are calculated from the mean values in this table.

The period 1944 to 1952 is viewed as a typical post war adjustment period, during which, the banking sector attempted to reduce its excess reserves, which had been accumulated during the war years. Excess reserves declined by 92 per cent, from R259 million in 1944 to R20 million in 1952, thereby, contributing to a post war decline in the excess reserve ratio from 0.49 to 0.024, a decline of 95 per cent.

The establishment of the first money market financial institution (the National Finance Corporation)in 1949, on the initiative of the South African government, undoubtedly accelerated the high rate of decline in e_{CB} in the post war period.[29] Thus, between 1944 and 1948, e_{CB} declined by 67 per cent (an annual average of 13.4 per cent) whereas from 1948 to 1953, the rate of decline increased to 94.2 per cent (an annual average of 15.7 per cent).

From 1953 to 1957, the excess reserve ratio declined by a further 58.5 per cent, representing a deceleration in the rate of post war downward adjustment compared to the previous period. We conclude that the period 1951 to 1957 reveals a strong secular downtrend representing the post war adjustment in the excess reserve ratio and the effects of the initiation of the South African money market. Monetary policy and business cycles appear not to have influenced the trend.

The instruments of monetary policy in the above period, were confined to moral suasion, variations in import controls, the imposition of exchange controls, variations in Bank Rate and adjustments to the pattern of rates quoted by the Reserve Bank, none of which, interrupted the post war trend.[30]

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29. See Chap. 2, Secs. 5.2.1 - 5.2.3. To facilitate the transfer of banking sector funds to the National Finance Corporation, to be held as interest-bearing call deposits, the Reserve Bank temporarily reduced the statuatory reserve requirement on demand deposits from 10 per cent to 7 per cent.

30. See Sec. 2.

Over five half-cycles occurring in the period, the Monetary Authorities used these methods in attempts to stabilize the pattern of rates on government debt and to protect the balance of payments.

The period 1958 to 1964 presents a different picture. The downtrend in the excess reserve ratio is halted in 1958 with an abrupt upward shift from 0.0029 to 0.0059, stabilizing along an historically low plateau at an annual average value for the seven years of 0.0049, compared to 0.01 in the previous seven years (Table 4.III). In 1957, e_{CB} reached an historically low level of 0.0029 not to be exceeded until 1965.

Monetary events explain both the discontinuity in the downtrend observed in 1958, and the subsequent relatively stable excess reserve ratio, maintained by the banking sector to the end of the period in 1964. By the end of 1958, mild deflation in aggregate demand in combination with an increase in the monetary base (brought about by larger international reserves) caused a building up of excess reserves in the banking sector. A resurgence of inflation induced the Reserve Bank to employ monetary and other measures, which enhanced the accumulation of excess reserves in the banking sector. These measures imposed limits on the ability of the banking sector to raise the supply of private sector credit and reduced the privates sector's demand for credit, while additional controls were placed on the outflow of international reserves.[31] The banking sector may have increased its desired excess reserve ratio in the face of an intention by the Treasury to increase its borrowing from the private

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31. The supply of banking sector credit was constrained by a Reserve Bank request that credit to the private sector should be curtailed (November 1957), and supplementary reserve requirements were imposed (May 1958); the latter were reduced in November 1958. The demand for banking sector credit was reduced by an increase in hire-purchase downpayments and a reduction in the payments period; borrowing by the Local Authorities was also curtailed (June 1958, becoming effective in September 1958). The outflow of capital was limited by an increase in import controls, and exchange controls were imposed on the outflow of resident capital ([88], 1968, 1959 and [65]).

sector for fiscal purposes.[32] These policy controls, together with an increase in the monetary base, are conducive to an increase in the excess reserve ratio in the short-run.

That the banking sector appears to have maintained a relatively higher excess reserve ratio until 1964 is attributable to a succession of further financial events accompanied by monetary policy decisions. Racial disturbances and political unrest in 1960, accompanied by further policy decisions by the Monetary Authorities to constrain inflation and to protect the balance of payments may have created an atmosphere of uncertainty, which induced the banking sector to raise its demand for excess reserves, while, the policy decisions would tend to constrain any desired reduction in the excess reserve ratio.[33]

In the absence of the above events, the creation of new private money market institutions in 1957, and their subsequent proliferation and growth, would be expected to have induced a continuation of the downtrend observed in the period prior to 1958. The events described above appear to have more than offset the expected influence of developments in the money market. On the other hand, the growth of the money market may account for the relative stability observed in the excess reserves ratio, despite the existence of four half-cycle fluctuations in economic activity.[34] These fluctuations, are

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32. Measures to achieve this were adopted in July 1958.

33. In April 1961, the Sharpville racial disturbances occured followed by a political crises which undermined investor's confidence. In June, exchange controls were imposed on the outflow of non resident capital and import controls were increased; the Treasury obtained special powers to transfer their loan proceeds to a Stabilization account (these powers were exercised in March 1963 and extended in 1964). In January 1964, the Reserve Bank requested the banking sector to further curtail the supply of credit to the private sector. An additional factor may have been the intention of the Reserve Bank to charge a penal Bank Rate on discounts.

34. Two mild recessions occurred in the period February 1958 - March 1959, and May 1960 - August 1961. An expansion phase occurred in April 1959 - April 1960, followed by a more prolonged period of sustained growth in the period September 1961 - April 1965 ([85]).

mirrored by pro-cyclical fluctuations in the adjusted monetary base and the level of international reserves.[35] An efficient money market would enable the banking sector to cushion the effects of cyclical fluctuations on its reserves by appropriate variations in money market assets.

In summary, we postulate that the discontinuity observed in the post war downtrend in the excess reserve ratio, is due to economic events and policy actions by the Monetary Authorities, which, in part, raised the level of desired excess reserves, and in part, prevented any desired downward adjustment despite an acceleration in the growth of the South African money market. However, the rapid evolution of the money market may have contributed to the relative stability observed in the excess reserve ratio. An alternative hypothesis is presented; that from a longer-run point of view, the observed shift identified in 1958 is not significant and that the observed plateau is really a continuation of a stable and fairly constant trend (starting in 1955) following the termination of the post war adjustment process in 1954. The excess reserve ratio has an average value of 0.0048 for the period 1955 to 1957, compared to an average of 0.0049 for the period under discussion. These hypothesis are subjected to empirical testing in Section 3.2.2 below.

The final period for consideration is 1965 to 1971. In 1965, a discontinuity in the plateau of the previous period is observed followed by a clear upward trend, which terminated in 1971. The excess reserve ratio dropped dramatically to almost zero in 1965 and then climbed to its highest value (0.01 in 1970) since 1953, thereafer, declining to an historically

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[35] The influence of the balance of paymented on the adjusted monetary base is discussed in Sec. 4.

low value of 0.0018 in 1971.[36]

The discontinuity in 1965 is again explicable in terms of economic events, policy decisions and a major structural change in the banking sector. The year 1965 marked the tail end of a mild recession of approximately nine months, preceded by a sustained economic upswing,which had commenced in September 1961. An excess demand for banking sector credit, an increase in competitive pressures from near banks and a decline in the adjusted monetary base (resulting from a fall in the stock of international reserves) induced the banking sector to adjust its excess reserve ratio downwards.

In addition, the promulgation of the new Banks Act of 1965 brought the near banks within the ambit of Reserve Bank control, thereby, removing their competitive advantage in the credit market, relative to that of the banking sector. The Act also shifted the emphasis of banking sector control to variable statutory liquid asset ratio requirements.[37] For these reasons also, the banking sector would be inclined to reduce its excess reserve ratio.

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36. In 1965, Bankers Balances amounted to R90.2 mill. and estimatned statutory reserves amounted to R90.45 mill. giving an estimated value of excess reserves equal to -R0.25 mill. Statistical error accounts for the negative sign and we approximate excess reserves as zero (see Appendix A.15).

37. The Act imposed more stringent regulations on the withdrawal of time deposits in the banking sector, and the statuatory cash reserve ratio on short-term liabilities was reduced. These factors may have induced the banking sector to lower its optimum excess reserve ratio.

The Reserve Bank introduced anti-inflationary measures by raising the statutory liquid asset ratio to its legal maximum in order to absorb excess reserves in the banking sector, and imposed a deposit rate ceiling to stem inflationary increases in interest rates and to curtail the interest rate war which had developed between the banking sector and the near banks.[38] The structural

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[38]. From March - July of 1965, the liquid asset ratio was progressively raised to its legal maximum, forcing the banking sector to invest in specialised assets ([88], March 1965). The deposit rate ceiling curtailed the interest rate war between the banking sector and the near banks (see Sec. 2 and n., 17). Thus, the banking sector may have lowered its excess reserve ratio to earn increased profits by lending to the private sector.

shift in 1965 is thus attributable to a decline in the demand for excess reserves by the banking sector and an increase in demand for banking sector credit.[39]

However, the low level of excess reserves was not maintained and the continuous upward trend until 1970 is attributable again to a combination of economic events and monetary policy.

The period 1965 to 1970 was marked by sustained economic growth and inflationary pressures, which caused an increase in demand for banking sector credit, and the supply of banking sector reserves were continuously fed by rising international reserves. However, the Monetary Authorities prevented the banking sector from achieving an optimum portfolio allocation, by imposing a ceiling on the supply of banking sector credit to the private sector, which was maintained to the end of 1971. Minor increases in the credit ceiling and lower import and exchange control failed to offset the accumulation of excess reserves in the banking sector.[40]

By 1970, the continuation of inflation, the collapse of the speculative stock exchange boom and the intensification of international currency crises, appears to have increased the banking sector's demand for excess reserves in the face of a mounting outflow of international reserves.[41] Call deposits in the money market declined from an historical peak of R329.5 million in 1969 to R213.2 million by the end of 1970 (a fall of 35.3 per cent) and the excess

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39. In the period December 1964 - December 1965, the quantity of excess reserve in the banking sector fell from 0.0055 to almost zero, while holdings of liquid assets (as defined by the Banks Act of 1965) increased from $151.3 mill. to R406.5 mill.

40. See Sec. 2.

41. Following a capital outflow (the first in four years) in 1969, the Reserve Bank lowered the statutory liquid asset ratios in the banking sector, raised the ceiling on banking sector credit and imposed a penalty rate of 2 per cent above Bank Rate on discounting. The discount houses were heavily indebted to the Reserve Bank to an extent of 45 per cent of their liabilities. These factors, together with fears of a unilateral devaluation of the Rand would be good reason for an increase in the excess reserve ratio.

reserve ratio increased to a value of 0.01, the highest level since 1953. Fears of an impending deflationary trend could well have raised the demand for excess reserves in the banking sector. By the end of 1971, the excess reserve ratio reached an historically low level of 0.0018 (the lowest value since 1951), thereby, reversing the upward trend of the previous five years. The banking sector appears to have adjusted its excess reserve ratio downwards by raising the money supply and increasing its holding of money market financial assets, while the continued decline in international reserves drained reserves from the banking sector. Monetary policy acted as an aid to this downward adjustment in the excess reserve ratio with reductions in supplementary liquid asset ratio requirements and an increase in the credit supply ceiling, in 1970.

That the banking sector did not cushion the accumulation of reserves by investing in the money market must be attributed to the existence of a state of general uncertainty which caused an increase in the demand for excess reserves. By the end of 1971, fears of a serious deflation proved groundless and the international currency situation may have appeared more stable with the suspension of dollar convertibility and the imposition of the 10 per cent United States surcharge. However, we clearly cannot conclude that the historically low level of excess reserves in 1971 consitutes a permanent adjustment to a lower optimum excess reserve ratio.

We postulate, therefore, that the period 1965 to 1971 stands apart from preceding years due to the constraints imposed on the banking sector by the Reserve Bank, uncertainties in the domestic economy generated by inflationary pressures, and international currency instability. Under these conditions, the banking sector was induced to depart from the low and stable excess reserve ratio which characterised the previous decade.

<u>3.2.2 Empirical evidence.</u> We turn to the regression results in Table 4.IV, to assess the influence of the money market and structural shifts on the banking sector's excess reserve ratio. Regression Equation 4-6 below, is the empirical counterpart of Equation 2-8:

$$e_{CB} = e_{CB}(i_{OD}, i_{cal}, LA, D_1, D_2, D_3) \qquad (4\text{-}6)$$

where:

e_{CB} = the banking sector's excess reserve ratio

i_{OD} = the minimum overdraft rate in the banking sector

i_{cal} = the interest rate on money market call deposits

D = dummy variables

LA = liquid assets in the banking sector other than call deposits.[42]

The interest rates capture the substitution relationships between excess reserves and interest yielding financial assets, in particular, i_{cal} captures the influence of the money market on the excess reserve ratio. The D variables represent dummies for π_1^b in Equation 2-8. On the basis of the historical analysis in the previous section, the dummies are constructed as follows: D_1, D_2, D_3, represent periods 1950 to 1957, 1958 to 1964, and 1965 to 1971, respectively; each being assigned the integer 1 for its own period and 0 for the remaining periods. Thus, the dummies capture the observed shifts in the e_{CB} time series due to the structural changes that

42. These quantity variables are included due to a lack of adequate interest rate data on banking sector liquid assets, for the period of this study.

have been described, and facilitate testing whether these changes have in fact materially affected variations in the excess reserve ratio over the period, or not.

In Table 4.IV, regression Equations 1 and 2 are for the period 1953 to 1964 and test the hypothesis that over this period the banking sector's excess reserve ratio was stable following the post war decumulation of excess reserves. The absence of dummy variables in the equations implies an assumption that no structural shift occurred in 1958.

In Equation 1, both interest rate variables are significant and the call deposit rate has the correct sign. Thus, over the period, call deposits were a close substitute for excess reserves. The positive sign and lower t-value on the overdraft rate may be due to the oligopolistic interest rate agreement between the commercial banks, and the policy constraint on sustitution between excess reserves and bank overdrafts. The variable LA_3 is the quantity of liquid assets other than call deposits. Its coefficient is significant and has the correct sign indicating that the banking sector substituted excess reserves for Treasury bills, short-term government debt and other liquid assets, in response to the development of the money market.

There is no indication of autocorrelation and the equation explains 62 per cent of the variation in the excess reserve ratio, which seems reasonable when we consider that monetary policy constraints and uncertainties of the period have not been accounted for. The importance of LA_3 is evident from Equation 2, where its exclusion lowers the explanatory power of the equation considerably. We conclude that in the period 1953 to 1964, the excess reserve ratio responded to the development of the money market following the post war downward adjustment.

TABLE 4.IV

REGRESSION ESTIMATES OF THE EXCESS RESERVE RATIO EQUATION

DEPENDENT VARIABLE = e_{CB}

	C	i_{o}	i_{cal}	LA_3	D_1	D_2	D_3	$\bar{R}^2$	DW
1. 1953-1964	-6.17	4.26	-1.19	-1.12				0.62	2.22
	(-1.65)	(1.97)*	(-2.36)**	(-2.92)**					
2.	-10.56	3.77	-1.45					0.30	1.96
	(-2.27)	(1.19)	(-2.17)**						
3. 1951-1964	-9.67	4.64	-1.61	-0.46				0.55	2.42
	(-1.50)	(1.34)	(-2.15)*	(-0.78)					
4.	-11.87	4.73	-1.84					0.57	2.27
	(-2.09)	(1.34)	(-2.74)**						
5. 1950-1965	-17.38	8.48	-2.69	-0.028		-0.34	-9.86	0.96	2.65
	(-1.65)	(1.53)	(-2.56)**	(-0.032)		(-0.85)	(-7.17)**		
6.	-17.57	8.51	-2.70			-0.34	-9.89	0.96	2.64
	(-2.09)	(1.64)	(-3.09)**			(-0.98)	(-11.57)**		
7. 1950-1971	-83.96	38.76	-8.34	3.79		-1.88	-13.25	0.39	2.45
	(-3.45)	(2.97)**	(-2.99)**	(1.44)		(-1.62)	(-3.20)**		
8.	-66.43	38.38	-6.76			-1.36	-8.67	0.35	2.44
	(-3.06)	(2.84)**	(-2.56)**			(-1.19)	(-3.17)**		
9	-67.78	38.39	-6.76		1.36		-7.32	0.35	2.44
	(-3.07)	(2.84)**	(-2.55)**		(1.19)		(-3.22)**		
10.	-75.10	38.39	-6.76		8.67	7.32		0.35	2.44
	(-3.11)	(2.84)**	(-2.56)**		(3.17)**	(3.22)**			

* 10% significance level (two tail).
** 5% significance level (two tail).

SOURCE: Basic data for the independent variables and method of calculation may be found in Appendix A.19. Data series for the excess reserve ratio are given in Table 4.II.

NOTES: $\bar{R}^2$ = adjusted coefficient of determination, DW = the Durbin-Watson statistic and t-values are in parentheses. The regression equations are estimated in logarithmic form using annual year-end data. e_{CB} = excess reserve ratio, C = constant term, i_{o} = commercial banks' minimum overdraft rate, i_{cal} = the call deposit rate at the National Finance Corporation, LA_3 = liquid assets. The D variables are constructed dummies taking the integer 1 as follows: D_1 = 1 for 1950-1957; D_2 = 1 for 1958-1964 and D_3 = 1 for 1965-1971. The remaining years are assigned zeros.

Equations 3 and 4, are for the period 1951 to 1964.[43] Extending the previous period backwards leaves the results essentially unaltered. Over 50 per cent of the variation in e_{CB} is explained by interest rates alone; the call rate remains significant and has the correct sign, while the overdraft rate is not significant. Liquid assets also become insignificant. Thus, the development of the money market was probably responsible for the observed plateau in the excess reserve ratio time series.

In order to test the significance of the structural shift in 1958 and in 1965, we insert dummy variables D_2 and D_3 into regression Equations 5 and 6, for the period 1950 to 1965.

The results pertaining to the interest rates and liquid assets remain unchanged. Both dummy variables have the correct sign and the insignificant t-value on D_2 supports our previous hypothesis that the structural shift observed for the period 1958 to 1964 is not significantly different from the period 1950 to 1957, and does not affect the generally stable behaviour of the excess reserve ratio.

As we mentioned in the historical analysis, it seems likely that the post war adjustment had terminated by the early 1950's and that henceforth, the money market dominated the continued secular decline in the excess reserve ratio (at a decelerating rate) with stabilizing fluctuations about a relatively constant trend, uninterrupted by structural shifts in underlying political and economic conditions.

The significance of D_3, lends support to the proposition that structural changes in 1965 did cause a dramatic decline in the excess reserve ratio and that 1965 is significantly different from all previous years. That the changed

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43. Since the dummy variables are not used in these equations, we omit the extreme observation for 1950 (see Table 4.II and Figure 4.I).

structure persisted to 1971 will be shown below.

Comparing the explanatory power of Equations 3 and 4 with that of Equations 5 and 6, the adjusted R^2 rises from over 50 per cent to over 95 per cent in the longer time period when the dummy variables are included. Over the longer run from 1950 to 1965, changes in the underlying structure must be taken into account to explain the behaviour of the banking sector's excess reserve ratio.

Finally, we test our hypotheses for the total period 1950 to 1971 with the inclusion of D_2 and D_3.[44] Equations 7 and 8 do not alter our previous conclusions. The call rate remains significant while liquid assets and D_2 are not significant. However, the significance of D_3 supports the hypothesis that the discrete structural shift which occurred in 1965 marked the commencement of a material change in the behaviour of the excess reserve ratio; a change which persisted until 1971, and which differentiates the period 1965 to 1971 from that of 1950 to 1957.[45] Equations 9 and 10 include the dummies D_1, D_3 and D_1, D_2, respectively, facilitating a comparison between the periods represented by the dummies and the constant term (D_1 = 1950 - 1957 and D_3 = 1965 - 1971). The t-values on D_1 and D_3 in Equation 9 show that with respect to the second period (1958 - 1964), the first period (1950 - 1957) is not significantly different, while the third period (1965 - 1971) differs significantly from the second. Similarly, in Equation 10, the first and the second periods are significantly different

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44. The exclusion of dummy variables reduces the adjusted R^2 to less than 1 per cent.

45. D_3 reflects a shift in the intercept for the period 1965 - 1971, compared to the intercept for the period 1950 to 1957, which is captured by the constant term

from the third period.[46]

The sharp drop in explanatory power of the equations for the whole period (1950 - 1971) is due to the addition of the third period (1965 - 1971) which clearly departs from the stable and fairly homogeneous behaviour observed earlier. We show in our analysis for the separate short-periods, that interest rates, liquid assets and the dummy variables are necessary to explain the excess reserve ratio. However, the structural changes in the last seven years of our period introduce complications into the functional relationship which may only be accounted for by fitting a different functional form. The low value for the adjusted R^2 would not appear sufficient to disturb our conclusions.

We summarise these results in Section 3.5 and draw implications concerning the functioning of the money market. First, however, we examine the statutory reserve ratio equation.

3.3 The Statutory Reserve Ratio

Having established that interest rates and monetary policy dominate the determination of the excess reserve ratio, we turn to an empirical investigation of the statutory reserve ratio (b_{11}). The theoretical underpinnings of this section are discussed in Chapter 3, (Section 2.2).

Equation 2-14a indicates that b_{11} depends upon the statutory reserve requirements on demand and time deposits and the ratio of demand to total deposits in the banking sector. An increase in statutory reserve requirements raises the statutory reserve ratio in proportion to the distribution of deposits between demand and time deposits (Equations 3-1 and 3-2). The statutory reserve ratio responds positively to an increase in demand deposits if the difference between the statutory reserve requirements on demand and time deposits is positive; this response being greater if the change in demand

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46. The constant term represents the excluded dummy with which the rest are compared.

TABLE 4.V

SELECTED ANNUAL VALUES OF STATUTORY RESERVE REQUIREMENTS AND DEPOSIT RATIOS

Statutory Reserve Require- ments	1950	1964	1965	1971
$r^{d'}$	0.1000	0.1000	0.0800	0.0800
$r^{s'}$	0.1000	0.1000	...	...
$r^{t'}$ (act)	0.0300	0.0300	...	...
$r^{fst'}$	...	...	0.0800	0.0800
$r^{t'}$	0.0586	0.0521	0.0116	0.0051
Deposit Ratios				
T/D+T	0.1090	0.441	0.508	0.495
S/T	0.4090	0.316	0.283	0.355
FST/T	...	...	0.145	0.064

NOTES: see Appendix A.15 for derivation of the statutory reserve requirement and deposit ratios.

The statutory reserve requirements on demand, savings and short-term fixed deposits ($r^{d'}$, $r^{s'}$, $r^{fst'}$, resp.) are as per the Banking Act of 1942 and the Banks Act of 1965; $r^{t'}$ (act) is the statutory reserve requirement on time deposits, defined by the Banking Act of 1942 as fixed deposits, and $r^{t'}$ is the calculated statutory reserve requirement on time deposits defined in this study as savings plus fixed deposits (see Appendix a.15). D+T=total banking sector deposits.

deposits is due to an equal but opposite change in time deposits (Equations 3-7, 3-8). Before considering the empirical magnitudes of these response patterns, we require additional information about changes in statutory reserve requirements and the time deposit ratio that occurred in the period to 1971 (see Table 4.V and notes in particular).[47]

From 1950 to 1964, the statutory reserve requirements on demand, savings, and fixed deposits (short-term, medium-term, and long-term) remained constant at 10 per cent on demand and savings deposits, and 3 per cent on fixed deposits. Since time deposits in this study include all deposits other than demand deposits, the statutory reserve requirement on time deposits ($r^{t'}$) is a weighted average requirement (with the ratios of savings and fixed deposits to total time deposits as weights), and depends on the distribution of time deposits between savings and fixed deposits. Since the ratio of savings to time deposits declined from 40.9 per cent in 1950 to 31.6 per cent in 1964, the transfer of deposits from savings to fixed deposits (a transfer to a relatively lower statutory reserve category) caused a decline in $r^{t'}$ from 5.9 per cent to 5.2 per cent. The period 1965 to 1971 is slightly more complicated. In 1965 the statutory reserve requirement on demand deposits ($r^{d'}$) was reduced to 8 per cent, that statutory reserve requirement on short-term fixed deposits was raised from 0 to 8 per cent, and the statutory reserve requirements on the remaining deposit categories were reduced to 0. In addition, from 1965 to 1971, the ratio of short-term fixed deposits to total time deposits fell from 14.5 per cent to 6.4 per cent (a transfer of deposits to a deposit category with zero reserve requirements). The result is a further decline in $r^{t'}$

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47. For the purpose of this study, time deposits are defined as all deposits which are not transferable by cheque and therefore include savings and fixed deposits. The rational for this definition is explained in Appendix A.15 together with the provisions of the legislation governing the statutory reserve requirements in the banking sector.

to 0.51 per cent in 1971. Overall, for the period 1950 to 1971, the statutory reserve requirements on demand deposits and time deposits fell by two percentage points and 5.4 percentage points respectively. Bearing this in mind, one further observation is necessary before turning to Table 4.VI. In the period 1950 to 1971, a marked increase in the private sector's time deposit ratio occurred, rising from 10.9 per cent in 1950 to 49.5 per cent in 1971.

The elasticities of the b_{11} ratio are evaluated in Table 4.VI by inserting data into the formulae and calculating mean values for the period 1950 to 1971. The statutory reserve ratio is relatively more responsive to changes in $r^{d'}$ and to a transfer of demand deposits to time deposits (a change in the time deposit ratio) than to changes in $r^{t'}$ or an increase in demand deposits, holding time deposits constant. The decline in $r^{d'}$ by 2 percentage points and the increase in the time deposit ratio by 38.6 per cent, explain the major portion of the decline in b_{11} over the period (b_{11} declined from 0.096 in 1950 to 0.043 in 1971; Table 4.II). Thus, a 1 per cent transfer of demand to time deposits lowers b_{11} by more than a 1 per cent decline in demand deposits holding time deposits constant. The signs on Expressions 3 and 4 are positive since $r^{d'}$ exceeds $r^{t'}$.

These results have implications for short-run monetary policy. A decline in the statutory reserve ratio implies an increase in the excess reserve ratio in the short-run, enabling the banking sector to expand the money supply by purchasing earning assets. The Monetary Authorities can prevent an endogenous expansion of the money supply due to private sector transfers of demand to time deposits, by raising the statutory reserve requirement on demand deposits. A 1 per cent transfer of demand to time deposits may be offset by an approximate increase in $r^{d'}$ of 0.61 per cent. However, $r^{t'}$ will rise by an amount depending on the specific category of time deposits which is increased,

TABLE 4.VI

ELASTICITIES OF THE STATUTORY RESERVE RATIO WITH RESPECT TO STATUTORY RESERVE REQUIREMENTS AND DEMAND DEPOSITS

Elasticities	Formulae	Means	Stantard Deviations
1. $e(b_{11}, r^{d'}) =$	$\frac{r^{d'} D}{r^{d'} D + r^{t'} T}$	0.83	0.92
2. $e(b_{11}, r^{t'}) =$	$\frac{r^{t'} T}{r^{d'} D + r^{t'} T}$	0.17	0.92
3. $e(b_{11}, D) =$ T constant	$(r^{d'} - r^{t'}) \frac{T}{D + T} (\frac{D}{r^{d'} D + r^{t'} T})$	0.21	0.15
4. $e(b_{11}, D) =$ D + T constant	$(r^{d'} - r^{t'}) (\frac{D}{r^{d'} D + r^{t'} T})$	0.51	0.23

NOTES: $e(b_{11}, x)$= elasticity of b_{11} with respect to x for x = $r^{d'}$, $r^{t'}$, D(T constant) and D(D+T constant). Expressions 1 and 2 are derived in Appendix A.6.4, and expressions 3 and 4 are derived by multiplying equations 3-7 and 3-8 in the text by D/b_{11} where:

$$b_{11} = \frac{r^{d'} D + r^{t'} T}{D + T}$$

Basic data is provided in Appendix A.15. The estimated elasticities are obtained by inserting annual year-end data into the expressions for the period 1950-1971 and calculating the means and standard deviations.

and on the statutory reserve requirement applicable to that category. To this extent the estimated increase in $r^{d'}$ which is required must be revised downwards but not by much since the effect on b_{11} of a 1 per cent increase in $r^{t'}$ is small.

It appears that a variable statutory reserve requirement on demand deposits is a relatively powerful instrument of monetary policy which the South African Monetary Authorities chose to ignore. In 1965, variable liquid asset ratios were adopted as an instrument of monetary control. Their failure, in the face of inflationary pressures, necessitated the imposition of direct credit controls.[48]

In Table 4.VII, we provide the results from regression analysis to determine the relative influences of statutory reserve requirements and the time deposit ratio on the statutory reserve ratio. The empirical counterpart to the theoretical equation for b_{11} (Equation 2-1) is:

$$b_{11} = b_{11}(\frac{DL}{DT}, D_3) \qquad (4\text{-}7)$$

where:

$\frac{DL}{DT}$ = ratio of demand liabilities to total deposits[49]

D_3 = a dummy variable for the period 1965 to 1971.

The dummy variable D_3, captures the change in statutory reserve requirements for the period 1965 to 1971, taking the integer 1 for these years and 0 for

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48. See Sec. 2.

49. For the purpose of regression analysis, we use the official definition of demand liabilities (deposits) as laid down in the Banks Act of 1942 and the Banks Act of 1965. For the period 1950 - 1964, DL is equal to the sum of demand deposits plus savings deposits and for the period 1965 - 1971, DL is equal to demand deposits plus short-term fixed deposits, where demand deposits are identified as deposits withdrawable by cheque (see Appendix A.15).

TABLE 4.VII

REGRESSION ESTIMATES OF THE STATUTORY RESERVE RATIO EQUATION

DEPENDENT VARIABLE = b_{11}

	C	DL/DT	D_3	$\bar{R}^2$	DW
1.	-2.46 (-151.72)		-0.68 (-23.50)	0.96	0.39
2.	-2.30 (-853.08)	0.66 (64.74)	-0.43 (-100.47)	0.99	1.91

NOTES: The statutory reserve ratio b_{11} is calculated in Table 4.11(see Appendix A.15). DL/DT is the ratio of demand liabilities to total deposits where demand liabilities are defined as demand plus savings deposits for the period 1950-1964 and demand plus short-term fixed deposits for the period 1965-1971, as per South African banking legislation (see Table A.15.III).The dummy variable D_3 = 0 (1950-1964);D_3 = 1 (1965-1971).Data on the statutory reserve ratio is given in Table 4.11. C = constant term, $\bar{R}^2$ = the adjusted coefficient of determination, DW = Durbin-Watson statistic, t-statistics are given in parentheses. The regression equations are estimated in logarithmic form using annual year-end data for the period 1950-1971.

the rest. The regression results indicate that the observed secular decline in the statutory reserve ratio is due not only to the reduction in statutory reserve requirements on demand and time deposits in 1965, but also to the strong shift in private sector preferences from demand to time deposits. Equation 1 excludes the ratio of demand to total deposits. Although the dummy variable D_3 is significant with the correct sign and the equation explains 96 per cent of the variation in b_{11}, serious autocorrelation is present with a Durbin-Watson value of 0.39. When the ratio of demand to total deposits is added in Equation 2, it is highly significant with the correct sign, the adjusted R^2 rises to 0.99 and the autocorrelation is almost completely removed. Hence, the private sector's time deposit ratio is an important determinant of the statutory reserve ratio.

3.4 The Aggregate Reserve Ratio

In Section 3.1, we conclude from preliminary evidence that variations in the aggregate reserve ratio are dominated by variations in the statutory reserve ratio, which, in turn, is determined by statutory reserve requirements and the private sector's time deposit ratio (Section 3.3). We now test the aggregate reserve ratio (Equation 4-5) using the empirical Equation 4-8 below.[50]

$$b_1 = b_1(i_{OD}, i_{cal}, \frac{DL}{DT}, D_{50}, D_3) \qquad (4\text{-}8)$$

The variables on the right hand side account for the excess and statutory reserve ratios and have been defined previously (Equation 4-6, 4-7). Perusal

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[50] A similar regression equation is tested by Clark and Bond [22] for Canadian chartered banks for various sub-periods ranging over the years 1900 - 1959.

of the aggregate reserve ratio time series in Table 4.II, for the period 1950 to 1971, indicates the rational for the dummy variables. D_{50} represents the extreme observation in 1950, taking a value of one for that year and zero for the rest, and D_3 captures structural changes for the years 1965 to 1971, as before. The regression results are given in Table. 4.VIII.

In Equation 1, all the coefficients are significant and have the correct sign. Thus, 97 per cent of the variation in b_1 is explained by the private sector's time deposit ratio and the reduction in the statutory cash reserve ratio in 1965; there is also no indication of autocorrelation in the residuals.[51] Accordingly, we accept the result of Equation 1 in support of our hypothesis that the statutory reserve ratio dominates movements in the aggregate reserve ratio. Adding the call rate and banking sector's overdraft rate (both separately and together) in Equations 2 to 4, leaves the result undisturbed. Interest rates are not significant in explaining the aggregate reserve ratio in South Africa.[52] The results also justify our assumption that the vault cash ratio is relatively unimportant and may be assumed to be exogenous.

It may be argued that an increase in the private sector's time deposit ratio will raise the excess reserve ratio so that variable DL/DT also

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51. The private sector's time deposit ratio is equal to 1 - (DL/DT). Note that D_3 is not a pure measure of the change in the statutory reserve requirement on demand deposits. It also captures the influence of monetary policy, economic events and other factors that prove significant in explaining the excess reserve ratio.

52. Clark and Bond [22] find that interest rates and the composition of Bank liabilities are significant explanatory variables for the aggregate reserve ratio in Canada.

TABLE 4.VIII

REGRESSION ESTIMATES OF THE AGGREGATE RESERVE RATIO
AND THE EXCESS RESERVE RATIO EQUATIONS

Dependent variable = b_1

	C	i_{OD}	i_{cal}	DL/DT	D_{50}	D_2	D_3	$\bar{R}^2$	DW
1.	-1.82			0.69	0.33		-0.25	0.97	2.09
	(-64.97)			(6.73)	(7.25)		(-6.03)		
2.	-1.83		0.015	0.74	0.33		-0.25	0.98	2.10
	(-63.25)		(0.31)	(3.82)	(6.79)		(-4.75)		
3.	-1.94	0.072		0.73	0.33		-0.25	0.98	2.08
	(-5.91)	(0.35)		(4.34)	(7.05)		(-5.86)		
4.	-1.91	0.056	0.0052	0.74	0.33		-0.25	0.98	2.09
	(-3.82)	(0.18)	(0.07)	(3.71)	(6.49)		(-3.69)		

Dependent Variable = e_{CB}

	C	i_{OD}	i_{cal}	DL/DT	D_{50}	D_2	D_3	$\bar{R}^2$	DW
5.	-68.93	39.52	-8.20	-8.11		-2.09	-11.35	0.33	2.32
	(-3.08)	(2.86)	(-2.44)	(-0.71)		(-1.35)	(-2.42)		

SOURCE: South African Reserve Bank Quarterly Bulletin. Basic data for the interest rate variables may be found in Table A.19.1 and data for the aggregate and excess reserve ratios are given in TABLE 4.II.

NOTES: $\bar{R}^2$ = the adjusted coefficient of determination, DW = Durbin-Watson statistic and t-values are given in parentheses. The regression equations are estimated in logarithmic form using annual year-end data for the period 1950-1971. b_1 = the aggregate reserve ratio and e_{CB} = the excess reserve ratio, calculated in Table 4.II (see Appendix A.15). DL/DT = the ratio of demand liabilities to total banking sector deposits, i_{cal} = call deposit rate at the National Finance Corporation, i_{OD} = commercial banks' minimum overdraft rate and the D variables are constructed dummy variables. See notes to Tables 4.IV and 4.VII for further information on the independent variables. D_{50} accounts for an extreme observation in 1950, taking the integer 1 for that year and zero for the years 1951-1971. C = constant term.

reflects variations in the excess reserve ratio. This may be true for the short-run, but in the long-run, the banking sector will adjust its excess reserve ratio to the desired level. Equation 5 indicates that the ratio of demand liabilities to total deposits (DL/DT) is not significant in the excess reserve ratio equation, while the remaining results in this equation are substantially unchanged (see Equation 10 in Table. 4.IV).

3.5 Summary and Conclusions

In Section 3 of this chapter, the determinants of the aggregate reserve ratio are evaluated; illuminating the effects on the banking sector of monetary policy, the function of the South African money market and the portfolio behaviour of the private sector. An analytical simplification is also justified empirically. The aggregate reserve ratio summarises the behaviour of the banking sector, and enters the money supply and interest rate determination process as a component of the money and credit market multipliers.

The determination of the aggregate reserve ratio is examined by constructing a set of formal hypotheses capable of empirical investigation.

1. As a set of profit maximising financial institutions, the banking sector lowers its optimum excess reserve ratio in response to the initiation of a money market.

2. The existence of a money market enables the banking sector to stabilize its excess reserve ratio against fluctuation in income, international reserves and the demand for bank credit, by varying its portfolio of money market earning assets.

3. Vault cash represent transactions balances held by the banking sector and varies slowly over time in response to structural changes in payments habits and technological innovation in the payments mechanism.

4. The largest and most volatile component of the aggregate reserve ratio is the statutory reserve ratio which varies directly with policy changes in statutory reserve requirements and inversely with the private sector's time deposit ratio.

Several implications follow from these hypotheses.

1. Variations in the aggregate reserve ratio are dominated by monetary policy and the portfolio allocation behaviour of the private sector, and hence, variations in the statutory reserve ratio explain almost all the variation in the aggregate reserve ratio.

2. The relative unimportance of the excess reserve and vault cash ratios, permit us to assume that the former is constant (although endogenously determined) and the latter is an exogenous constant. Such assumptions facilitate convenient analytical simplification in our comparative static analysis in Chapter 3 (Section 2.3).

3. In the long-run, the banking sector is able to adjust to exogenous changes in the excess reserve ratio by making use of the stabilizing function performed by the money market.

4. In the short-run, an increase in the statutory reserve requirement

on demand deposits may be used to offset endogenous increases in the money supply due to an increase in the time deposit ratio.

We present empirical evidence to support the above hypotheses and associated implications.

1. The vault cash ratio (v).

The vault cash ratio has a high mean relative to the excess reserve ratio but an extremely low standard deviation relative to the statutory and aggregate reserve ratio. In terms of simple correlation coefficients, the aggregate reserve ratio has a stronger positive association with the vault cash ratio than with the excess reserve ratio but the statutory reserve ratio is the most strongly correlated component of the aggregate reserve ratio.

From regression analysis, 97 per cent of the variation in the aggregate reserve ratio is explained by endogenous and policy variables that, a priori, do not affect the vault cash ratio, e.g. interest rates and wealth. Consequently, the vault cash ratio appears to be exogenously determined and unimportant in explaining the aggregate reserve ratio. For analytical purposes, it seems justifiable to treat the vault cash ratio as an exogenous constant in the South African context; a device which provides convenient analytical simplification.

2. The excess reserve ratio (e_{CB}).

Observing the time series for the excess reserve ratio (identified as cash reserves held as deposits in the Reserve Bank as speculative balances) reveals a sharp downward shift followed by a stable plateau, terminating in an upward trend. The initial downward shift is explained by the post war decline in the optimum excess reserve ratio held by the banking sector and the initiation of the South African money market, which accelerated the post war decline. The plateau period which followed is explained by the function of money market.

We conclude that the banking sector initially reduced its optimum excess reserve ratio in the post war period followed by an accelerated rate of decline due to the creation of interest-bearing money market earning assets. From then on, the excess reserve ratio was stabilized against economic fluctuation and monetary policy. Thus, the South African money market performed the function expected of it by channeling otherwise idle resources into productive uses, thereby, stabilizing the excess reserve ratio in the banking sector. Money market earning assets replaced excess cash reserves in the banking sector as the first line of defence, following a cash reserve drain or inflow.

In 1965, a discontinuity occurred in the relatively stable behaviour of the excess reserve ratio, maintained in the previous fifteen years. From 1965 to 1971, the optimum excess reserve ratio increased steadily due to continuing structural changes in the underlying economic situation, both domestically and internationally, and due to monetary policy constraints, which prevented the banking sector from maintaining its historically low excess reserve ratio. While the excess reserve ratio remained responsive to interest rate changes, it varied systematically with fluctuations in economic activity and international reserves. We attribute the lack of stability in this period to a continuous state of uncertainty due to persistent domestic inflation, erratic monetary policy control and international currency crises. In this period, the money market appears to have been less efficient in its stabilization function, suggesting that in periods of relative uncertainty, cash reserves replace money market earning assets as the banking sector's first line of defence.

For the period 1950 to 1971 as a whole, therefore, the evidence suggests that the excess reserve ratio is unimportant in explaining the aggregate reserve ratio. Relative to the means and standard deviations of the aggregate and statutory reserve ratios, the mean and standard deviation of the excess reserve ratio is small in magnitude. Of all the components of the aggregate reserve ratio, the correlation coefficient of the excess reserve ratio is the lowest. The variables in the aggregate reserve ratio regression equation explain 97 per cent of the variation in the aggregate reserve ratio; these variables being not significant in the excess reserve ratio regression equation; while, the explanatory variables in the excess reserve ratio equations are not significant in the aggregate reserve ratio regression equation.

These results support our a priori hypotheses, that the establishment and successful functioning of a money market will lower and stabilize the optimum excess reserve ratio in the banking sector at an historically low level. We find that the excess reserve ratio is analytically unimportant in the money supply and interest rate determination process in South Africa, and treat it as a constant. This device facilitates, with empirical justification, an analytical simplification adopted in our comparative static analysis of the money supply model.

3. The statutory reserve ratio (b_{11}).

Empirical analysis supports our hypotheses about the response patterns of the statutory reserve ratio. Comparing the average elasticities of the statutory reserve ratio with respect to changes in statutory reserve requirements and the private sector's time deposit ratio, we find that the statutory reserve ratio responds positively to changes in statutory reserve requirements and negatively to the time deposit ratio; the response being strongest in the case of a change in the statutory reserve requirement on demand deposits and a transfer of demand deposits to time deposits, relative to a change in the time deposit ratio, and a change in demand deposits holding time deposits constant.

From our regression analysis, the private sector's time deposit ratio and monetary policy explain 99 per cent of the variation in the statutory reserve ratio. In the period 1950 to 1971, we ascribe the observed decline in the statutory reserve ratio, to reductions in the statutory reserve requirements on demand and time deposits by the Monetary Authorities, and to variations in interest rates and wealth which caused the private sector to raise their time deposit ratio.

That this decline in the statutory reserve ratio in the banking sector did not cause a corresponding increase in the excess reserve ratio, supports the hypothesis that in the long-run the banking sector adjusts to an exogenous increase in excess reserves by purchasing money market earning assets. In the short-run, the results have implications for monetary policy. The Monetary Authorities can offset an endogenous increase in the money supply due to a rise in the time deposit ratio, by raising the statutory reserve requirement on demand deposits. A 1 per cent transfer of demand to time deposits requires an increase in the statutory reserve requirement on demand deposits of less than 1 per cent, approximately. The South African Monetary Authorities never used this instrument effectively however, relinquishing their power to vary the cash reserve ratio in favour of a variable liquid asset ratio policy instrument; a change which proved unsuccessful in controlling the money supply.

4. The aggregate reserve ratio (b_1): an overall view.

The aggregate reserve ratio regression results support our empirical observations above, and our hypotheses about the behaviour of the excess reserve and vault cash ratios.

We find that 97 per cent of the variation in the aggregate reserve ratio is explained by monetary policy and private sector portfolio allocation behaviour. Statutory reserve requirements and the time deposit ratio are highly significant while interest rates are statistically insignificant. That the excess reserve ratio is not important is further demonstrated, by the insignificance of the time deposit ratio in the excess reserve ratio regression equation. This implies that in the short-run, variations in the time deposit ratio do not disturb the long-run stabilization of the excess reserve ratio, due to the functioning of the money market. Hence, the observed decline in the aggregate reserve ratio is explained by the observed rise in the time deposit ratio and a decline in statutory reserve requirements.

We conclude that the aggregate reserve ratio is dominated by variations in the statutory reserve ratio due to the development of the South African money market. Since excess reserves and vault cash are unimportant, we treat them as constants for analytical purposes (the excess reserve ratio is endogenously determined and the vault cash ratio is assumed exogenous). This simplified formultion of banking sector behaviour (embodied in the aggregate reserve ratio and correspondingly in the statutory reserve ratio) appears to be empirically justifiable as an appropriate procedure for monetary analysis in South Africa. The behaviour of the banking sector and the money market is in accordance with our a priori hypotheses during periods of relative stability, whereas, during periods of economic uncertainty, the efficient functioning of the money market is impaired.

4. SOURCES OF THE MONETARY BASE

In our theoretical framework in Chapter 2 (Section 2), the adjusted monetary base is defined as an exogenous policy variable linking the actions of the Monetary Authorities to the money supply and credit market rate. In principle, the Reserve Bank may control the base through variations in its portfolio of government debt, thereby, insulating the banking sector from exogenous fluctuations in international reserves, and the monetary effect of Government fiscal policy, financed by changes in the net indebtedness of the Treasury to the Reserve Bank.

Inspection of the literature on South African monetary policy reveals no systematic analysis of the monetary base for the simple reason that the South African Monetary Authorities, in pursuance of an interest rate stabilization programme, have permitted the monetary base to fluctuate exogenously in response to variations in international reserves. Open market operations have not been used as a policy instrument in South Africa, due to the lack of a sufficiently well organized private market for government debt. We demonstrate in Section 8.4 that the monetary base is indispensible to an understanding of the money supply and interest rate determination process in South Africa.

In this section, we examine the sources of the monetary base and find that the base is dominated by the balance of payments.

The complete source identity for the monetary base is defined in Equation 2-1, in terms of assets and liabilities contained in the consolidated balance sheets of the South African Reserve Bank and the South African Mint. In Table 4.IX we provide the average annual contribution of the most important source components to percentage changes in the monetary base, for twelve half-cycles and for the period 1954 to 1971.[53] Our analysis concentrates on the

53. Appendix A.16 contains the data from which Table 4.IX is calculated.

TABLE 4.IX

AVERAGE CYCLICAL CONTRIBUTIONS OF BASE SOURCES TO CHANGES IN THE MONETARY BASE:1954-1971 (%)

Business Cycles		ΔB/B	ΔIR/B	Δ(GLOAN-RG)/B	ΔAFI/B	ΔS/B	ΔGLOAN/B	ΔRG/B
EXP.	54.I -55.I	3.64	8.91	10.29	- 0.76	- 4.06	- 3.50	- 6.80
CONTR.	55.II-56.III	4.17	- 2.43	0.68	5.32	7.76	0.52	0.16
EXP.	56.IV-57.IV	3.78	- 0.41	5.84	0.24	4.56	2.20	3.55
CONTR.	58.I -59.I	1.21	- 9.04	- 0.95	7.79	7.89	- 0.68	- 0.27
EXP.	59.II-60.I	1.90	22.30	- 8.45	-12.85	-18.95	- 2.06	- 6.39
CONTR.	60.II-61.III	-0.80	-18.17	2.35	9.28	2.10	- 0.25	2.61
EXP.	61.IV-65.I	9.81	23.41	- 6.99	- 1.38	- 3.73	1.26	- 8.25
CONTR.	65.II-65.IV	-3.82	-29.20	16.40	5.06	9.35	3.60	12.79
EXP.	66-I -67.I	9.77	24.59	-16.63	1.21	- 1.28	- 0.99	-15.64
CONTR.	67.II-67.IV	6.05	-16.14	5.87	7.59	4.95	- 4.58	10.45
EXP.	68.I -69.III	11.03	59.57	- 44.18	- 1.80	0.16	- 0.75	-43.43
CONTR.	69.IV-71.IV	8.30	-30.96	31.54	10.56	3.39	8.30	23.24
MEAN	54.I -71.IV	5.78	5.78	-2.50	2.50	0.57	0.88	- 3.42

SOURCE: South African Reserve Bank Quarterly Bulletin: balance sheet of the South African Reserve Bank. Basic quarterly data at an annual rate is provided in Table A.16.I.The business cycles for 1954-1967 are those identified by D. J. Smit and B. E. vander Walt [85]; cycles for 1968-1971 are obtained from analysis of our own data. NOTES: The average contribution of source component x (say) to percentage changes in the base for a particular half-cycle is obtained from the following formula:

$$\frac{\Delta x}{B} = \frac{1}{n}\sum_{t=1}^{T} \frac{X_t - X_{t-1}}{B_{t-1}}$$

where n = the total number of quarters covered by the half-cycle, and Δ = the first difference between corresponding quarters in adjacent years. EXP. and CONTR. denote expansion and contraction phases respectively. The mean for the period 1954.I-1971.IV (calculated from Table A.16.1) is the average annual contribution.

B = monetary base, IR = international reserves, GLOAN = Reserve Bank loans to the Government, RG = Government deposits at the Reserve Bank, AFI = Reserve Bank loans to the banking and private sectors, S = government securities held by the Reserve Bank.

four source components IR, GLOAN-RG, AFI, S, which summarise respectively, the influence on the monetary base of the balance of payments, the monetary effects of the Government's deficit finance, Reserve Bank credit to the banking and private sectors, and open market operations.[54]

For the period 1954.I to 1971.IV, the monetary base grew at an average annual rate of 5.78 per cent, exactly matched by the annual average growth rate in the contribution of international reserves (IR) . Reserve Bank lending to the banking and private sectors, and open market operations, contributed a further 3.07 per cent increase which was almost completely offset by a decline in the base of -2.53 per cent due to an increase in Government net indebtedness to the Reserve Bank.[55] Thus, on average over the long-run, the monetary base is dominated positively by the balance of payments and Reserve Bank lending to the financial system, with a strong negative influence being exercised by the financing of the Governments budget deficit. Open market operations are not a significant determinant of the base.

Turning to a cyclical analysis of the base and the contributions of its source components, the period 1954 to 1971 is divided into twelve half-cycles, over which the monetary base clearly moved in a pro-cyclical fashion either declining or growing at a relatively slower rate during periods of contraction. Strong pro-cyclical variations in the base appear to commence in the first quarter of 1958, continuing to the fourth quarter of 1971, with contra-cyclical variations for the period 1954.I to 1957.IV.

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54. IR = the stock of international reserves held by the Reserve Bank, GLOAN = Reserve Bank loans to the Government, RG = the Government's account at the Reserve Bank, AFI = Reserve Bank lending to the banking and private sectors, S = the Reserve Bank's portfolio of government debt.

55. The residual increase in the base of 0.54 per cent is accounted for by the positive contribution of the currency supply, and measurement error.

TABLE 4.X

CORRELATION MATRIX BETWEEN SOURCE CONTRIBUTIONS OF AND PERCENTAGE CHANGES IN THE MONETARY BASE

	B	IR	AFI	S	GLOAN - RG	GLOAN	$\dot{RG}$
B	...	0.47	0.044	-0.22	-0.32	0.029	-0.36
IR	...	...	-0.450	-0.55	-0.85	-0.350	-0.85
AFI	...	...	...	0.56	0.11	0.074	0.10
S	...	...	...	...	0.28	0.230	0.25
GLOAN - RG	...	...	...	...	...	0.510	0.99
RG	...	...	...	...	...	...	0.32

NOTES : The simple correlation coefficients are calculated from quarterly data at an annual rate for the period 1954-1971 (see Table A.16.1).

The balance of payments (measured by changes in the stock of international reserves at the Reserve Bank), are closely tied to business cycles in South Africa, exerting a pro-cyclical influence on the base, which is dampened by the contra-cyclical contributions of (GLOAN-RG) and S. This much is evident from the larger contributions of IR relative to cyclical percentage changes in B, indicating that the contra-cyclical actions of the Monetary Authorities, exercised through Reserve Bank lending (AFI) and open market operations (S), are ineffectual. The evidence also suggests that these policies were fairly closely co-ordinated; the simple correlation coefficient between the contribution of AFI and S being 0.56 (Table 4.X). However, that contra-cyclical monetary policy was not exercised by the Reserve Bank through the monetary base, by failure to offset balance of payments influences, is seen from the low negative correlation coefficient between the contribution of international reserves, Reserve Bank lending to the banking and private sectors and open market operations, where $r_{IR,AFI}$ = -0.45 and $r_{IR,S}$ = -0.55. Open market operations appear to have been more closely linked to the balance of payments than was Reserve Bank lending to the banking and private sectors.

The monetary effects of fiscal finance are assessed from the contribution to changes in the base of Government net indebtedness to the Reserve Bank (GLOAN-RG). For the period 1954 to 1959, (GLOAN-RG) is pro-cyclical with a contra-cyclical movement from 1959.II to 1971.IV. Thus, fiscal policy financed by the Reserve Bank appears to have been part of the dampening policy of the Monetary Authorities.

The main source of contra-cyclical variation in (GLOAN-RG) stems from the Government's account at the Reserve Bank (RG).[56] From Table 4.IX, the

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56. See Sec. 2.

contribution of GLOAN displays no obvious cyclical tendencies. For the overall period, variations in RG caused an annual average decline in the base of -3.42 per cent, as opposed to a weak positive contribution of 0.88 per cent due to variations in GLOAN, the difference reflecting the negative contribution of -2.50 per cent caused by net Government indebtedness to the Reserve Bank.

In Table 4.X, the strong negative correlation between IR and RG indicates a concerted policy to offset pro-cyclical balance of payments movements with contra-cyclical variations in the Government's account at the Reserve Bank. However, with respect to variations in the base, the contra-cyclical effects of RG are weak relative to the pro-cyclical effects of changes in IR. RG dominates the contra-cyclical influences of AFI and S, and S in turn, dominates the influence of AFI. Hence, Government net indebtedness to the Reserve Bank became a tool of contra-cyclical monetary policy in the second quarter of 1959, exercised mainly through variations in the Government's account at the Reserve Bank. The close association between the Government's net indebtedness to the Reserve Bank and movements in the balance of payments, is seen from the high negative correlation coefficient of -0.85, compared with those for open market operations and Reserve Bank lending (Table 4.X).

By comparing the correlation coefficients between the percentage changes in the monetary base and the percentage contributions of its source components, it appears that pro-cyclical variations in the balance of payments exercise the strongest positive influence which is not offset by the weak contra-cyclical actions of the Monetary Authorities exercised through Government net indebtedness to the Reserve Bank and open market operations, while Reserve Bank lending to the banking and private sectors contributes weakly to increases in the monetary base.

TABLE 4.XI

AVERAGE CYCLICAL CONTRIBUTIONS OF THE MONETARY BASE AND RESERVE BANK LENDING TO CHANGES IN THE ADJUSTED MONETARY BASE (%)

Business Cycles	$\Delta B^a/B^a$ =	$\Delta B/B$	$-\Delta AFI/B$
EXP. 54.I -55.I	5.34	4.02	- 1.32
CONTR. 55.II-56.III	- 0.77	4.46	5.23
EXP. 56.IV-57.IV	4.62	4.18	- 0.44
CONTR. 58.I -59.I	- 3.18	1.63	4.81
EXP. 59.II-60.I	20.52	2.25	-18.23
CONTR. 60.II-61.III	-11.05	- 2.28	9.77
EXP. 61.IV-65.I	13.81	11.29	- 2.52
CONTR. 65.II-65.IV	- 9.86	- 4.30	5.56
EXP. 66.I -67.I	11.07	11.75	0.67
CONTR. 67.II-67.IV	- 2.23	7.36	9.59
EXP. 68.I -69.III	16.81	12.93	- 3.88
CONTR. 69.IV-71.IV	- 1.81	10.81	12.62
54.I-71.IV			
Mean	4.98	6.82	1.83
Standard Deviation	17.78	6.15	16.15

NOTES: The adjusted monetary base (B^a) is defined as B - AFI. This table is calculated from Table 4.IX using the formula:

$$\left(\frac{\Delta B^a}{B^a}\right)_j = \frac{1}{n}\sum_{t=1}^{T}\left(\frac{\Delta B_t}{B^a_{t-1}} - \frac{\Delta AFI_t}{B^a_{t-1}}\right)_j$$

where: j = any half-cycle, n = the number of quarters contained in j and
Δ = the first difference between corresponding quarters in adjacent years. The means and standard deviations are calculated for the period 1954-1971 using quarterly data with changes at an annual rate (Table A.16.2).

By deducting the endogenously determined supply of Reserve Bank credit (AFI) from the monetary base (B) we obtain the adjusted monetary base (B^a), which is the exogenous policy variable in our analytical framework (see Chapter 2, Sections 2, 5). Contra-cyclical variations in AFI accompanied by pro-cyclical movements in B generate strong pro-cyclical movements in B^a.

In Table 4.XI, this cyclical pattern is obvious over the twelve half-cycles. The adjusted monetary base increased at an average annual growth rate of 4.98 per cent due to a positive average annual contribution by the monetary base of 6.82 per cent and a negative contribution by AFI of 1.83 per cent per annum. On these grounds we conclude that the Monetary Authorities negated the possibility of contra-cyclical monetary policy by failing to use the adjusted monetary base as a policy instrument.

4.1 Summary and Conclusions

An examination of the relative percentage contributions of the four main components of the monetary base to percentage changes in the base, provides quantitative information on the determinants of the central policy variables in our analytical framework, and on the course of monetary policy exercised through open market operations, Reserve Bank lending, and the Reserve Bank's role as Government Banker. The thrust of monetary policy pursued by the Monetary Authorities is measured by the adjusted monetary base (defined as the monetary base adjusted for Reserve Bank lending to the banking and private sectors, which is endogenously determined). The information we obtain bears directly on further empirical issues to be examined later in this chapter: the determinants of the money stock and credit market rate; the relative importance of open market operations, Bank Rate policy and variable cash reserve ratios as policy instruments; the role of last resort lending; and the monetary impact of Government fiscal finance from the Reserve Bank.

From our analysis, the following broad results are obtained on an average per annum basis.

1. The balance of payments exercises the strongest single influence on the monetary base.

2. Open market operations and lender of last resort facilities contribute positively to the annual average growth rate in the monetary base.

3. However, the monetary effects of fiscal policy financed by the Reserve Bank, contributes negatively to the average per annum growth rate in the monetary base, mainly through variations in the Government's account at the Reserve Bank. This influence is sufficiently strong to offset the positive effects of open market operations and lender of last resort facilities.

Over the course of the business cycle, the evidence suggests the following.

1. The monetary base behaves pro-cyclically on average for the period 1958 to 1971, reflecting similar movements in international reserves. The contributions of all other source components, behave contra-cyclically.

2. The contributions of Reserve Bank lending, open market operations and the Government's account, exhibit contra-cyclical tendencies, which are insufficient to offset the influence of international reserves. Of these three policy instruments, the strongest contra-cyclical influence is exerted by the Government's account, followed by open market operations and last resort lending facilities.

These empirical results imply that the balance of payments is the main source component of the monetary base on an average per annum basis as well as over the business cycle. Pro-cyclical movements in the base are caused solely by similar variations in international reserves. The Monetary Authorities employed a consistent but inadequate contra-cyclical policy exercised mainly through variations in the method of Government fiscal finance.

We conclude, in general, that the monetary base is exogenously determined by the balance of payments, both cyclically and secularly, reflecting the pro-cyclical movement in international reserves as well as its average annual growth rate. Linking the monetary base to pro-cyclical movements in the balance of payments, is consistent with the interest rate stabilization policy pursued by the Monetary Authorities. This may explain the lack of analytical interest displayed by the Monetary Authorities in the monetary base, as a policy instrument. That the monetary base is exogenously determined does not negate its causal influence on the money supply or credit market rate; the strength of this relationaship is measured in Section 7, and supports the view that the monetary base is indispensable to an understanding of the money supply and interest rate determination process in South Africa. These conclusions apply equally to the adjusted monetary base, which is a mirror image of the monetary base corrected for endogenous influences.

5. THE RELATIVE CONTRIBUTIONS OF THE ADJUSTED MONETARY BASE AND THE MONEY MULTIPLIER TO CHANGES IN THE MONEY SUPPLY

The money supply model implies that all movements in the money stock (M_2) are due to changes in the money multiplier (m) and the adjusted monetary base. While the adjusted monetary base summarises the exogenous influences of the Reserve Bank, the Treasury and the balance of payments, the money multiplier reflects the portfolio allocation behaviour of the banking and private sectors, which respond to changes in the endogenously determined credit market rate and exogenous variables (real wealth, the price level and income distirbution). Policy actions of the Monetary Authorities are also reflected in the multiplier through the aggregate reserve ratio and the Reserve Bank lending ratio, which respond to changes in statutory reserve requirements and Bank Rate, respectively. The money multiplier links the adjusted monetary base to the money supply and is not a constant, varying in response to changes in the credit market rate, caused by an initial change in the adjusted base. Whether or not the Monetary Authorities choose to exercise monetary policy through the adjusted base, the feedback effect on the multiplier of changes in the adjusted base must be taken into account; induced changes in the multiplier resulting from changes in the base may accentuate or attenuate the effects on the money stock of changes in the monetary base.

In this section, we examine the relative contributions of the adjusted monetary base and the money multiplier to the growth rate of the money stock.

The semi-reduced form for the money supply is:

$$M_2 = mB^a \qquad (4-9)$$

which is written in logarithmic form as:

$$\log M_2 = \log m + \log B^a \qquad (4\text{-}10)$$

Differentiating with respect to time, we obtain the percentage change in the money supply in terms of percentage changes in the multiplier and the adjusted monetary base.

$$\frac{1}{M_2}\frac{dM_2}{dt} = \frac{1}{m}\frac{dm}{dt} + \frac{1}{B^a}\frac{dB^a}{dt} \qquad (4\text{-}11)$$

Approximating the above expression for discrete time, the percentage change in the money supply is defined as the sum of the percentage changes in the multiplier and the adjusted base plus an error term.[57]

$$\frac{\Delta M_2}{M_2} = \frac{\Delta m}{m} + \frac{\Delta B^a}{B^a} + u \qquad (4\text{-}12)$$

In Table 4.XII we calculate the annual percentage changes in the money stock, the adjusted monetary base and the money multiplier (as well as the H coefficient, to be explained below) for corresponding quarters of adjacent years, and the means for the entire period 1954.I to 1957.IV. The same information for quarterly periods is contained in Table 4.XIII.

Referring to Table 4.XII, the money supply increased at an average per annum growth rate of 8 per cent, accounted for by an average growth rate in the adjusted monetary base and the money multiplier of 5 per cent and 3 per cent respectively. Hence, the base and the multiplier contribute 60 per cent and 40 per cent respectively to the average growth rate of the money stock.

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57. Since the error term (u) is small we ignore it, and approximate $\Delta m/m = \Delta M_2/M_2 - \Delta B^a/B^a$ for the purpose of calculating Tables 4.VII and 4.XIII.

TABLE 4.XII

RELATIVE ANNUAL CONTRIBUTIONS OF THE ADJUSTED MONETARY BASE AND THE MONEY MULTIPLIER TO CHANGES IN THE MONEY SUPPLY: 1954-1971 (%)
(Money Values In Millions of Rand)

Year and Quarter		M_1	$\Delta M_1/M_1$	B^a	$\Delta B^a/B^a$	m	$\Delta m/m$	H
1954	1	961.00	2.38	236.40	-18.03	4.07	20.41	0.47
	2	976.00	1.16	296.60	8.80	3.29	- 7.64	0.54
	3	1024.40	5.78	306.60	11.90	3.34	- 6.12	0.66
	4	1072.00	7.30	321.80	9.98	3.33	- 2.68	0.79
1955	1	1024.80	6.64	269.60	14.04	3.80	- 7.41	0.65
	2	1042.40	6.80	264.60	-10.79	3.94	17.59	0.38
	3	1095.20	6.91	286.20	- 6.65	3.83	13.56	0.33
	4	1128.80	5.30	310.80	- 3.42	3.63	8.72	0.28
1956	1	1090.00	6.36	233.60	-13.35	4.67	19.72	0.40
	2	1124.30	7.86	307.40	16.18	3.66	- 8.32	0.66
	3	1180.80	7.82	324.60	13.42	3.64	- 5.60	0.71
	4	1229.40	8.91	331.00	6.50	3.71	2.41	0.73
1957	1	1193.40	9.49	276.20	18.24	4.32	- 8.75	0.68
	2	1231.50	9.53	321.00	4.42	3.84	5.11	0.46
	3	1287.90	9.07	340.80	4.99	3.78	4.08	0.55
	4	1318.70	7.26	294.40	-11.06	4.48	18.32	0.38
1958	1	1226.00	2.73	189.60	-31.35	6.47	34.09	0.48
	2	1259.70	2.29	223.20	-30.47	5.64	32.76	0.48
	3	1268.50	- 1.51	289.20	-15.14	4.39	13.63	0.53
	4	1298.10	- 1.56	322.00	9.38	4.03	-10.94	0.46
1959	1	1248.60	1.84	287.60	51.69	4.34	-49.84	0.51
	2	1315.90	4.46	341.10	52.82	3.86	-48.36	0.52
	3	1353.60	6.71	342.40	18.40	3.95	-11.69	0.61
	4	1373.50	5.81	354.50	10.09	3.87	- 4.28	0.70
1960	1	1375.00	10.12	289.80	0.76	4.75	9.36	0.08
	2	1399.90	6.38	296.60	-13.05	4.72	19.43	0.40
	3	1413.10	4.40	303.20	-11.45	4.66	15.84	0.42
	4	1407.40	2.47	294.30	-16.98	4.78	19.45	0.47
1961	1	1397.90	1.67	233.10	-19.57	6.00	21.23	0.48
	2	1370.40	- 2.11	269.40	- 9.17	5.09	7.06	0.56
	3	1436.20	1.63	315.00	3.89	4.56	- 2.26	0.63
	4	1469.80	4.43	349.10	18.62	4.21	-14.19	0.57
1962	1	1463.00	4.66	353.80	51.78	4.14	-47.12	0.52
	2	1578.80	15.21	384.60	42.76	4.11	-27.55	0.61
	3	1660.80	15.64	371.60	17.97	4.47	- 2.33	0.89
	4	1726.90	17.49	364.50	4.41	4.74	13.08	0.25

TABLE 4.XII - Continued

Year and Quarter	M_2	$\Delta M_2/M_2$	B^a	$\Delta B^a/B^a$	m	$\Delta m/m$	H
1963 1	1678.80	14.75	368.20	4.07	4.56	10.68	0.28
2	1754.40	11.12	391.80	1.87	4.48	9.25	0.17
3	1792.00	7.90	394.80	6.24	4.54	1.66	0.79
4	1858.10	7.60	433.90	19.04	4.28	-11.44	0.62
1964 1	1853.20	10.39	419.10	13.82	4.42	- 3.44	0.80
2	1952.90	11.31	430.50	9.88	4.54	1.44	0.87
3	2003.40	11.80	421.30	6.71	4.76	5.08	0.57
4	2161.80	16.34	463.50	6.82	4.66	9.52	0.42
1965 1	2119.10	14.35	374.60	-10.62	5.66	24.97	0.30
2	2231.80	14.28	344.90	-19.88	6.47	34.17	0.37
3	2224.80	11.05	396.80	- 5.82	5.61	16.87	0.26
4	2328.60	7.72	445.50	- 3.88	5.23	11.60	0.25
1966 1	2253.10	6.32	453.90	21.17	4.96	-14.85	0.59
2	2447.10	9.65	458.80	33.02	5.33	-23.38	0.59
3	2493.40	12.07	407.20	2.62	6.12	9.45	0.22
4	2563.30	10.08	451.70	1.39	5.68	8.69	0.14
1967 1	2550.50	13.20	441.00	- 2.84	5.78	16.04	0.15
2	2663.70	8.85	462.80	0.87	5.76	7.98	0.10
3	2603.20	4.40	343.90	-15.55	7.57	19.95	0.44
4	2748.50	7.23	487.70	7.97	5.64	- 0.74	0.91
1968 1	2727.00	6.92	547.20	24.08	4.98	-17.16	0.58
2	2931.60	10.06	534.50	15.49	5.49	- 5.44	0.74
3	3003.70	15.38	461.80	34.28	6.50	-18.90	0.64
4	3182.80	15.80	556.80	14.17	5.72	1.63	0.90
1969 1	3170.70	16.27	562.80	2.85	5.63	13.42	0.18
2	3348.80	14.23	557.40	4.28	6.01	9.95	0.30
3	3305.40	10.04	565.60	22.48	5.84	-12.43	0.64
4	3616.10	13.61	647.20	16.24	5.59	- 2.62	0.86
1970 1	3595.80	13.41	543.20	- 3.48	6.62	16.89	0.17
2	3710.30	10.79	590.60	5.96	6.28	4.84	0.55
3	3717.00	12.45	395.50	-30.07	9.40	42.53	0.41
4	3739.20	3.40	519.40	-19.75	7.20	23.15	0.46
1971 1	3754.90	4.42	558.00	2.72	6.73	1.70	0.62
2	3983.70	7.37	567.90	- 3.84	7.02	11.21	0.26
3	3905.20	5.06	472.90	19.57	8.26	-14.51	0.57
4	3948.40	5.59	500.70	- 3.60	7.89	9.20	0.28
Mean	...	8.14	...	4.98	...	3.16	0.50
Standard Deviation	...	4.63	...	17.78	...	17.63	0.21
Mean Ratio	...	100.00	...	61.18	...	38.82	...

SOURCE: South African Reserve Bank Quarterly Bulletin. Basic data used to calculate M_2 and B^a are given in Tables A.19.VII and A.19.X.

NOTES: Percentage changes in M_2 and B^a are calculated with the formula:

$$\frac{\Delta X}{X} = \frac{X_t - X_{t-1}}{X_{t-1}}$$

where Δ = first differences of corresponding quarters in adjacent years. B^a = C_p + R where C_p = currency in the hands of the public and R = aggregate banking sector reserves. $M_2 = C_p + D + T$ where, D = demand deposits and T = time deposits. The money multiplier is defined as M_2/B^a and percentage changes in the multiplier are approximated by the formula:

$$\frac{\Delta m}{m} = \frac{\Delta M_2}{M_2} - \frac{\Delta B^a}{B^a}$$

(see footnote 57 in Chap.4). The H coefficient is obtained from the formula:

$$H = \frac{\left|\frac{\Delta B^a}{B^a}\right|}{\left|\frac{\Delta B^a}{B^a}\right| + \left|\frac{\Delta m}{m}\right|}$$

where Δ is as defined above. The means and standard deviations of percentage changes are calculated at an annual rate for the period 1954-1971 from quarterly data. The mean ratio is the ratio of the means of percentage changes in m and B^a to the mean of percentage changes in M_2.

On an average annual basis therefore, both the adjusted base and the money multiplier contribute positively to the growth rate in the money stock, with the influence of the base being only slightly stronger than that of the multiplier; the latter, accentuating the influence of the former.

The correlation coefficients between M_2, B^a and m, provide a measure of association supporting the above conclusions. These correlation coefficients are $r_{M_2,B^a} = 0.89$ and $r_{M_2,m} = 0.84$, indicating that the association between the money supply and the adjusted base is only slightly stronger than between the money supply and the multiplier. The multiplier and the base are positively associated, where $r_{B^a,m} = 0.52$. It appears that in the long-run (a decade or more), the growth rate of the money stock is dominated by the monetary base, but the accentuating influence of the multiplier cannot be ignored on average.

In order to strengthen these conclusions, we introduce another measure of the relative importance of the monetary base and the multiplier, defined as the H coefficient, where:

$$H = \frac{\left| \frac{\Delta B^a}{B^a} \right|}{\left| \frac{\Delta B^a}{B^a} \right| + \left| \frac{\Delta m}{m} \right|} \qquad (4\text{-}13)$$

If changes in the adjusted base are zero, then H = 0 and if changes in the multiplier are zero, then H = 1. If the percentage change in the base and the multiplier are equal, then H = 0.5. Thus, as percentage changes in the base rise relative to changes in the multiplier, the H coefficient approaches unity. Since the H coefficient is computed with absolute values of percentage changes, it does not account for signs (this is discussed below). On an average per annum basis, H = 0.5 (Table 4.XII) which indicates that percentage changes in the base are matched by equal percentage changes in the multiplier.

From year to year, the adjusted base and the multiplier are of equal significance over the long-run.

Viewing the long-run trend as a succession of quarterly periods, a different pattern emerges. In Table 4.XIII the base accounts for 94 per cent of the change in the money stock and the H coefficient rises to a value of 0.53, indicating that on an average quarterly basis the influence of the multiplier declines and the dominance of the base increases. On average over the trend, quarterly changes in the base exceed quarterly changes in the multiplier in absolute terms.

The sign patterns attached to percentage changes in the base and the multiplier are of crucial importance for analysis of the medium-run (year to year) and short-run (quarter to quarter), reversing the trend relationship. The multiplier attenuates the influence of the base if the signs are different and accentuates the influence of the base if the signs are the same. Attenuation is complete if the percentage change in the multiplier exceeds that of the base and is incomplete, if the percentage change in the base exceeds that of the multiplier. In Table 4.XIV and 4.XV we provide summary information based on the frequency distributions of annual and quarterly percentage changes and for the H coefficients (the frequency distributions are given in Appendix A.17).

Moving from the long-run to the medium and short-run, the importance of the multiplier increases, the increase being relatively greater for the medium-run than for the short-run. In Table 4.XIV we see that in contrast to the accentuating influence of the multiplier over the trend, the multiplier attenuates the influence of the base in the medium and short-run. This attenuating pattern is exhibited for 90 per cent of quarterly changes and 75 per cent of annual changes. In the case of annual and quarterly changes, attenuation is

TABLE 4.XIII

QUARTERLY PERCENTAGE CHANGES IN THE MONEY SUPPLY, THE ADJUSTED MONETARY BASE AND THE MONEY MULTIPLIER: 1954-1971 (%)

Year and Quarter		$\Delta M_2/M_2$	$\Delta B^a/B^a$	$\Delta m/m$	H
1954	1	-3.81	-19.21	15.39	0.56
	2	1.56	25.47	23.90	0.52
	3	4.96	3.37	1.59	0.68
	4	4.65	4.96	- 0.31	0.94
1955	1	-4.40	-16.22	11.82	0.58
	2	1.72	- 1.85	3.57	0.34
	3	5.07	8.16	- 3.10	0.72
	4	3.07	8.60	- 5.53	0.61
1956	1	-3.44	-24.84	21.40	0.54
	2	3.15	31.59	28.45	0.53
	3	5.03	5.60	- 0.57	0.91
	4	4.12	1.97	2.14	0.48
1957	1	-2.93	-16.56	13.63	0.55
	2	3.19	16.22	13.03	0.55
	3	4.58	6.17	- 1.59	0.80
	4	2.39	-13.62	16.01	0.46
1958	1	-7.03	-35.60	28.57	0.55
	2	2.75	17.72	14.97	0.54
	3	0.70	29.57	28.87	0.51
	4	2.33	11.34	- 9.01	0.56
1959	1	-3.81	-10.68	6.87	0.61
	2	5.39	18.60	13.21	0.58
	3	2.86	0.38	2.48	0.13
	4	1.47	3.53	- 2.06	0.63
1960	1	0.11	-18.25	18.36	0.50
	2	1.81	2.35	- 0.54	0.81
	3	0.94	2.23	- 1.28	0.63
	4	-0.40	- 2.94	2.53	0.54
1961	1	-0.68	-20.80	20.12	0.51
	2	-1.97	15.57	17.54	0.47
	3	4.80	16.93	12.12	0.58
	4	2.34	10.83	- 8.49	0.56
1962	1	-0.46	1.35	- 1.81	0.43
	2	7.92	8.71	- 0.79	0.92
	3	5.19	-3.38	8.57	0.28
	4	3.98	- 1.91	5.89	0.24

TABLE 4.XIII - Continued

Year and Quarter		$\Delta M_2/M_2$	$\Delta B^a/B^a$	$\Delta m/m$	H
1963	1	-2.79	1.02	- 3.80	0.21
	2	4.50	6.41	- 1.91	0.77
	3	2.14	0.77	1.38	0.36
	4	3.69	9.90	- 6.22	0.61
1964	1	-0.26	- 3.41	3.15	0.52
	2	5.38	2.72	2.66	0.51
	3	2.59	- 2.14	4.72	0.31
	4	7.91	10.02	- 2.11	0.83
1965	1	-1.98	-19.18	17.20	0.53
	2	5.32	- 7.93	13.25	0.37
	3	- 0.31	15.05	15.36	0.49
	4	4.67	12.27	- 7.61	0.62
1966	1	-3.24	1.89	- 5.13	0.27
	2	8.61	1.08	7.53	0.13
	3	1.89	-11.25	13.14	0.46
	4	2.80	10.93	- 8.12	0.57
1967	1	-0.50	- 2.37	1.87	0.56
	2	4.44	4.94	- 0.50	0.91
	3	-2.27	-25.69	23.42	0.52
	4	5.58	41.81	36.23	0.54
1968	1	-0.78	12.20	12.98	0.48
	2	7.50	- 2.32	9.82	0.19
	3	2.46	-13.60	16.06	0.46
	4	5.96	20.57	14.61	0.58
1969	1	-0.38	1.08	- 1.46	0.43
	2	5.62	- 0.96	6.58	0.13
	3	-1.30	1.47	- 2.77	0.35
	4	9.40	14.43	- 5.03	0.74
1970	1	-0.56	-16.07	15.51	0.51
	2	3.18	8.73	- 5.54	0.61
	3	0.18	-33.03	33.21	0.50
	4	0.60	31.33	30.73	0.50
1971	1	0.42	7.43	- 7.01	0.51
	2	6.09	1.77	4.32	0.29
	3	-1.97	-16.73	14.76	0.53
	4	1.11	5.88	- 4.77	0.55
Mean		1.99	1.87	0.12	0.53
Standard Deviation		3.40	14.77	13.72	0.18
Mean Ratio		100.00	93.97	6.03	...

SOURCE: South African Reserve Bank Quarterly Bulletin. Quarterly data for M_2 and B^a are listed in Table 4.XII. See notes to the latter table for details of formulae used to calculate percentage changes and the H coefficient. In this table, changes are the first differences of adjacent quaters.

TABLE 4.XIV

ATTENUATING AND ACCENTUATING EFFECTS OF CHANGES IN THE MONEY MULTPLIER'ON THE GROWTH RATE OF THE MONEY STOCK:1954-1971

	No. of Changes per Period			% of Total Changes per Period		
	12 Months	3 Months	12 Half-Cycles	12 Months	3 Months	12 Half-Cycles
Attenuation						
Complete	25	20	6	34.72	27.78	50.00
Incomplete	29	45	5	40.28	62.50	41.67
Total	54	65	11	75.00	90.28	91.67
Total Accentuation	18	7	1	25.00	9.72	8.33
Total Changes	72	72	12	100	100	100

NOTES: Frequence distributions of percentage changes in the money multiplier relative to percentage changes in the adjusted monetary base for annual and quarterly periods and over the business cycle are obtained from Tables 4.XII and 4.XIII, and are listed in Table A.17.I, from which this table is derived. Attenuation implies that percentage changes in m and B^a take different signs and accentuation implies that the signs are the same. Complete attenuation implies that percentage changes in m exceed that of B^a in absolute value and incomplete attenuation implies the converse.

TABLE 4.XV

SUMMARY OF THE FREQUENCY DISTRIBUTION OF H COEFFICIENTS:1954-1971

Percentage of H Coefficients taking a Value	Proporton of Total Changes per Period (%)		
	12 Months	3 Months	12 Half-Cycles
Less Than			
0.4	29.17	19.44	33.33
0.5	48.61	34.72	50.00
Greater Than			
0.5	51.39	65.28	50.00
0.6	31.94	25.01	41.67
0.7	16.67	13.90	0.33
0.4 - 0.59	38.89	55.56	25.00
Mean	0.50	0.53	0.52
Standard Deviation	0.21	0.18	...

NOTES: Frequency distributions of the H coefficients for annual and quarterly periods and over the business cycle are obtained from Tables 4.XII and 4.XIII and are listed in Table A.17.II. Data in this table gives the percentage of H coefficients which take certain values between 0 and 1.The means and standard deviations refer to H values which are calculated for annual changes from quarterly data at an annual rate, quarterly changes and average cyclcal changes over twelve half-cycles: all for the period 1954-1971.

complete 34 per cent and 28 per cent of the time respectively. Hence, while attenuation is more likely in the short-run, complete attenuation is more likely in the medium-run. Using this information in conjunction with the means of the H coefficient (H = 0.53 quarterly and 0.5 annually) we conclude that the money multiplier is of greater importance for annual periods than for quarterly periods. The impact of the monetary base on the growth rate of the money stock is less certain for shorter periods relative to long sweeps of time (trends) but is more reliable in the short-run relative to the medium-run. The standard deviation of quarterly percentage changes in the multiplier is 13.72 (Table 4.XIII) and 17.63 for annual percentage changes (Table 4.XII).

From Table 4.XV, the growth rate of the multiplier exceeds that of the base in 49 per cent of annual changes (H is less than 0.5) and in 35 per cent of quarterly changes, confirming the relative dominance of the adjusted monetary base in the short-run. Notice that the percentage of H coefficients lying in the range 0.4 to 0.59 is 56 per cent for quarterly and 39 per cent for annual changes, while 29 per cent of H coefficients take a value of less than 0.4 for annual changes as opposed to 19 per cent for quarterly changes. Finally, the standard deviation of the H coefficient for annual changes is 0.21 and 0.18 for quarterly changes. Clearly, movements in the multiplier are more varied and the likelihood of complete attenuation is greater for yearly than for quarterly time periods.

On the evidence so far, it seems that if monetary policy is to rely on manipulation of the adjusted monetary base, the impact on the money stock is more certain for quarterly than for yearly periods. We should stress however, that judging from the concentration of the H coefficients about a mean of 0.5 and the relatively low values of the standard deviations of the distributions (Table 4.XV), the greater importance of the base relative to that of the multiplier is slight.

Having established that the influence of the base is accentuated in the long-run and attenuated in the medium and short-run, by feedback changes in the multiplier, we turn to an analysis of the relative contributions of the base and the multiplier over the course of the business cycle.

In Table 4.XVI we calculate the average percentage contributions of the adjusted base and the multiplier to percentage changes in the money stock over twelve half-cycles, from the data in Table 4.XII. We find that the long-run accentuating influence of the multiplier is reversed over the cycle, where percentage increases in the base are accompanied by percentage decreases in the multiplier. The strong inverse association between the base and the multiplier is apparent from the correlation coefficient calculated for quarterly percentage changes at an annual rate, $r_{B^a,m} = -0.97$.

Over the twelve half-cycles, the money stock and the adjusted monetary base display pro-cyclical variations. However, the money multiplier is strongly contra-cyclical (consistently so from 1959.II), dampening, but not offsetting the pro-cyclical influence of the base on the money supply. Hence, over the business cycle, the money supply mirrors the pro-cyclical influence of the base, attenuated by contra-cyclical variations in the multiplier. But the base retains slight dominance over the multiplier on average where the H coefficient = 0.52 (Table 4.XV).

A more detailed scrutiny of Tables 4.XIV to 4.XVI reveals an interesting asymmetry in the attenuating influence of the multiplier. The multiplier attenuates the influence of the base in 92 per cent of all half-cycles, with complete attenuation occurring 50 per cent of the time and incomplete attenuation occurring 42 per cent of the time. These statistics provide the clue to

TABLE 4.XVI

AVERAGE CYCLICAL CONTRIBUTIONS OF THE ADJUSTED MONETARY BASE AND THE MONEY MULTIPLIER TO CHANGES IN THE MONEY STOCK:1954-1971 (%)

Business Cycles		$\Delta M_2/M_2$	$\Delta B^a/B^a$	$\Delta m/m$	H
EXP.	54.I -55.I	4.65	5.34	- 0.69	0.89
CONTR.	55.II-56.III	6.84	- 0.77	7.61	0.09
EXP.	56.IV-57.IV	8.85	4.62	4.23	0.52
CONTR.	58.I -59.I	0.76	- 3.18	3.94	0.45
EXP.	59.II-60.I	6.78	20.52	-13.74	0.60
CONTR.	60.II-61.III	2.41	-11.05	13.46	0.45
EXP.	61.IV-65.I	11.64	13.81	- 2.17	0.86
CONTR.	65.II-65.IV	11.02	- 9.86	20.88	0.32
EXP.	66.I -67.I	10.26	11.07	- 0.81	0.93
CONTR.	67.II-67.IV	6.83	- 2.23	9.06	0.20
EXP.	68.I -69.III	12.67	16.81	- 4.13	0.80
CONTR.	69.IV-71.IV	8.46	-1.81	10.26	0.15
Mean					
	Expansion	1.37	1.80	- 0.43	0.81
	Contraction	1.14	- 0.90	2.04	0.31

SOURCE: South African Reserve Bank Quarterly Bulletin. Business cycles for 1954-1967 are those identified by D. J. Smit and B. E. van der Walt [85]; cycles for 1968-1971 are obtained from analysis of our own data. Basic quarterly data are provided in Table 4.XII.

NOTES: The average annual change in the variables for each half-cycle is obtained from the formula:

$$\left(\frac{\Delta X}{X}\right)_j = \frac{1}{n}\sum_{t=1}^{T}\left(\frac{X_t - X_{t-1}}{X_{t-1}}\right)_j$$

where j = any half-cycle, n = the number of quarters contained in j and Δ = the first difference between corresponding quarters of adjacent years. Average annual values of the H coefficient for each half-cycle are obtained by inserting the data in this table into the formula:

$$H = \frac{|\Delta B^a/B^a|}{|\Delta B^a/B^a| + |\Delta m/m|}$$

The mean values for the expansion phase (say) are calculated by inserting the data in the table into the formula:

$$\frac{1}{q_e}\cdot\sum_{e}^{6}\left(\frac{\Delta X}{X}\right)_e$$

where e = any expansion phase, q = the number of quarters covered by six expansion phases during the period 1954- 1971 (in this case, q = 40) and Δ is defined as above. Similarly, mean values for the contraction phase are calculated for q = 32.

the asymmetry which is revealed clearly in Table 4.XVI, where complete attenuation is identified with the contraction phase of the cycle, and incomplete attenuation occurs in all but one expansion phase. Over eleven out of twelve half-cycles, percentage increases in the base are accompanied by percentage declines in the multiplier reflecting the attenuating relationship. In the contraction phase the percentage change in the multiplier exceeds that of the base in numerical value and conversely for the expansion phase. Of all H coefficients, 50 per cent take a value greater than 0.5 and occur in the expansion phase; while the remaining 50 per cent of H coefficients are less than 0.5, and occur during the contraction phase (Tables 4.XV and 4.XVI). The means of the H coefficients in the expansion and contraction phase are 0.8 and 0.3, respectively, indicating that the attenuating influence of the multiplier is stronger during contractions than expansions, thereby exerting a relatively stronger contra-cyclical influence during contractions. Therefore, the base exerts a greater influence on the growth rate of the money stock during periods of expansion than during periods of contraction, relinquishing importance in favour of the multiplier during the latter periods.

Referring back to Table 4.XIV, it is interesting to notice how the attenuating influeince of the multiplier declines as we shorten the time span from longer cyclical movements to annual periods. Over twelve half-cycles, the multiplier exerts an attenuating influence 92 per cent of the time, but only 75 per cent of the time for annual changes, while quarterly changes are not much different from the cycle. However, complete attenuation is highest over the cycle (50 per cent), second highest over annual periods (35 per cent) and lowest over quarterly periods (28 per cent). From this data, it is clear that a shortening of the time span lowers the likelihood of complete attenuation by the multiplier. With respect to the trend, the multiplier gains in importance in shorter periods, but as between shorter periods (cycles, years or quarters) the multiplier is least important for quarterly periods.

The evidence so far, provides preliminary support for a crucial hypothesis in this study. In Chapter 3, we analysed the theoretical effects of a change in the adjusted monetary base on the money supply and found the influence to be, a priori, positive, attenuated by the positive interest elasticity of the money multiplier. This hypothesis provides an explanation for the observed asymmetry. We postulate that the elasticity of the multiplier with respect to the credit market rate is positive and that the elasticity of the credit market rate with respect to the adjusted monetary base is negative. Hence, the multiplier will attenuate the influence of the base on the money stock. If the base moves pro-cyclically we expect the credit market rate and the money multiplier to move contra-cyclically. Furthermore, if the credit market rate is relatively sticky during the expansion phase, the attenuating effect of the multiplier is less. Thus, the influence of the base is relatively stronger during the expansion phase than during the contraction phase. It remains to be demonstrated that the above mentioned elasticities are empirically supported. We provide such evidence in Section 7 below. Firstly, however, we adduce further preliminary evidence (Section 6) bearing on the interest rate mechanism, by examining the relative contributions of the portfolio allocation ratios to percentage changes in the money multiplier.

5.1 Summary and Conclusions.

A central hypothesis of the money supply model is that all movements in the money supply are explained by changes in the adjusted monetary base and the money multiplier. In this section, we evaluate the relative influence of the base and the multiplier on the growth rate of the money stock, and obtain important information about the feedback effect on the multiplier generated by changes in the adjusted monetary base. Our conclusions here, bear crucially on the role of the interest rate mechanism and the differential behaviour of the money multiplier over the long-run, the short-run and phases of the business cycle.

We obtain the following empirical evidence.

1. On an average per annum basis over the long-run, both the adjusted monetary base and the money multiplier contribute positively to the growth rate of the money stock, the relative contribution of the base being slightly stronger than that of the multiplier, and the latter accentuates the influence of the former.

2. On average using quarterly data, the trend behaviour pattern remains unaltered, but the positive influence of the base increases relative to that of the multiplier for the average quarter.

3. In the medium-run (year to year) and the short-run (quarter to quarter) the accentuating influence of the multiplier over the trend is reversed; the multiplier attentuates the influence of the base, more strongly in the medium-run than for the short-run. Overall attenuation occurs more frequently in the short-run, but complete attenuation occurs more frequently in the medium-run.

4. Over the course of the business cycle, the multiplier exhibits contra-cyclical movements while the adjusted monetary base and the money stock vary pro-cyclically. But relative dominance of the base remains.

5. We isolate an asymmetry in the behaviour of the multiplier by distinguishing between expansionary and contractionary phases of the business cycle. During the expansion phase, the multiplier attenuates the pro-cyclical influence of the base incompletely, while in the contraction phase this attenuation is complete.

On the basis of this evidence, we deduce various implications.

1. Over long sweeps of time the base dominates the accentuating influence of the multiplier. A shortening of the period to yearly or quarterly changes raises the influence of the multiplier, which completely attenuates percentage changes in the base in certain years or quarters. However, the increased importance of the multiplier is relatively greater for yearly than for quarterly changes. Since complete attenuation by the multiplier is more likely over yearly changes, the base has a more reliable impact on the money stock in the short-run and the multiplier is less dominant relative to the medium-run.

2. Over each phase of the business cycle, the multiplier gains in importance relative to the trend, attenuating the influence of the base, with complete attenuation occurring in 50 per cent of half-cycles. However, over the complete period, the base retains its dominance over the money stock, due to the asymetric behaviour of the multiplier during expansion and contraction phases. The gain in the attenuating influence of the multiplier during the contraction phase is insufficient to reverse the pro-cyclical effects of the base on the money stock; but does provide a dampening influence, by obviating an absolute decline in the money stock in favour of a pro-cyclical reduction in its growth rate.

From the evidence, it follows that whether the adjusted monetary base is exogenously determined by the Monetary Authorities or by the balance of payments, its causal link with the money stock is strongly modified by induced variations in the multiplier in shorter periods.

Over the long-run, the multiplier accentuates the influence of the base for the average twelve-month or three-month period. If the Monetary Authorities wish to achieve some long-run growth rate in the money supply, then the target rate will be achieved by a growth rate in the adjusted monetary base of just over 50 per cent of the target rate.[58]

In the medium and short-run, the influence of the multiplier is paramount, dampening the positive impact of the base on the growth rate of the money stock, over 75 per cent of the time. Hence, a desired target rate for yearly or quarterly changes in the money stock will be attained by a growth rate in the base which exceeds the target rate. Since attenuation by the multiplier is stronger over quarterly changes, and complete attenuation is more likely over annual changes, a desired growth rate in the money stock is more likely to be achieved through the base for quarterly rather than for annual changes.[59]

Over the business cycle in general, the money supply is dominated by procyclical variations in the adjusted monetary base; dampened by contra-cyclical variations in the multiplier. So that, if the adjusted base is to be used as an instrument of contra-cyclical monetary policy, the attenuating effects of the multiplier must be taken into account. In particular, the asymmetric

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58. Since the average annual value of the H coefficient is 0.5 and the average annual contribution of the base to the growth rate in the money stock is 61 per cent, and since the multiplier accentuates the influence of the base in the long-run on average, it follows that a 50 per cent increase in the base is likely to result in an annual average growth rate in the money stock of just less than 100 per cent.

59. The standard deviation of percentage changes in the multiplier on average for quarterly changes, is 13.72, and 19.63 for yearly changes.

behaviour of the multiplier suggests that a 1 per cent increase in the adjusted monetary base during a contraction phase would have a larger impact on the money supply than would a 1 per cent decline in the base during an expansion phase.[60] Of course, this conclusion presumes that the interest rate mechanism which links variations in the multiplier to variations in the adjusted base operaties symmetrically for both pro-cyclical and contra-cyclical variations in the base.

Since the adjusted monetary base in South Africa is exogenously determined by the balance of payments, the path of influence of monetary policy rests with the money multiplier, the determinants of which are investigated in Section 6. Our general conclusions at this stage are that whether or not the Monetary Authorities choose to vary the adjusted monetary base as a policy instrument, the impact of the adjustment base on the money stock is accentuated by the multiplier over the long-run, whereas in the short-run and medium-run, and over the business cycle, the multiplier exerts an attenuating influence. Both the adjusted base and the multiplier exert almost equal influence on the growth rate of the money stock; the base dominates slightly in the long-run and the multiplier gains marginal dominance over business cycles and in the medium-run. Neither the base nor the multiplier may be neglected in money supply analysis for South Africa.

The evidence in this section suggests that the differential pattern of behaviour of the money multiplier in the long-run, the short-run and over phases of the business cycle is explicable in terms of the interest rate mech-

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60. Since the attenuating influence of the multiplier is greater for a decline in the base than for an increase, we conclude that contra-cyclical movements in the base are likely to have a stronger influence on the money supply during the contraction phase than during the expansion phase.

anism which underpins the money supply hypothesis of the model. If the elasticities of the money supply and the credit market rate with respect to the base are positive and negative respectivley, and if the interest elasticity of the multiplier is positive, then an increase in the base induces a decline in the credit market rate and the money multiplier; the multiplier attenuates the positive influence of the base on the money stock. A relatively sticky credit market rate, lowers the influence of the multiplier and raises the dominance of the adjusted monetary base. We investigate these elasticities in Section 7.

Before proceeding with the discussion of the portfolio allocation ratios and the money multiplier, it is necessary to point our that our results in this section are in accordance, for the most part, with money supply studies carried out for numerous countries in the world.[61] However, our conclusions in one respect are reversed. We find, in agreement with the studies, that over the trend, the base dominates the growth rate of the money supply and that the multiplier gathers increased importance over shorter time horizons such as years or quarters relative to the trend. Contrary to most of these studies, and in particular with respect to those for Canada by A. K. Kelly and G. I. Weber, and for Italy by M. Fratianni, we find that the multiplier is not relatively more important than the base for shorter time periods, comparing years and quarters.[62] Our results indicate that the multiplier is less

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61. Money supply studies for Canada have been conducted by A. K. Kelly [67], and G. I. Weber [97]; for Great Britain by Brunner-Crouch [14] and for Italy by M. Fratianni [39]. W. Hoebler [58] has conducted similar studies for France, Israel, Brazil, Germany and India. It is of interest to note that all these studies embrace at least ten years of the twenty-two year period investigated in this study. Cf. also J. Ahrensdorf and S. Kanesathasan [1] p. 134.

62. Kelly, ibid., Chap. 3, pp. 38-41; Weber, ibid., Chap. 3, pp. 43-52; Fratianni, ibid., Chap. 3, pp. 141-147, 152.

important for quarterly periods than for yearly periods, implying that a desired growth rate in the money stock is more likely to be achieved through variations in the base in the short-run than in the medium-run. A shortening of the time period from years to quarters raises the reliability of of the link between the base and the money stock. We adduce further evidence to support this conclusion in Section 8.3.

6. DETERMINANTS OF THE MONEY MULTIPLIER

In the previous section, we demonstrate that the money multiplier (m) is of vital importance in explaining the growth rate of the money stock; its importance being relatively less in the short-run over quarterly periods. In the long-run, m is responsible for almost 40 per cent of the average annual growth rate in the money stock, while over the course of the business cycle and over annual and quarterly periods, m exerts an attenuating influence more than 75 per cent of the time. Complete attenuation occurrs 50 per cent, 35 per cent, and 28 per cent of the time respectively, over the business cycle, and over annual and quarterly periods.

The money multiplier is determined by four portfolio allocation ratios: two of which, the currency ratio (P_1) and the time deposit ratio (P_2), reflect the portfolio allocation behaviour of the private sector; and the remaining two, the aggregate reserve ratio (b_1) and the Reserve Bank lending ratio (P_8), summarise the actions of the Reserve Bank. In Chapter 2, we provide an extensive exposition on the theoretical foundations of these ratios.

Our empirical analysis in this section, furnishes evidence on the relative contributions of the ratio parameters to changes in the money multiplier and the determinants of the ratio parameters themselves. We obtain suggestive evidence, in addition to that provided in the previous section, that the interest rate mechanism underpinning our theoretical analysis of the money supply process (Chapter 3) is capable of explaining residual variations in the money supply not explained by the adjusted monetary base. Following from Section 3, we extend our investigation of the roles of the money market, Reserve Bank lending and Bank Rate policy. Finally, the behaviour of interest rates is examined and this section is concluded with a summary of the empirical results.

6.1 The Money Multiplier Elasticites With Respect to the Ratio Parameters and the Relative Contributions of the Ratio Parameters to Changes in the Multiplier.

We commence with a discussion of the elasticities of m with respect to the ratio parameters P_1, P_2, P_8, b_1. In Chapter 3, the interest rate mechanism is summarised by the interest elasticity of the money multiplier, written as $e(m,i_e)$, which is hypothesised as being positive (see Equation 3-22 and discussion) depending upon the signs of the elasticities of m with respect to its constituent ratio parameters (see Table 3.VI). The latter elasticities are evaluated in Table 4.XVII (the formulae are derived in Appendix A.8.1) using the mean values of annual data for the period 1950 to 1971.

From these calculations we find that the empirical sign pattern conforms to that postulated in our theoretical discussion (Table 3.VI), so that the associated inequalities upon which the signs depend are satisfied (Appendix A.8.1). P_1 and b_1 exert both negative and stronger influences on m relative to the positive influences of P_2 and P_8. The implication is, that if the Reserve Bank wishes to offset undesired changes in the money multiplier (and hence the money supply) through endogenous variations in P_1 and P_2, then it shoud influence b_1 by varying statutory reserve requirements, rather than trying to influence P_8 by varying Bank Rate. The response of m to changes in statutory reserve requirements is given in Expressions 3 and 4 of Table 4.XVII. A 1 per cent increase in the statutory reserve requirement on demand deposits will result in a decline in m of 0.2 per cent, which would be sufficient to offset the positive effects on m of a 1 per cent increase in P_2. A 1 per cent decline in P_1 requires a corresponding increase in the statutory reserve requirement on demand deposits of over 2 per cent. These policy conclusions hold on average assuming that the elasticities are constant.

TABLE 4.XVII

ELASTICITIES OF THE MONEY MULTIPLIER WITH RESPECT TO THE PORTFOLIO ALLOCATION RATIOS AND STATUTORY RESERVE REQUIREMENTS

Elasticities	Formulae	Mean Value
1. $e(m,P_1)$	$P_1(\frac{1}{1 + P_1 + P_2} - \frac{1}{\Delta_2})$	-0.53
2. $e(m,P_2)$	$P_2(\frac{1}{1 + P_1 + P_2} - \frac{b_1}{\Delta_2})$	0.16
3. $e(m,P_8)$	$\frac{P_8}{\Delta_2}$	0.14
4. $e(m,b_1)$	$-\frac{(1 + P_2)b_1}{\Delta_2}$	-0.46
5. $e(m,r^{d'})$	$-\frac{(1 + P_2)r^{d'}D}{\Delta_2(D + T)}$	-0.20
6. $e(m,r^{t'})$	$-\frac{(1 + P_2)r^{t'}T}{\Delta_2(D + T)}$	-0.06
	where $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$	

NOTES: The elasticities are evaluated at the mean points of annual data for the period 1950-1971 (see Table A.19.IV for data series on the ratio parameters). The calculated variable $r^{t'}$ is listed in Table A.15.IV and $r^{d'}$ is as per Table A.15.I. The mean values of the variables in the table are as follows: $P_1 = 0.30$, $P_2 = 0.67$, $P_8 = 0.062$, $b_1 = 0.123$, $D = 926.59$, $T = 695.44$, $r^{d'} = 0.094$, $r^{t'} = 0.040$. The formulae are derived in Appendix A.8.1.

In fact, the elasticities vary from period to period. In order to assess the influence of the ratio parameters over shorter periods we calculate the contribution of the ratio parameters to percentage changes in the multiplier over the course of the business cycle. This enables us to draw conclusions relevant for contra-cyclical monetary policy, as well as highlighting the causes of asymmetrical contra-cyclical variations in the multiplier in terms of the ratio parameters. The function to be evaluated is obtained as follows.

Writing the reduced form for the money stock:

$$M_2 = m\, B^a$$

where:

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_8}$$

let $\alpha = 1 + P_1 + P_2$, $\beta = P_1 + b_1(1 + P_2) - P_8$ and y = a vector containing the ratio parameters P_1, P_2, P_8, b_1. The logarithmic form of the reduced-form equation is now written as:

$$\log M_2 = \log \alpha - \log \beta + \log B^a \qquad (4\text{-}14)$$

Differentiating totally with respect to time, we obtain an expression for the percentage change in M_2 in terms of percentage changes in m and B^a.

$$\frac{d \log M_2}{dt} = \sum \left[\frac{\partial \log \alpha}{\partial \alpha} \frac{\partial \alpha}{\partial y} - \frac{\partial \log \beta}{\partial \beta} \frac{\partial \beta}{\partial y} \right] \frac{dy}{dt} + \frac{\partial \log B^a}{\partial B^a} \frac{d B^a}{dt} \qquad (4\text{-}15)$$

$$= \sum \left[\frac{1}{\alpha} \frac{\partial \alpha}{\partial y} \quad \frac{1}{\beta} \frac{\partial \beta}{\partial y} \right] \frac{dy}{dt} + \frac{1}{B^a} \frac{d B^a}{dt} \qquad (4\text{-}16)$$

Regrouping terms in Equation 4-16, it becomes clear that the square bracket term contains the instantaneous rate of change in the money multiplier due to very small changes in each of the ratio parameters, thus:

$$\frac{d \log M_2}{dt} = \sum \left[\left(\frac{\partial \alpha}{\alpha} - \frac{\partial \beta}{\beta} \right) \frac{1}{\partial y} \right] \frac{dy}{dt} + \frac{1}{B^a} \frac{d\, B^a}{dt} \qquad (4\text{-}17)$$

$$= \sum \left[\left(\frac{\partial m}{m} \right) \frac{1}{\partial y} \right] \frac{dy}{dt} + \frac{1}{B^a} \frac{d\, B^a}{dt} \qquad (4\text{-}18)$$

Summing over all ratio parameters of course gives the total percentage change in the multiplier, which, when added to the percentage change in the adjusted monetary base, gives the total percentage change in the money supply. Notice that the square bracket term is identical to the contribution of the ratio parameters to percentage changes in the money stock. To obtain an empirical expression, Equation 4-18 is approximated by an expression written in discrete form.[63]

$$\frac{M_{2t+1} - M_{2t}}{M_{2t}} = \sum \left[\frac{1}{\alpha} \frac{\partial \alpha}{\partial y} - \frac{1}{\beta} \frac{\partial \beta}{\partial y} \right]_t (y_{t+1} - y_t) + \frac{B^a_{t+1} - B^a_t}{B^a_t} \qquad (4\text{-}19)$$

Expression 4-19 is evaluated using quarterly data with changes at an annual rate, and then calculating the mean value for each term, over the phases of the business cycle.[64]

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63. Equation 4-19 is a standard analytical expression used in money supply analysis; see Appendix A.18, n. 1.

64. In Appendix A.18, we provide the fully expanded version of Equation 4-19, together with the explicit expressions for the partial derivatives. Table A.18.I, in Appendix A.18, provides the quarterly data from which the tables in the text are calculated.

In Table 4.XVIII, data on all the terms in the expression are given for completeness. The sum of the contributions of the ratio parameters to changes in the multiplier plus the adjusted monetary base is equal to the estimated percentage change in the money stock $(\hat{M}_2)$. In Column M_2, we give the actual percentage change in the money stock and notice that the difference between actual and predicted values are mostly small, and due to measurement error. Since we are interested in the relative contributions of the ratio parameters to changes in m, we separate this data from Table 4.XVIII for convenience, and list them in Table 4.XIX.[65]

In what follows, the reader should bear in mind that P_1 and b_1 exert a negative influence on the multiplier, and P_2 and P_8 exert a positive influence. From Table 4.XIX the average per annum increase in the multiplier is 2.95 per cent. The influence of P_2, P_8 and b_1 cause the multiplier to increase by 3.78 per cent and P_1 induces a decline in the multiplier of 0.8 per cent. The strongest positive influence on the multiplier is exerted by b_1 followed by P_2 and then P_8 on an average per annum basis over the trend. Over the phases of the business cycle, P_2, P_8 and b_1 exert broad contra-cyclical influences on the multiplier while the influence of P_1 is broadly pro-cyclical.

In every contraction phase, increases in P_1 induce a percentage decline in the multiplier and in four out of six expansion phases the opposite is true. Contra-cyclical variations in the currency ratio induce pro-cyclical

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[65] Notice that the percentage changes in the multiplier in Tables 4.XVIII and 4.XIX are not identical to the data in Table 4.XVI due to an approximation error. In the first two tables, the percentage change in m is obtained by summing over the percentage contributions of the ratio parameters (see table notes), whereas in Table 4.XVI the percentage change in m is calculated as the difference between the percentage changes in M_2 and B^a (see notes to Table 4.XII and Sec. 5, n. 57).

TABLE 4.XVIII

AVERAGE CYCLICAL DETERMINANTS OF CHANGES IN THE MONEY MULTIPLIER AND THE MONEY SUPPLY: 1954-1971 (%)

Business Cycles	M_2	$\hat{M}_2$	m	Contributions of Ratio Parameters to Changes in m: P_1	P_2	P_3	b_1	B^a
EXP. 54.I -55.I	4.65	4.59	- 0.75	-2.85	1.60	- 1.29	1.78	5.34
CONTR. 55.II-56.III	6.84	7.05	7.82	-5.29	4.75	6.01	2.36	- 0.77
EXP. 56.IV-57.IV	8.85	8.63	4.01	0.19	2.48	- 0.84	2.19	4.62
CONTR. 58.I -59.I	0.76	1.08	4.26	-2.18	1.16	5.29	- 0.01	- 3.18
EXP. 59.II-60.I	6.78	7.03	-13.39	3.27	0.24	-19.09	2.19	20.52
CONTR. 60.II-61.III	2.41	1.99	13.04	-0.99	0.93	9.86	3.25	-11.05
EXP. 61.IV-65.I	11.64	11.32	- 2.50	1.34	0.46	- 3.65	- 0.65	13.81
CONTR. 65.II-65.IV	11.02	9.53	19.39	-7.36	6.43	6.25	14.07	- 9.86
EXP. 66.I -67.I	10.26	10.12	- 0.95	-2.09	0.21	- 1.16	2.09	11.07
CONTR. 67.II-67.IV	6.83	6.63	8.86	-3.17	1.49	8.93	1.61	- 2.23
EXP. 68.I -69.III	12.67	12.52	- 4.29	7.51	-1.58	- 7.22	- 3.00	16.81
CONTR. 69.IV-71.IV	8.46	8.03	9.84	- 4.42	0.83	10.31	3.12	- 1.81

SOURCE: See Table 4.XVI for notes to cycle sources and calculation of average cyclical data.
NOTES: Basic quaterly data and the relevent equations used to derive this table may be found in Appendix A.18. Note that the average cyclical percentage change in m is equal to the sum of the percentage contributions of the ratio parameters; and the average cyclical percentage change in $\hat{M}_2$ is equal to the sum of the percentage changes in m and B^a.

TABLE 4.XIX

AVERAGE CYCLICAL CONTRIBUTIONS OF THE RATIO PARAMETERS
TO CHANGES IN THE MONEY MULTIPLIER:1954-1971

Business Cycles		m	P_1	P_2	P_8	b_1
EXP.	54.I -55.I	- 0.75	-2.85	1.60	- 1.29	1.78
CONTR.	55.II-56.III	7.82	-5.29	4.75	6.01	2.36
EXP.	56.IV-57.IV	4.01	0.19	2.48	- 0.84	2.19
CONTR.	58.I -59.I	4.26	-2.18	1.16	5.29	- 0.01
EXP.	59.II-60.I	-13.39	3.27	0.24	-19.09	2.19
CONTR.	60.II-61.III	13.04	-0.99	0.93	9.86	3.25
EXP.	61.IV-65.I	- 2.50	1.34	0.46	- 3.65	- 0.65
CONTR.	65.II-65.IV	19.39	-7.36	6.43	6.25	14.07
EXP.	66.I -67.I	- 0.95	-2.09	0.21	- 1.16	2.09
CONTR.	67.II-67.IV	8.86	-3.17	1.49	8.93	1.61
EXP.	68.I -69.III	- 4.29	7.51	-1.58	- 7.22	- 3.00
CONTR.	69.IV-71.IV	9.84	-4.42	0.83	10.31	3.12
Mean	54.I -71.IV	2.96	-0.82	1.24	0.91	1.63
	Expansion	- 0.45	0.18	0.09	- 0.83	0.12
	Contraction	1.98	-0.73	0.49	1.46	0.76

NOTES: See notes to Table 4.XVIII. The mean for the period 1954-1971 is obtained from quarterly data with changes at an annual rate(Table A.18.I.) Mean values for the expansion and contraction phase are calculated using the formula in the notes to Table 4.XVI.

changes in the money multiplier. The influence of P_2 is contra-cyclical; in five out of six contractions, increases in P_2 raise the growth rate of the multiplier above that of the previous expansion phase. Contra-cyclical movements in the time deposit ratio induce contra-cyclical movements in the multiplier. The ratio parameter P_8 exerts a strong and consistent contra-cyclical influence on the multiplier, both with respect to sign and magnitude. Increases in P_8 during the expansion phase cause the multiplier to decline, and decreases in P_8 during the contraction phase cause the multiplier to increase. In five out of six contractions, the percentage decline in the multiplier is greater than the percentage increase, in the previous expansion phase. Clearly, the Reserve Bank's lending ratio is strongly contra-cyclical causing contra-cyclical variations in the multiplier.

Since we have already explained the determinants of b_1 (Section 3.4), our analysis of the aggregate reserve ratio is a little more detailed. The b_1 ratio moves pro-cyclically for the most part, causing an increase in the growth rate of the multiplier in four out of six contraction phases, relative to the previous expansion phase. Hence, the aggregate reserve ratio is pro-cyclical, causing contra-cyclical variations in the growth rate of the multiplier. In two contraction phases, the growth rate of b_1 actually increases inducing a pro-cyclical decline in the growth rate of the multiplier. The causes of these two exceptions are to be found in the behaviour of the time deposit ratio, in the monetary events of the period and the course of monetary policy.[66]

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[66] In Sec. 3.4, we show that b_1 responds negatively to an increase in the time deposit ratio and positively to changes in statutory reserve requirements, where the time deposit ratio is equal to 1 - (DL/DT) (see the regression equations for b_1 in Table 4.VIII).

The first contraction phase is from 1958.I to 1959.I and the only one in which b_1 increases, growing at an average rate of 0.4 per cent (having declined by 50.7 per cent in the previous expansion phase (see Table 4.XX). This increase in b_1 induced a decline in m of 0.01 per cent (Table 4.XIX). The increase in b_1 is due, firstly; to an 11 per cent fall in the rate of growth of P_2, having declined from an average annual growth rate of 19 per cent in the previous expansion phase, to 8 per cent in the contraction phase in question (Table 4.XX), and secondly; to controls imposed by the Monetary Authorities to dampen inflationary pressures and to protect the balance of payments. These measured forced the banking sector to accumulate reserves in excess of their historically low optimum level, the increased supply of reserves arising from a balance of payments surplus in the third quarter of 1958. An increase in Reserve Bank lending to the banking sector in the first quarter of 1959, contributed to the build up of reserves, indicating, that the banking sector may have raised its desired aggregate reserve ratio as a defence against the intention of the Treasury to finance its deficit by increased borrowing from the private sector.[67]

The second contraction phase in question, is for the period 1967.II to 1967.IV, in which, the rate of decline in b_1 fell by 1 per cent from the previous expansion phase, causing a pro-cyclical increase in the multiplier of 1.6 per cent compared to a 2 per cent increase in the previous expansion phase. In this instance, the higher rate of accumulation of reserves in the

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67. That the banking sector increased its indebtedness to the Reserve Bank at this point in time is associated with the decline in Bank Rate from 4.5 per cent to 4 per cent in the first quarter of 1959. Bank Rate moves contra-cyclically historically, and the contraction in question is the only one in which Bank Rate was actually reduced. The intentions of the Treasury were announced in July 1958. See Sec. 3.2.1 for a discussion of monetary policy in the period 1958-1971.

TABLE 4.XX

AVERAGE CYCLICAL CHANGES IN THE RATIO PARAMETERS:
1954-1971 (%)

Business Cycles	p_1	p_2	p_γ	b_1
EXP. 54.I -55.I	6.07	25.50	239.77	- 4.03
CONTR. 55.II-56.III	11.00	52.01	666.48	- 5.69
EXP. 56.IV-57.IV	- 0.21	18.85	30.27	- 5.07
CONTR. 58.I -59.I	3.63	7.57	241.51	0.40
EXP. 59.II-60.I	- 5.37	1.82	- 59.69	- 4.58
CONTR. 60.II-61.III	1.24	5.91	306.81	- 6.70
EXP. 61.IV-65.I	- 2.79	3.74	2.65	1.75
CONTR. 65.II-65.IV	13.92	37.71	63.85	30.99
EXP. 66.I -67.I	3.02	0.83	18.04	- 5.36
CONTR. 67.II-67.IV	4.61	6.17	38.28	- 4.38
EXP. 68.I -69.III	-10.53	- 5.88	61.23	9.53
CONTR. 69.IV-71.IV	6.07	3.52	67.24	- 6.68

NOTES: Qu arterly data on the ratio parametersare given in Table A.19.VIII. The average annual change in the variables for each half-cycle is obtained from the formula in Table 4.XVI.

banking sector is due solely to monetary policy controls which prevented the banking sector from adjusting its aggregate reserve ratio in the face of an increase in international reserves experienced in the previous upswing (see Section 3.2.1). These controls tended to offset the negative influence on b_1 of an increase in P_2 .

Over the general course of the business cycle, then, it appears that the contribution of P_8 dominates contra-cyclical movements in the multiplier, followed by the contributions of b_1 and P_2. The contribution of the currency ratio is relatively unimportant. These conclusions are confirmed by the correlation coefficients (Table 4.XXI) between the relative contributions of the ratio parameters, providing some idea of the relative strengths of association between variations in the ratio parameters and the multiplier. While $r_{m,P_8} = 0.96$, the second most dominant ratio is b_1, where $r_{m,b_1} = 0.30$, followed by P_2 and P_1 with correlation coefficients of 0.22 and -0.16 respectively. Of the three contra-cyclical ratio parameters, only P_8 induces an actual decline in the multiplier during the expansion phase and all three exert a positive influence in the contraction phase (Table 4.XIX).

In order to highlight the immediate causes of the asymmetric behaviour of the multiplier, we calculate the average quarterly contributions of each ratio parameter during the expansion and the contraction phases, separately (Table 4.XIX). In the expansion phase, the multiplier declines by 0.45 per cent on average per quarter, caused by the negative contribution of P_8 of 0.8 per cent, which is partially offset by small positive contributions of the remaining ratio parameters. During an average quarterly contraction, P_2 and b_1 reinforce the positive influence of P_8, and the multiplier increases by almost 2 per cent, 0.5 per cent of which, is due to increases in P_8, which, on its own, offsets the negative impact of P_1 (P_1 induces an average

TABLE 4.XXI

CORRELATION MATRIX BETWEEN CONTRIBUTIONS OF THE RATIO PARAMETERS AND PERCENTAGE CHANGES IN THE MONEY MULTIPLIER: 1954-1971

	m	P_1	P_2	P_8	b_1
m	...	-0.16	0.22	0.96	0.30
P_1	...	...	-0.68	-0.21	-0.48
P_2	...	...	...	0.12	0.50
P_8	...	...	...	...	0.089

SOURCE: Basic data is provided in Table A.18.1.
NOTES: The simple correlation coefficients are calculated from quarterly data with changes at an annual rate for the period 1954-1971.

decline in the multiplier of 0.7 per cent). On average, therefore, in the expansion phase, P_8 dominates variations in the multiplier followed by P_1, b_1 and P_2; while in the contraction phase, b_1 is second in significance, followed by P_1 and P_2. Thus, the influence of P_1 is stronger in the expansion phase relative to the contraction phase and conversely for b_1. The existence of the contra-cyclical asymmetry in the money multiplier is due to the contributions of P_2, P_8 and b_1 being stronger in the contraction phase relative to the expansion phase, dampened by the pro-cyclical influence of P_1. The clue to the cause of the asymmetry rests with the positive contribution of P_2 and b_1 in the expansion phase. That they induce an increase in the multiplier in the expansion phase, be it at a lower rate, dampens the negative contribution of P_8, thereby, lowering the absolute percentage change in the multiplier; whereas, in the contraction phase, P_2 and b_1 augment the positive contribution of P_8 and raise the absolute percentage change in the multiplier. However, even if the signs on the P_2 and b_1 parameters were negative, the change in the multiplier in the contraction phase would still exceed that of the expansion phase for the average quarter, by over 1 per cent in absolute terms. Essentially, the ultimate cause of the asymmetry rests with those factors that determine the differential behaviour of P_2, P_8 and b_1 in expansions and contractions; a matter to which we turn in Sections 6.2.1 to 6.2.4.

Our conclusions so far are, that over the course of the business cycle in general, P_8, b_1 and P_2 are responsible for the contra-cyclical movement in the money multiplier, with P_8 providing the dominant influence. In both expansion and contraction phases, P_8 retains its dominance, and P_1 appears to be more important for the average quarter over the trend than over the business cycle as a whole, but is not significant in general, relative to the other ratio parameters.[68] The asymmetric characteristic of the multiplier's contra-cyclical movement is due to differential patterns of behaviour of P_2, P_8 and b_1 as between phases of the cycle. P_8 is of particular importance since it dominates P_2 and b_1 over the average quarter as well as over the cycle in general.

6.2 Determinants of the Ratio and Non Ratio Demand Functions

In Chapter 2, we discuss the theoretical foundations of the four ratio parameter demand functions and attach sign patterns to the partial derivitives of these functions, based on the existing theoretical and empirical work on the demand for money.[69] The comparative static results in Chapter 3, are derived on the basis of our theoretical specification of these structural equations. Accordingly, a complete test of our money supply hypothesis requires empirical support for both the underlying theoretical structure, as well as the comparative static implications. At the outset, it is necessary to point out that, whereas, the empirical results for the aggregate reserve ratio (Section 3.4) and the Reserve Bank lending ratio (to be discussed below in Section 6.2.3) appear satisfactory, the regression equations that we have tested for the currency ratio and time deposit ratio demand functions are completely unsatisfactory, providing insufficient grounds for rejecting our

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68. In money supply studies for Canada and Great Britain, the currency ratio is a crucial determinant of the money supply, contrary to our findings for South Africa: cf. Kelly [67], p. 53; Brunner-Crouch [14], Passim; Crouch [27], pp. 149-152; Weber [97].

69. We use as a basis, the work of Brunner and Metzer for America (see bibliography); Brunner and Crouch, ibid., for Great Britain; Kelly, ibid., and Weber, ibid., for Canada; Fratianni [38] for Italy; and Maxwell [74] and Heller [51] for South Africa.

theoretical specification.[70] Three factors mitigate in favour of maintaining the structure of the model: firstly, the currency and time deposit ratios are the two least important determinants of the money multiplier; secondly, the results for the non ratio demand functions, upon which the ratio demand functions depend, appear reasonable; and thirdly, the interest elasticity of the money multiplier does not depend on the currency ratio.[71] In the sections that follow, we provide empirical evidence on the private sector's non ratio demand functions for currency, demand deposits, and time deposits, and on the Reserve Bank's lending ratio.

6.2.1 The Private Sector's Demand for Currency, Demand Deposits and Time Deposits. Before presenting the empirical evidency on the demand functions for currency, demand deposits and time deposits, we should bear in mind a few points about the currency and time deposit ratio.

In the period 1950 to 1971, thr currency ratio increased in value from 0.21 to 0.34 at an average annual rate of 2.8 per cent, and the time deposit ratio experienced a spectacular increase from 0.12 in 1950 to 0.98 in 1971, at an average annual rate of 32.6 per cent (see Table A.19.IV, Appendix A.19). On a general basis, variations in the currency ratio appear to be negatively associated with nominal income judging from its contra-cyclincal pattern of

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70. The regression equations for the currency and time deposit ratios contain severe autocorrelation, extremely low adjusted R^2 coefficients and non significant coefficients for all the explanatory variables. An Hildreth-Lu [57] procedure did not improve the results materially. It is likely that the interest rate used may not be a good measure of the opportunity costs of holding currency. Omitted variables such as the transactions cost attached to the encashment of savings deposits and the substantial growth of near money (provided by the near banks) in the period, may account for the low Durbin-Watson statistics. Since autocorrelation is present to a lesser extent in the non ratio demand functions, it is likely to be compounded in the ratio demand function regression equations (see Sec. 6.2.1 and n. 74, below).

71. In conformity with other money supply studies, we assume that the currency ratio (P_1) is not responsive to the credit market rate. See Equations 3-13 and 3-22, and Chap. 3, n. 12.

movement. We proceed how to assess the determinants of the demand for currency, demand deposits and time deposits.

The regression equations are specified as follows (Equations 2-22 to 2-24 are the theoretical counterparts to these equations):[72]

$$C_p = C_p(i_{12CB}, WN, YDIS) \quad (4\text{-}20)$$

$$D = D(i_{12CB}, WN. YDIS) \quad (4\text{-}19)$$

$$T = T(i_{12CB}, WN, YDIS) \quad (4\text{-}22)$$

where:

C_p = currency (notes and coin) held by the private sector

D = demand deposits

T = time deposits

i_{12CB} = the interest rate on 12-month fixed deposits in the banking sector

YDIS = an income distribution proxy defined as the ratio of wage income to nominal net national income

WN = a nominal wealth proxy variable.[73]

The regression results are given in Table 4.XXII, Equations 1 to 3. All the signs are as postulated, the equations explain over 90 per cent of the

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72. We use the 12-month fixed deposit rate at commercial banks (i_{12CB}) as a measure of the opportunity cost of holding currency and demand deposits. It is a consistant time series for our period of study and was used by Maxwell and Heller in their studies of the demand for money in South Africa (Maxwell, ibid., and Heller, ibid.).

73. Nominal wealth is used to minimise the level of multicollinearity in the equations due to the intercorrelation between real wealth and the price level.

TABLE 4.XXII

REGRESSION ESTIMATES OF THE DEMAND FOR CURRENCY,DEMAND DEPOSITS, TIME DEPOSITS AND THE RESERVE BANK'S LENDING RATIO

Dependent Variables	C	i_{12cs}	i_{OD}	i_{br}	IR	YDIS	WN	$\bar{R}^2$	DW	ρ
1. C_p	- 0.96 (-0.88)	-0.016 (-0.016)				0.56 (1.24)	0.95 (6.53)*	0.98	2.15	0.85
2. D	2.91 (1.41)	-0.034 (-0.67)				-0.073 (-0.11)	0.56 (1.98)*	0.94	1.36	0.96
3. T	- 7.38 (-3.75)	0.91 (3.27)*				-1.27 (-0.89)	1.61 (5.78)*	0.97	1.04	
4. P_g	-17.73 (-5.62)		18.97 (3.59)*	-9.95 (-2.36)*	-0.95 (-1.65)			0.54	2.29	

* 10 % significance level (two tail)

SOURCE: Basic data for the dependent and independent variables are listed in Appendix A.19.

NOTES: C = constant term, i_{12cs} = the deposit rate on comercial bank twelve-month fixed deposits, i_{OD} = the minimum rate on commercial bank overdrafts, i_{br} = Reserve Bank discount rate, IR = inter- national reserves with the Reserve Bank, YDIS = income distribution, WN = nominal wealth proxy, $\bar{R}^2$ = adjusted coefficient of determination, DW = Durbin-Watson statistic, ρ = the coefficient of of autocorrelation which minimises the standard error of the equation using an Hildreth-Lu procedure. The equations are estimated in logarithmic form with annual data for the period 1950-1971. Data points for the years 1965,1966 are omitted due to missing data in the i_{12cs} variable. DW is significant at the 5% level in equations 1 and 4 and lies in the indeterminate range in equations 2 and 3.

variation in the dependent variables and there is no indication of auto-correlation. In Equations 1 and 2, an Hildreth-Lu procedure has been used to calculate the coefficient of autocorrelation that minimises the standard error of the equation.[74]

In the currency equation (Equation 1) the income distribution variable is not seriously insignificant and the interest rate is not significant, due perhaps to the 12-month time deposit rate being an unsatisfactory measure of the opportunity cost of holding currency. A similar argument applies to the demand deposit equation (Equation 2), and the time deposit rate is (not surprisingly) significant in the time deposit equation (Equation 3). An increase in nominal wealth raises the demand for all three components of money balances. Since all the signs in the equations are correct, we feel justified in not rejecting our a priori specification of these functions.[75]

On the basis of the above empirical evidence, there appears to be no strong cause for rejecting our specification of the private sector's currency and time deposit ratio demand functions (P_1 and P_2). That the income distribution variable is almost significant in the currency equation is particularly informative. We discuss the income distribution hypothesis in Section 11.

6.2.2 The Aggregate Reserve Ratio Again. The behaviour of the banking sector is summarised by the aggregate reserve ratio (b_1), which has been fully

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74. Substantial autocorrelation existed in the original equations estimated, due probably to the ommission of important variables measuring the costs of and yields from the various components of money balances; for instance, the price of commodities habitually purchased with currency relative to thos purchased by cheque transfers, service charges and incidential benefits accruing to demand deposit holders, and flexibility in the implimentation of the required notice of withdrawal on time deposits. It is possible that the problem of autocorrelation is compounded when estimating the ratio demand functions.

75. Wonnacott and Wonnacott suggest that insignificant coefficients do not constitute grounds for rejecting a strongly held theoretical view ([98], pp. 65-67).

investigated in Section 3. of this chapter. We provide a brief summary of the main conclusions.

Empirically, aggregate reserves are divided into three components, statutory reserves, vault cash, and excess reserves held as deposits with the Reserve Bank. The empirical evidence indicates that the vault cash ratio is not determined by the variables of the model and is unimportant in explaining the aggregate reserve ratio. This permits us to treat it as a constant for the purpose of analytical simplification.

Similarly, the excess reserve ratio (identified as excess reserves with the Reserve Bank) is found to be unimportant in explaining the aggregate reserve ratio, since those variables that are significant in explaining the excess reserve ratio are not significant in explaining the aggregate reserve ratio and *vice versa*. In consequence, the excess reserve ratio is also treated as a constant for analytical simplification. The role of the money market is crucial to this result by enabling the banking sector to economise on excess reserves by holding money market liquid assets and maintaining a low and stable optimum excess reserve ratio.

The statutory reserve ratio dominates changes in the aggregate reserve ratio. Changes in the private sector's time deposit ratio and variations in statutory reserve requirements explain 99 per cent of the variations in the statutory reserve ratio. The time deposit ratio is, in turn, determined by interest rates, wealth, the price level and income distribution. Our regression equation for the aggregate reserve ratio indicates that 97 per cent of the variation in the aggregate reserve ratio is explained by changes in the time deposit ratio and statutory reserve requirements. In the case of South Africa, the interest rate mechanism affects b_1 via the statutory reserve ratio and not the excess reserve ratio. Contra-cyclical variations in the money multiplier may therefore be enhanced by pro-cyclical changes in statutory reserve reserve requirements by the Reserve Bank.[76]

6.2.3 The Reserve Bank's Lending Ratio, Bank Rate Policy, and the Money Market. The remaining ratio parameter to be examined is the Reserve Bank's lending ratio (P_8). In Section 5 of Chapter 2, we formulate the theoretical structure underlying the behaviour of P_8. This structure incorporates the institutional linkage between the Reserve Bank, the banking sector, the money market and other private sector financial institutions; and the profit maximising behaviour of financial institutions. In support of this framework, we show in Section 3.2, that the money market in South Africa performs its function of mobilising otherwise idle short-term funds, of dealing in short-term financial assets and of intermediating between the banking sector and the Reserve Bank as the banking sector's first line of defence. The evidence brought to bear, shows, that the banking sector effectively reduced its optimum excess reserve ratio and maintained it at an historically low level. In this section, we present evidence to support our view of the importance of Reserve Bank lending in the money supply process; a function of the central bank upon which the life of the money market depends.

The numerator of the P_8 ratio is the endogenous variable AFI, defined as the supply of banking and private sector earning assets to the Reserve Bank (Chapter 2, Section 5) and referred to for short as Reserve Bank lending. Since AFI is endogenous, (and being a source component of the monetary base) we deduct it from the monetary base to obtain the adjusted monetary base. AFI enters the money supply process as a component of the P_8 ratio and hence of the money multiplier. Now we know so far, that AFI varies contra-cyclically (Section 4), and not surprisingly, P_8 varies contra-

76. In Sec. 6.1, we noted that a 1 per cent increase in the statutory reserve requirement on demand deposits causes a decrease in the money multiplier of 0.2 per cent.

cyclically, dominating contra-cyclical variations in the money multiplier and exerting a contra-cyclical influence on the money supply. One more piece of evidence about interest rates enables us to formulate an empirical hypothesis to test the role and importance of the Reserve Bank's lending ratio in the money supply process. We provide this evidence in Section 6.2.4 below, viz. that Bank Rate and the credit market rate vary contra-cyclically, rising in the contraction phase and declining (or rising less) in the expansion phase.

The hypothesis is formulated as follows. Since business cycles in South Africa are closely linked to the balance of payments, the contraction phase is characterised by an outflow of international reserves, which, reflects a tightening of liquidity conditions in financial markets, and an increase in the credit market rate and Bank Rate. The banking sector withdraws call deposits from the money market, forcing the discount houses to incur losses by seeking accomodation from the Bank at penal rates. The Land Bank and other financial institutions, who receive regular aid from the Reserve Bank, may turn to the Bank for additional funds. Thus, the Reserve Bank provides lender of last resort facilities to the financial system and P_8 rises. Conversely, P_8 falls during the expansion phase as international reserves are replenished, interest rates decline (or rise more slowly) and the discount houses expunge their indebtedness to the Reserve Bank as profits increase.[77] We conclude that the contra-cyclical interest rate mechanism is responsible for contra-cyclical variations in the multiplier, transmitted mainly through the ratio

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[77]. A. B. Dickman points out that discount houses make profits during periods of declining interest rates and losses when rates are rising, due to the time lag between adjustments in yields on earning assets and rates on call deposits ([34], p. 237 and n. 57).

parameter P_8. The Reserve Bank's lending ratio is indeed an important element in the money supply process.

We test this hypothesis with regression Equation 4-23 (its theoretical counterpart is Equation 2-44).

$$P_8 = P_8(i_{OD}, i_{br}, IR) \qquad (4-23)$$

where:

i_{OD} = commercial banks' overdraft rate

i_{br} = Bank Rate

IR = international reserves held by the Reserve Bank.

The overdraft rate is a proxy for the credit market rate, and measures the cost of sourcesof finance alternative to Reserve Bank credit; and IR is a proxy for the state of liquidity in financial markets.[78]

The regression results in Table 4.XXII (Equation 4), indicate that all the coefficients are highly significant with the exception of IR (which is short of being significant by 0.1). The signs are as expected and the equation is free of autocorrelation. We conclude that pro-cyclical variations in the balance of payments and contra-cyclical movements in interest rates explain the observed contra-cyclical path of P_8 and the money multiplier. However, the equation only explains 54 per cent of the variation in P_8.

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78. The use of international reserves instead of demand deposits, total deposits or the adjusted monetary base, as a measure of liquidity, minimises intercorrelation with the dependant variable and lowers the level of multicollinearity in the equation. IR proves to be the most significant of these alternative liquidity measures and gives the highest adjusted R^2.

We suggest that Bank Rate is not a measure of the true cost of Reserve Bank credit. During the period, the cost of Reserve Bank credit varied erratically from no penalty at all to preferential penalty rates well below Bank Rate. Open back door operations, special rediscounting privileges and the periodic transfer of Treasury funds from the Reserve Bank to the banking sector and the money market served to induce variations in P_8 not accounted for by Bank Rate.[79] That Bank Rate is significant, however, is due to the fact that the rediscounting of eligible paper (other than Treasury bills) is subject to the Bank Rate penalty. Only Treasury bills are discounted at preferential rates and subject to special privileges. Another reason for the low adjusted R^2 may rest with the fact that we have no measure for the cost of Reserve Bank credit extended to non money market financial institutions in the private sector.

In summary, the empirical evidence indicates that P_8 is endogenously determined by the credit market rate and exogenously determined by the balance of payments and by Bank Rate. Pro-cyclical movements in international reserves and contra-cyclical movements in interest rates induce contra-cyclical movements in P_8. The traditional function of the Reserve Bank as the lender of last resort, together with the profit maximising behaviour of financial institutions (and the discount houses in particular), transmit changes in interest rate and the balance of payments, to P_8, by setting in motion the classic mechanism which forces the discount houses (and the banking sector) to adjust P_8, since permanent reliance on Reserve Bank accommodation is impossible.[80] Since Bank Rate varies contra-cyclically, it attenuates the contra-cyclical influence of P_8 on the money multiplier in the contraction phase,

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79. See Sec. 2 for a description of Reserve Bank discounting policy.

80. A. B. Dickman [34], p. 234.

while discounting privileges and preferential discount rates on Treasury bills tend to raise P_8 in the contraction phase. The interest rate mechanism together with Reserve Bank lending policy forms a crucial part of the money supply process in South Africa. We elaborate further on this subject in Section 8.2.

6.2.4 Cyclical Behaviour of Credit Market Rates and Bank Rate. We introduce evidence in this section, that interest rates vary contra-cyclically and display asymmetric behaviour between the expansion and contraction phase; and in Section 8, this information is used to show that the interest rate mechanism is responsible for the observed differential behaviour of the money multiplier over different periods of time. An explanation of the contra-cyclical behaviour of interest rates, observed here, is provided in Section 7.1 and Section 8.

We choose as our sample of credit market rates, two long-term interest rates (the rate on long-term government securities and the minimum overdraft rate at commercial banks) and one short-term rate (the call deposit rate at the National Financial Corporation). The long-term rate on government securities is part of the pattern of interest rates quoted by the Reserve Bank (see Section 2); the minimum overdraft rate is the rate paid by commercial bank clients tendering government and other stock as security or pledging fixed and notice deposits;[81] and the National Financial Corporation's call deposit rate sets the floor level to the call rate offered by the private discount houses, the latter rate being conventionally set at 0.125 per cent

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[81]. The minimum overdraft rate is defined in [88], Dec. 1972, p. S-29, n. 2. Commercial banks act as a cartel by quoting a uniform rate on overdrafts ([88], March 1965, P. xii; Goedhuys [44], p. 216 and Kantor [64], p. 316).

below the weekly tender rate on 91-day Treasury bills.

In Table 4.XXIII, average quarterly interest rates over each phase of the business cycle are calculated from quarterly interest rate data (Table A.19.VI, Appendix A.19), and Figure 4.II presents this quarterly data in diagramatic form. Perusal of the table reveals a clear contra-cyclical pattern for long-term and short-term credit market rates and for Bank Rate. In each expansion phase the average quarterly rate is lower than in the succeeding contraction phase.

Notice in the diagram that all interest rates have a secularly rising trend. Over the course of the business cycle, these rates tend to be relatively stable during the expansion phase and to rise during the contraction phase. Thus, the pro-cyclical movements observed in Table 4.XXIII, are due, not to a decline in the rate of interest in the expansion phase, but rather to an increase in the contraction phase followed by relative stability in the expansion phase. On average, interest rates are higher in the contraction than in the expansion phase due to greater variations in the former relative to the latter.

This phenomenon is evident in Table 4.XXIV where the average annual percentage change in interest rates over each phase of the cycle is calculated from quarterly percentage changes at an annual rate.

On average, over the entire period, all rates increase; Bank Rate, the long-term rate on government securities, the overdraft rate and the call rate, rising at an average annual rate of 3.27 per cent, 3.86 per cent, 2.64 per cent and 10.2 per cent, respectively. Over the cycle, however, the average annual percentage change during each contraction phase exceeds that of the previous expansion phase.

TABLE 4.XXIII

AVERAGE CYCLICAL VARIATIONS IN INTEREST RATES:1954-1971

Business Cycles	Mean Interest Rates in %				Standard Deviations			
	i_{br}	i_{LT}	i_{OD}	i_{cal}	i_{br}	i_{LT}	i_{OD}	i_{cal}
EXP. 54.I -55.I	4.00	4.40	5.50	1.92	0.00	0.12	0.00	0.23
CONTR. 55.II-56.III	4.33	4.57	5.83	2.83	0.24	0.22	0.24	0.34
EXP. 56.IV-57.IV	4.50	4.75	6.00	3.12	0.00	0.00	0.00	0.00
CONTR. 58.I -59.I	4.40	5.30	6.30	3.45	0.20	0.25	0.25	0.064
EXP. 59.II-60.I	4.00	5.25	6.00	2.93	0.00	0.00	0.00	0.40
CONTR. 60.II-61.III	4.58	5.57	6.58	3.78	0.34	0.25	0.34	0.40
EXP. 61.IV-65.I	3.93	5.04	6.00	2.52	0.49	0.43	0.57	0.79
CONTR. 65.II-65.IV	5.00	5.83	7.00	3.92	0.00	0.24	0.00	0.12
EXP. 66.I -67.I	5.60	6.30	7.40	4.21	0.49	0.24	0.37	0.41
CONTR. 67.II-67.IV	6.00	6.50	7.83	4.77	0.00	0.00	0.24	0.078
EXP. 68.I -69.III	5.64	6.50	7.64	4.64	0.23	0.00	0.23	0.16
CONTR. 69.IV-71.IV	5.83	7.64	7.83	4.70	0.47	0.76	0.47	0.56
Standard Deviation 54.I -71.IV	0.83	1.05	0.89	1.03	...	...	...	...

SOURCE: South African Reserve Bank Quarterly Bulletin. Quarterly interest rate data are provided in Table A.19.VI. The business cycles for 1954-1967 are those identifies by D. J. Smit and B. E. van der Walt [95], and cycles for 1968-1971 are obtained from analysis of our own data.

NOTES: Average cyclical interest rates are obtained by summing over respective quarters in each half cycle and dividing through by the number of quarters. i_{br} = Reserve Bank discount rate, i_{LT} = the long-term rate on government debt, i_{OD} = minimum rate on commercial bank overdrafts, i_{cal} = call deposit rate at the National Finance Corporaton.

TABLE 4.XXIV

AVERAGE CYCLICAL PERCENTAGE CHANGES IN INTEREST RATES:1954-1971

Business Cycles		Mean Percentage Change			
		i_{br}	i_{LT}	i_{OD}	i_{cal}
EXP.	54.I -55.I	0.00	- 2.22	0.00	15.38
CONTR.	55.II-56.III	8.33	5.47	6.06	35.10
EXP.	56.IV-57.IV	0.00	0.57	0.00	1.74
CONTR.	58.I -59.I	- 2.22	10.47	5.00	8.91
EXP.	59.II-60.I	- 8.33	- 2.17	- 5.77	-15.47
CONTR.	60.II-61.III	12.27	5.58	8.23	24.51
EXP.	61.IV-65.I	- 1.70	- 3.61	- 1.41	4.67
CONTR.	65.II-65.IV	26.32	21.19	17.21	33.85
EXP.	66.I -67.I	12.00	9.81	5.71	6.71
CONTR.	67.II-67.IV	6.67	2.78	4.60	19.05
EXP.	68.I -69.III	- 4.76	0.00	- 1.67	- 2.98
CONTR.	69.IV-71.IV	6.06	11.80	4.44	7.99
Mean	54.I - 71.IV	3.27	3.86	2.64	10.20
Standard Deviation		12.90	9.06	8.73	26.71
Mean	Expansion	0.07	0.24	0.079	0.25
	Contraction	1.79	1.79	1.42	4.04

SOURCE: See source notesto Table 4.XXIII.

NOTES: Average cyclical percentage changes in interest rates are calculated by summing over quarterly percentage changes at an annual rate for each half-cycle and dividing through by the number of quarters. The means and standard deviations for the period 1954.I-1971.IV are calulated from quarterly percentage changes at an annual rate.
Separate quarterly means for the expansion and contraction phase are obtained by inserting the data in this table into the formula given in the notes to table 4.XVI. i_{br} = Reserve Bank discount rate, i_{LT} = long- term rate on government debt, i_{OD} = minimum rate on commercial bank overdrafts and i_{cal} = call rate at the National Finance Corporation.

In the last two rows of Table 4.XXIV we calculate the average quarterly percentage change in interest rates in the expansion and contraction phases, separately. These statistics summarise the extent to which interest rates vary as between contractions and expansions. It is immediately obvious that all rates rise by a greater percentage in the contraction phase relative to the expansion phase; the increase in the expansion phase being less than 0.25 per cent, compared to an increase of almost 2 per cent in the contraction phase. Curiously enough, both Bank Rate and the long-term rate on government debt increase by 1.79 per cent in the contraction phase. This is more than coincidence, since both rates are set by the Monetary Authorities, and, as we shall see in Section 8.2, the same economic rational induces changes in both these rates.

Thus, the evidence indicates that interest rates vary contra-cyclically with variations being greater in the contraction phase than the expansion phase. Now the money supply hypothesis implies that the elasticity of the credit market rate with respect to the adjusted monetary base is negative. Since the base varies pro-cyclically and interest rates vary contra-cyclically, the evidence points to a negative association (the elasticity is estimated in Section 7.1). Furthermore, the evidence suggest that the elasticity of the money multiplier with respect to the credit market rate is positive (this elasticity is estimated in Section 7.2). And finally, the asymmetric behaviour of both the money multiplier and interest rates is explained in Section 8.

6.3 Summary and Conclusions

This section has been devoted to a discussion of the determinants of the money multiplier, by examining the behaviour of the ratio parameters and the forces that determine them. We emphasise particularly the role of interest rates, which respond to changes in the adjusted monetary base and induce feedback variations in the multiplier via the ratio parameters.

According to the money supply hypothesis, the interest elasticity of the money multiplier is positive. The hypothesis implies that the observed differential behaviour in the money multiplier is due to a similar differential behaviour in interest rates. The mechanism linking interest rate changes to the multiplier rests with the behaviour of the banking and private sectors and the Monetary Authorities, embodied in the ratio parameters P_1, P_2, P_8 and b_1.

Examining the elasticities of the money multiplier with respect to the ratio parameters, we find that the multiplier responds negatively to changes in P_1 and b_1, and positively to changes in P_2 and P_8; and on average over the long-run, P_1 and b_1 exert a stronger influence on the multiplier relative to P_2 and P_8. Since changes in statutory reserve requirements raise b_1, and hence, lower the multiplier, a 1 per cent increase in the statutory reserve requirement on demand deposits will offset the positive influence on the multiplier of a 1 per cent increase in P_2; but a 1 per cent decline in P_1 requires a corresponding increase in the statutory reserve requirement on demand deposits of more than 2 per cent.

Over the business cycle, we observe that contra-cyclical variations in the multiplier are due to P_2, P_8 and b_1, while P_1 (the currency ratio) exerts a weak pro-cyclical influence and is unimportant in explaining variations in the multiplier. This result contrasts with studies for Great Britain and Canada, where the currency ratio proves vital. Of the three contra-cyclical ratio parameters, P_8 exerts the dominant influence, inducing an actual decline in the multiplier during the expansion phase, while all three ratio parameters exert a positive influence in the contraction phase. The asymmetric behaviour of the multiplier is also dominated by similar movements in P_8, aided by weaker asymmetric contributions by P_2 and b_1. All three ratio parameters cause the multiplier to change by a greater percentage in the contraction phase than in the expansion phase, and P_8 accounts for the greatest part of the change.

Using regression analysis, we find no cause for rejecting our theoretical specification of the ratio parameters in Chapter 2. The demands for currency and demand deposits vary inversely with interest rates, and the demand for time deposits varies positively. Nominal income and income distribution appear to be important determinants of these variables.

Reviewing the results of our investigation of b_1 (the aggregate reserve ratio), we recall that b_1 is explained by changes in the time deposit ratio and statutory reserve requirements, responding negatively to the former and positively to the latter. The excess reserve ratio plays no part in the determination of b_1, since the money market enables the banking sector to stabilize its optimum excess reserve ratio against fluctuation in the adjusted monetary base, a result that supports our theoretical formulation of the South African money market.

Turning to the ratio parameter P_8, regression analysis shows that P_8 responds positively to the credit market rate, and negatively to Bank Rate and international reserves (a measure of liquidity conditions in the money market). This evidence supports the hypothesis that contra-cyclical variations in P_8 are due to contra-cyclical movements in the credit market rate, with contra-cyclical movements in Bank Rate acting as a dampening influence. Pro-cyclical variations in the balance of payments induce contra-cyclical movements in P_8. Accordingly, our view of the role of Reserve Bank lending and the function of the money market, which underpins the theoretical formulation of P_8, is empirically supported.

Finally, it is demonstrated that interest rates vary contra-cyclically with the same asymmetric behaviour observed for the multiplier. Interest rates change by more in the contraction phase than in the expansion phase, implying that the interest rate mechanism effectively transmits its contra-cyclical and asymmetric behaviour to the multiplier, via the ratio parameter P_8.

So far, we have adduced stong evidence in support of the theoretical structure and the comparative static implications of the model. In particular, it appears that interest rates respond negatively to the adjusted monetary base and that the multiplier responds positively to changes in interest rates. The final test of the hypothesis is conducted in Section 7, where we estimate the reduced form equations, and calculate the elasticities of the money multiplier with respect to the credit market rate and the exogenous variables.

7. THE DETERMINANTS OF THE CREDIT MARKET RATE AND THE MONEY SUPPLY

In the previous section of this chapter, our empirical discussion of the structure of the model yields important information bearing on the money supply and interest rate determination process in South Africa, and substantially supports the assumptions of the model.

In brief, we find that pro-cyclical variations in the adjusted monetary base are dominated by pro-cyclical movements in the balance of payments. Open market operations, Reserve Bank discounting policy and variations in the Government's deposit at the Reserve Bank exert a contra-cyclical influence on the base, too weak to offset the influence of the balance of payments. Thus, the adjusted monetary base is not an effective policy instrument of the Monetary Authorities and is exogenously determined.

The major determinants of the banking sector's aggregate reserve ratio are statutory reserve requirements and the time deposit ratio. The money multiplier, which links variations in the money stock to variations in the adjusted monetary base, is of prime importance in explaining observed movements in the money stock in the long-run and the short-run. Over the course of the business cycle, the money multiplier exhibits a consistent contra-cyclical movement which dampens the pro-cyclical influence of the adjusted monetary base on the money stock. Observed variations in the multiplier are due primarily to the contra-cyclical influence exerted by the ratio parameters P_2, P_8 and b_1, reflecting the behaviour of the banking and private sectors and the Reserve Bank, with the dominant influence being exerted through P_8. It appears that observed contra-cyclical variations in credit market rates and Bank Rate explain the behaviour of the ratio parameters, and hence, the money multiplier.

What now remains to be established, is the relationship between the exogenous variables of the model, and the money supply and credit market rate. The central hypothesis of the model is that changes in the exogenous variables are transmitted to the money supply through a two-path mechanism; the direct effect and the secondary or interest rate effect. The direct effect involves an initial or impact change in the money multiplier at the existing credit market rate. Attempted portfolio adjustments in response to a change in the exogenous variables, alter the credit market rate, thereby, inducing a second round of portfolio adjustments which induce a further change in the money multiplier. The net change in the money supply in response to an initial change in the exogenous variables, is the combination of the direct and secondary effects.

In the following sub-sections, we obtain estimates of the net effect on the money stock and the credit market rate of a change in the exogenous variables, by estimating the reduced forms of the model. These estimates are then used to obtain further estimates of the relative strengths and direction of influence of the direct and secondary effects, which characterise the transmission mechanism linking the exogenous variables to the credit market rate and the money supply.

7.1 Estimation of the Credit Market Rate Solution Function

The solution function for the credit market rate is derived from the equilibrium condition for the credit market (Equation 2-51) written in general form in Equation 2-52. Our empirical counterpart to Equation 2-52 is specified as:

$$i_{LT} = i_{LT}(B^a, W/P_w, P_y, YDIS, i_{br}, F, i_o, P_8) \qquad (4\text{-}24)$$

where:

i_{LT} = the interest rate on long-term government debt

B^a = the adjusted monetary base

W/P_w = real wealth

P_y = the price level

YDIS = income distribution

i_{br} = Bank Rate

F = the stock of outstanding government debt

i_o = the interest rate on non banking sector earning assets

P_8 = a proxy for Reserve Bank discounting policy.

An immediate problem arises in choosing empirical counterparts to the theoretical variables contained in the reduced form equation; in particular, this applies to the appropriate budget constraint on the demand functions of the model (wealth or income), the appropriate government debt variable, and a proxy for Reserve Bank lending privileges (i.e. open back door operations, and lending to non money market and non banking sector financial institutions).

In our theoretical specification of the private sector's demand functions (Chapter 2, Section 4), portfolio allocation decisions are constrained by the quantity of real wealth. For the purpose of empirical estimation, three alternative budget constraints are suggested in the literature, viz., some measure of real non human wealth, some measure of real income and some measure of real human plus non human wealth.[82] Resulting from preliminary tests, we choose real non human wealth as the appropriate budget constraint for the purpose of estimating the credit market rate solution function.[83]

Neither is the choice of an appropriate government debt variable straight forward. Following the results of preliminary tests, we use the stock of government debt held by the banking and private sectors, excluding government debt in the portfolio of the Public Debt Commissioners (and of course the Reserve Bank).[84]

The variable P_8, is the ratio parameter discussed in Section 6.2.3 and is used as a proxy variable to capture the effect of Reserve Bank open back door operations, discounting privileges and lending to non money market financial institutions.[85] That these factors are of importance is indicated by the low coefficient of determination obtained in the P_8 regression equation

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82. Real income or nominal income may be used in the demand function for money. To assess the separate effects of price changes on the demand for money, nominal income is split into two components; real income and the price level. Friedman suggests that real permanent income is the appropriate budget constraint on the money demand function, being a proxy for the broader concept of wealth which includes both human and non human wealth ([39]). D. Laidler provides an excellent discussion of alternative budget constraints used in the empirical literature on the demand for money. (See Chap. 2, n. 9 of this study).

83. In our search for an appropriate budget constraint, we tested real net national income, real permanent income and real non human wealth. The latter variable provided the best statistical results, minimising the degree of autocorrelation and multicollinearity, and maximising the coefficient of determination and the t-statistic. The coefficients on the net national income and permanent income variables are never significant.

84. Test with the aggregate stock of government debt (excluding the portfolio of the Reserve Bank) yield the wrong sign and an insignificant coefficient. This is due to the institutional nature of the government debt issue and the jobbing activities of the Public Debt Commissioners. We discuss these issues in Sec. 10 Using a government debt variable net of the Public Debt Commissioners' portfolio, in the credit market rate regression equation, yields higher t-statistics and minimises the degree of autocorrelation and multicollinearity in the equation.

85. See Sec. 2 for a discussion of Reserve Bank lending policy, Sec. 6.2.3 for a discussion of the P_8 regression equation and Chap. 2 Sec. 5.2.6 for a discussion of Reserve Bank lending to non money market financial institutions.

(Table 4.XXII). Since variations in P_8 determine movements in the credit market multiplier (and the money multiplier) three options present themselves; firstly, we could use a dummy variable to capture the annual contributions of P_8 to percentage changes in the credit market multiplier; secondly, the residuals from the P_8 regression equation could be used; and thirdly, we could use P_8 itself. Preliminary tests indicate that P_8 itself is the more appropriate proxy variable.[86]

As a measure of the credit market rate, we use the long-term rate on government debt. Although this rate is part of the pattern of rates administered by the Reserve Bank, changes in the pattern tend to follow market sentiment and therefore reflect changes in liquidity conditions in financial markets.[87] In consequence, we are able to assess the implications of the interest rate stabilization policy pursued by the Monetary Authorities. In our preliminary tests, we also used the minimum overdraft rate at commercial banks without success. Indirect evidence indicates that both rates move together with the long-term government debt rate having a relatively higher variance.[88] Furthermore, our results are comparable with other studies which also use the long-term rate on government debt, and our data series for

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86. Regression tests using the residuals from the P_8 structural equation injects a high degree of multicollinearity, and the results are generally not satisfactory. The P_8-dummy variable yields substantially the same results as P_8 itself but the latter has a slightly higher t-value. Both P_8 and the P_8-dummy have lower intercorrelation with the variables in the equation than do the residuals.

87. Sec. 2.

88. Regression equations with the overdraft rate failed due to excessive autocorrelation and low adjusted R^2 coefficients. These poor results are probably due to the interest rate cartel arrangement between commercial banks, which causes stickiness in interest rate movements and implies that the rate is determined by factors outside the realm of market forces, for which we have no measures ([71], p. 124). That the long-term securities rate and the overdraft rate move together is evident in Fig. 4.II and in Tables 4.XXIII and 4.XXIV; the standard deviation of the government debt rate exceeds that of the overdraft rate.

the latter is the most complete and consistent for the period.[89]

In Table 4.XXV we present the regression results for the credit market rate solution function.[90] Equations 1 and 2 focus attention on the two government debt variables; the total stock of government debt (F^N) and the stock of long-term government debt (F_2^N) held by the banking and private sectors. In all respects the equations are similar.

Adding the proxy variable P_8 to Equations 1 and 2,we obtain Equations 3 and 4. The most significant changes to note are the increases in the coefficients on the adjusted monetary base, real wealth, and the price level. In all other respects the equations are the same as Equations 1 and 2. P_8 is not seriously insignificant and has the correct sign, which appears sufficient justification to retain it in the equation. As between Equation 3 and 4, the coefficient values are substantially the same. However, in Equation 4, five out of the eight explanatory variables have higher t-values and the Durbin-Watson statistic is increased. On these grounds we choose Equation 4 as the appropriate credit market rate estimating equation.

In Equation, 5 we add the interest rate on non banking sector earning assets (i_o) using as a proxy the dividend yield on industrial shares.[91] Our preliminary tests with this interest rate altered the estimating equation

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89. In general short-term and long-term rates tend to move together and both appear adequate in estimating money demand relationships (Laidler [70] Pp. 82, 83).

90. The credit market rate solution function is estimated in logarithmic form with annual data for the period 1950 to 1971, and the coefficients are interpreted as the elasticity expressions in Equation 3-12, the expanded version of which is given in Equation A.9.1-4 (Appendix A.9.1).

91. Laidler indicates that in many studies on the demand for money in America, the yield on 20-year corporate bonds is used as a measure of the opportunity cost of holding money (ibid., p. 82). Brunner and Meltzer use the Durand measure of the interest rate on 20-year bonds when estimating a non linear money supply function ([18]).

TABLE 4.XXV

REGRESSION ESTIMATES OF THE CREDIT MARKET RATE SOLUTION FUNCTION

Dependent Variable = i_{LT}

	C	B^a	W/P_w	P_Y	YDIS	i_{br}	F^N	F_2^N	i_o	P_8	$\bar{R}^2$	DW
1.	1.39	-0.28	0.25	0.86	0.84	0.31	0.011				0.96	1.90
	(1.23)	(-2.52)	(1.41)	(3.34)	(1.69)	(2.90)	(0.30)					
2.	1.11	-0.28	0.28	0.83	0.81	0.31		0.02			0.96	1.94
	(0.82)	(-2.78)	(1.44)	(3.17)	(1.63)	(3.00)		(0.49)				
3.	1.08	-0.38	0.35	1.02	0.60	0.31	0.0087			-0.017	0.96	1.89
	(0.93)	(-2.58)	(1.75)	(3.40)	(1.11)	(2.89)	(0.23)			-1.04)		
4.	0.73	-0.39	0.40	0.99	0.57	0.31		0.017		-0.018	0.96	1.93
	(0.54)	(-2.73)	(1.78)	(3.30)	(1.03)	(2.99)		(0.51)		-1.08)		
5.	-3.37	-0.30	0.82	0.40	1.23	0.22		0.11	0.17	-0.036	0.97	2.06
	(-1.40)	(-1.07)	(3.45)	(1.15)	(1.12)	(2.60)		(1.63)	(0.91)	-1.73)		

SOURCE: South African Reserve Bank Quarterly Bulletin. Data listings of the variables may be found in Appendix A.10.

NOTES: The equations are estimated in logarithmic form using annual year-end data. Equations 1-4 are estimated for the period 1950-1971 and equation 5 is estimated for the period 1954-1971 due to lack of data for the i_o variable. i_{LT} = the long-term rate on government debt, c = constant term, B^a = the adjusted monetary base, W/P_w = real wealth, P_Y = the price level, YDIS = income distribution, i_{br} = Bank Rate, F^N = outstanding government debt, F_2^N = long-term government debt, i_o = interest rate on non banking sector earning assets, P_8 = the Reserve Bank's lending ratio used as a dummy variable for Reserve Bank discounting policy, $\bar{R}^2$ = the adjusted coefficient of determination, DW = the Durbin-Watson statistic. Figures in parentheses are t-values.

completely; several variables were rendered insignificant and a substantial degree of autocorrelation was introduced. The best estimate obtained is in Equation 5, from which it is clear that the coefficient magnitudes on the other variables are altered as well as their levels of significance. Thus, we are reluctant to use Equation 5 as the estimating equation for two main reasons; firstly, the results in Equation 4 are robust in a step-wise regression test, and secondly, the indications are that the dividend yield on industrial shares is not a good measure of the opportunity cost of holding money. In fact, the simple correlation coefficient between the long-term rate on government securities and the dividend yield is negative indicating that the substituion relationship is tenous. For lack of a better measure, we use the coefficient on i_o in Equation 5 as the best estimate of the elasticity of the credit market rate with respect to i_o.

As indicated above, regression Equation 4 is used as the estimating equation for the credit market rate. We turn now, to a discussion of these results in conjunction with the comparative static implications of the model in Chapter 2 (Section 3).

The relevant data for the discussion is arranged as follows. Table 4.XXVI contains the credit market rate elasticities taken from regression Equations 4 and 5 (Table 4.XXV) together with accompanying elasticity formulae (from Table 3.II). Since each elasticity formula contains only one unknown, all the numerators and denominators can be solved for, providing estimates of the interest rate effect in the credit market, $e(a,i_e) - e(h,i_e)$, and the direct effect of changes in the exogenous variables working through the credit market multiplier and the h function (the numerators of the expressions). These estimates are calculated in Table 4.XXVII, and Table 4.XXVIII provides a convenient summary of all the estimates.

All the signs on the elasticities in Table 4.XXV are in accordance with our comparative static results, and all the coefficients are significant with the exception of income distributions and the government debt variable.

Referring to Expression 1 in Table 4.XXVI and Table 4.XXVII, we discuss the elasticity of the credit market rate with respect to the adjusted monetary base.

In accordance with the money supply hypothesis, the base exerts a negative influence on the credit market rate, from which it is implied (by solving for the denominator of the elasticity expression (see Tabel 4.XXVII), that the interest rate effect working through the credit market multiplier and the h function is positive, $e(a,i_e) - e(h,i_e) = 2.56$. Now we do not have separate estimates of the interest elasticities of the credit market multiplier and the h function. However, indirect empirical information permits the imposition of constraints on these elasticities, indicating that $e(a,i_e)$ lies in the interval $1.33 < e(a,i_e) < 2.56$ if $e(h,i_e)$ is negative, in which case, $0 < |e(h,i_e)| < 1.23$.[92]

An important general implication of the hypothesis is established. All the elasticity expressions (Table 4.XXVI) contain the term $e(a,i_e) - e(h,i_e)$ in the denominator, which represents the secondary effect of a change in the exogenous variables. A positive secondary effect which exceeds unity attenuates

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92. Proof: $e(m,i_e) < e(a,i_e)$ if $e(m,P_2) < e(a,P_2)$ - (proved a priori in Appendix A.12). Since $e(m,P_2) = 0.16$ (Table 4.XVII) and $e(a,P_2) = 0.22$ (data in notes to Table 4.XVII and formula in Appendix A.7.1), therefore, $e(m,i_e) < e(a,i_e)$. Since $P_1 > P_8$ and $r^{d'} > r^{t'}$ (notes to Table 4.XVII), therefore, $e(m,i_e) < [e(a,i_e) - e(h,i_e)]$ - (proved in Appendix A.12). Since $e(m,i_e) = 1.33$ (Table 4.XXXI) and $[e(a,i_e) - e(h,i_e)] = 2.56$ (Table 4.XXVII), $1.33 < e(a,i_e) < 2.56$ if $e(h,i_e) < 0$ (assumed a priori) and $0 < |e(h,i_e)| < 1.23$. (Q.E.D.).

TABEL 4.XXVI

REGRESSION ESTIMATES OF THE CREDIT MARKET RATE ELASTICITIES WITH RESPECT TO THE EXOGENOUS VARIABLES

1.	$e(i_e,B^a)$	$= -\dfrac{1}{e(a,i_e) - e(h,i_e)}$	$= -0.39$
2.	$e(i_e,r^{d'})$	$= -\dfrac{e(a,r^{d'})}{e(a,i_e) - e(h,i_e)}$	$= 0.101$
3.	$e(i_e,r^{t'})$	$= -\dfrac{e(a,r^{t'})}{e(a,i_e) - e(h,i_e)}$	$= 0.032$
4.	$e(i_e,i_{br})$	$= -\dfrac{e(a,i_{br})}{e(a,i_e) - e(h,i_e)}$	$= 0.31$
5.	$e(i_e,i_o)$	$= \dfrac{e(h,i_o) - e(a,i_o)}{e(a,i_e) - e(h,i_e)}$	$= 0.17$
6.	$e(i_e,W/P_w)$	$= \dfrac{e(h,W/P_w) - e(a,W/P_w)}{e(a,i_e) - e(h,i_e)}$	$= 0.40$
7.	$e(i_e,P_y)$	$= \dfrac{e(h,P_y) - e(a,P_y)}{e(a,i_e) - e(h,i_e)}$	$= 0.99$
8.	$e(i_e,YDIS)$	$= -\dfrac{e(a,YDIS)}{e(a,i_e) - e(h,i_e)}$	$= 0.57$
9.	$e(i_e,F_2^N)$	$= \dfrac{e(h,F_2^N)}{e(a,i_e) - e(h,i_e)}$	$= 0.017$

NOTES: The elasticity formulae are taken from Table 3.II; the estimates are taken from regression equations 4, 5 in Table 4.XXV; and elasticity estimates for r^d and r^t are calculated in Table 4.XXVII, expressions 4, 5, respectively.

TABLE 4.XXVII

ESTIMATES OF THE DIRECT AND SECONDARY EFFECTS
ON THE CREDIT MARKET RATE OF A CHANGE
IN THE EXOGENOUS VARIABLES

1.	$e(a,i_e) - e(h,i_e)$	$= 1/ - e(i_e,B^a)$	$= 2.56$
2.	$e(a,i_e)$		$= 1.33 < e(a,i_e) < 2.56$
3.	$e(h,i_e)$		$= 0 < e(h,i_e) < 1.23$
4.	$e(i_e,r^{d'})$	$= e(i_e,B^a)e(a,r^{d'})$	$= 0.101$
5.	$e(i_e,r^{t'})$	$= e(i_e,B^a)e(a,r^{t'})$	$= 0.032$
6.	$e(a,i_{br})$	$= e(i_e,i_{br})/e(i_e,B^a)$	$= - 0.79$
7.	$e(h,i_o) - e(a,i_o)$	$= e(i_e,i_o)/ - e(i_e,B^a)$	$= 0.44$
8.	$e(h,W/P_w) - e(a,W/P_w)$	$= e(i_e,W/P_w)/ - e(i_e,B^a)$	$= 1.03$
9.	$e(h,P_y) - e(a,P_y)$	$= e(i_e,P_y)/ - e(i_e B^a)$	$= 2.54$
10.	$e(a,YDIS)$	$= e(i_e,YDIS)/e(i_e,B^a)$	$= - 1.46$
11.	$e(h,F_2^N)$	$= e(i_e,F_2^N)/ - e(i_e,B^a)$	$= 0.044$

NOTES: Estimates in this table are obtained by solving for the unknown terms in Table 4.XXVI. The inequalities for expressions 2, 3 are obtained from indirect empirical information (see n.92). Expressions 4, 5 are estimated as follows: $e(i_e,B^a)$ is obtained in Table 4.XXVI; formulae for $e(a,r^{d'})$, $e(a,r^{t'})$ are given in the summary to Appendix A.7.1, and annual mean date is given in the notes to Table 4.XVII.

a positive or negative direct effect (in the numerator) on the credit market rate resulting from changes in the exogenous variables. The inequalities above suggest that the major attenuating force emerges from portfolio adjustments via the credit market multiplier, rather than from debt adjustments. For example, a 1 per cent increase in the adjusted monetary base initially lowers the credit market rate equi-proportionately (the direct effect is equal to -1 in the numerator of Expression 1 in Table 4.XXVI). Asset portfolios and debt positions are adjusted in response to the lower interest rate, causing a decline in the credit market multiplier in excess of 1.33 per cent and an increase in the demand for banking sector credit (the h function) by something less than 1.23 per cent. The total secondary effect (the denominator of Expression 1 in Table 4.XXVI) resulting from asset and debt adjustments is to raise the credit market rate by 2.56 per cent so that the net decline in the credit market rate is 0.39 per cent for a 1 per cent increase in the adjusted monetary base. This process is completely clarified in Table 4.XXVIII where the secondary interest rate effect (Column 4) is represented by the reciprocal of the credit market multiplier and h function expression, and is equal to 0.39. The net change in the credit market rate, (Column 2) is the product of the secondary and direct effects (Column 3). Hence, comparing Columns 2 and 3, it is evident that for all the exogenous variables, the secondary effect attentuates the direct effect. This pattern of causation is completely general for changes in all the exogenous variables.

An increase in the statutory reserve requirement on demand and time deposits, and in Bank Rate, raises the credit market rate as hypothesised, with the secondary effect attenuating the direct effect. Of the three policy variables, Bank Rate exerts the strongest influence, followed by the statutory reserve requirement on demand deposits. The statutory reserve requirement

TABLE 4.XXVIII

SUMMARY OF THE ESTIMATES OF THE DIRECT AND SECONDARY EFFECTS AND THE CREDIT MARKET RATE ELASTICITIES

	Exogenous Variables (1)	Elasticities (Net Effect) = (2)	Direct Effect (3)	X	Secondary Effect (4)
	x	$e(i_e,x)$			$1/e(a,i_e) - e(h,i_e)$
1.	B^a	$- 0.39$		$= - 1$	0.39
2.	$r^{d'}$	$0.101 = - e(a,r^{d'})$		$= 0.26$	"
3.	$r^{t'}$	$0.032 = - e(a,r^{t'})$		$= 0.083$	"
4.	i_{br}	$0.31 = - e(a,i_{br})$		$= 0.79$	"
5.	i_o	$0.17 = e(h,i_o) - e(a,i_o)$		$= 0.44$	"
6.	W/P_w	$0.40 = e(h,W/P_w) - e(a,W/P_w)$		$= 1.03$	"
7.	P_y	$0.99 = e(h,P_y - e(a,P_y)$		$= 2.54$	"
8.	YDIS	$0.57 = - e(a,YDIS)$		$= 1.46$	"
9.	F_2^N	$0.017 = e(h,F_2^N)$		$= 0.044$	"

NOTES: Col. 2 = regression estimates from Table 4.XXVI; col. 3 = numerators of the formulae in Table 4.XXVI and the values are calculated in Table 4.XXVII. The calculation of expressions 2, 3 are discussed in Table 4.XXVII, notes. Col. 4 = $- e(i_e,B^a)$ from expression 1, Table 4.XXVI .

on time deposits exerts the weakest influence (Tables 4.XXVI and v.XXVIII).

It is possible to evaluate the relative efficacies of the three policy instruments; the adjusted monetary base, statutory reserve requirements and Bank Rate. From the elasticity ordering, the adjusted monetary base exerts the strongest influence followed by Bank Rate, with statutory reserve requirements last. The explanation rests with the relative difference in the strengths of the direct effect, since the secondary effect is the same for all exogenous variables. In Column 3 of Table 4.XXVIII, we find that the direct effects exhibit the same ordering as the net effect in Column 2. While the direct effect of an increase in the adjusted base is -1, those for the other policy variables do not exceed 0.8. The economic explanation is simply, that an initial increase in the adjusted base lowers the credit market rate by inducing a shift in the demand for financial assets, as well as generating excess reserves in the banking sector. The direct effect is characterised by a two-pronged thrust; an attempted portfolio adjusted by the private sector, which does not occur in the direct effects due to changes in statutory reserve requirements or Bank Rate, and the generation of excess reserves in the banking sector, which is the only initial result of a reduction in statutory reserve requirements; while a reduction in Bank Rate merely changes the price of Reserve Bank credit. In the case of all three policy variables, the banking sector of course attempts to purchase earning assets, thereby lowering the credit market rate. Thus, the dominant force giving strength to the adjusted base is the initial shift in the asset demands of the private sector.

In the case of real wealth, the price level and the interest rate on non banking sector earning assets, the credit market rate response is positive as postulated. Our estimates of the direct effects in Table 4.XXVII are positive, indicating that the debt effect (the h function elasticity) outweighs the asset effect (the credit market multiplier elasticity).

An increase in income distribution in favour of a low income group, raises the credit market rate. The demand for currency rises causing a fall in the credit market multiplier. That the direct effect is negative (Table 4.XXVII, Expression 10), implies that the credit market multiplier is dominated by the increase in the ratio parameter P_1 due to the change in income distribution, as postulated.

Expression 9 in Table 4.XXVI, shows that an increase in the stock of long-term government debt raises the credit market rate, implying that the elasticity of the h function with respect to F_2^N is positive (Table 4.XXVII, Expression 11).

The negative sign and almost significant coefficient on the proxy variable P_8 in the regression Equation 4, indicates that open back door operations, Reserve Bank discounting privileges and Reserve Bank lending to non money market financial institutions, exert a negative impact on the credit market rate.

In the following section, we estimate a money supply function and use the data from this section, in conjuction with the money supply elasticites, to obtain estimates of the money multiplier elasticites with respect to the exogenous variables. The empirical results in this section are summarised in Section 7.3 below.

7.2 Estimation of the Money Supply Function

In Chapter 2, Section 7, the money supply reduced form is derived from definitions for the adjusted monetary base and the money stock, the ratio demand functions of the banking and private sectors, and the credit market rate solution function. From the general form of the money supply reduced form (Equation 2-57), we specify the regression equation for the money supply function as:

$$M_2 = M_2(B^a, W/P_w, P_y \text{ YDIS}, i_{br}, F^N, i_o, P_8D) \qquad (4\text{-}25)$$

where the money supply depends on the adjusted monetary base, real wealth, the price level, income distribution, Bank Rate, the stock of government debt, the interest rate on non banking sector earning assets and a proxy variable for Reserve Bank discounting privileges. The measures used for the exogenous variables on the right hand side of Equation 4-25 are discussed in the previous section (with the exception of P_8D) and apply here for the same reasons.[93] W/P_w is a measure of real non human wealth and F^N is the stock of outstanding government debt held by the banking and private sectors (excluding the Public Debt Commissioners). P_8D is a dummy variable capturing the effects of unmeasurable determinants of Reserve Bank lending. As indicated in Section 7.1, three possible proxy variables are available; the lending ratio P_8, the residuals from the P_8 structural regression equation, and the P_8D variable, which is a dummy variable capturing the effect on the money multiplier of changes in the ratio parameter P_8. P_8D is constructed by calculating the annual percentage contribution of P_8 to percentage changes in the money multiplier, and assigning the integer 1 for positive contributions and the

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93. Multicollinearity is minimised with the use of real non human wealth, as opposed to real net national income or real permanent income, and the stock of outstanding government debt (excluding the Public Debt Commisioners) has the lowest correlation with the other independent variables, in contrast to the total stock of government debt.

integer -1 for negative contributions.[94] Since a Reserve Bank lending proxy is included in the credit market equation it must also appear in the money supply equation. P_8D is almost significant and has the correct sign, facilitating a test of the influence of movements in the money multiplier not explained by a change in Bank Rate and the adjusted monetary base (or international reserves). A dummy variable is chosen here in favour of the P_8 variable, since P_8D is more significant than P_8.[95]

Our choice of a broad definition of money (including time deposits) should be explained.[96] In theory, we distinguish between the transactions and speculative demand for money but in practice the two categories are not clearly distinguishable. While currency and demand deposits are clearly media of exchange, and therefore satisfy the transactions demand, time deposits are often held for transaction purposes if transactions costs are sufficiently low, while at the same time satisfying the speculative motive. The appropriate definition of money turns on the substitution relationship between money and non money assets, which is an empirical question. However, of relevance to this study is the question of the group of money assets controlled by the Monetary Authorities. Finally, a narrow definition of money, which concentrates on the transactions demand, is threatened with a high degree of instability due to the existence of very close substitutes such as time deposits. We have

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94. The method of calculating the percentage contribution of P_8 to changes in the money multiplier is explained in Appendix A.18 for quarterly data. Exactly the same method us used on annual data for the purpose of constructing P_8D.

95. Using the residuals from the P_8 structural equation introduces a high degree of multicollinearity and autocorrelation which significantly alters the otherwise robust coefficients on the remaining independent variables; signs are often reversed and t-values become insignificant. P_8 generates broadly the same results as P_8D, with respect to coefficient values and t-statistics.

96. D. Laidler [70], Pp. 79, 80.

adduced evidence to show that the substitution relationship between money (narrowly defined) and time deposits in South Africa is likely to be close and that a narrow definition is highly unstable due to the observed increase in the time deposit ratio over the period.[97] Such a consistent change in portfolio practices exerts a secular upward pressure on the money supply (broadly defined) due to the existence of differential cash reserve requirements. To remove the instability and to capture the effects of the statutory reserve differential, we choose a broad definition which includes time deposits. And of course, from a policy point of view the Monetary Authorities can control the broader aggregate.

In Table 4.XXIX the regression results are presented.[98] Equations 1 and 2, direct attention to the government debt variable and the dummy variable is excluded. Both the total stock of government debt (F^N) and the stock of long-term debt (F_2^N) are significant with the correct signs and almost identical coefficients, indicating that either variable is appropriate in explaining the money supply. The same phenomenon is observed in the credit market rate regression results. Whereas long-term debt is relatively more significant for the credit market rate, total government debt is relatively more significant for the money supply.

In Equations 3 and 4, the dummy variable P_8D is added without altering the results materially. The coefficients on the adjusted monetary base and income distribution are increased somewhat and the latter gains in significance. P_8D is not seriously insignificant and has the correct sign. Bank Rate is

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97. See Secs. 3.3 and 6.2.1 for a discussion of the time deposit ratio and the structural equation regression estimations, respectively.

98. The money supply equation is estimated in logarithmic form with annual data for the period 1950 - 1971, and the coefficients are interpreted as the elasticity expressions in Equation 3-19, the expanded version of which is given in Equation A.10.1-4 (Appendix A.10.1).

TABLE 4.XXIX

REGRESSION ESTIMATES OF THE MONEY SUPPLY FUNCTION

Dependent Variable $= M_2$

	C	B	W/P_w	P_Y	YDIS	i_{br}	F^N	F_2^N	i_o	P_8D	$\bar{R}^2$	DW
1.	-0.32	0.36	0.69	1.31	0.38		0.13				0.99	2.02
	(-0.023)	(2.64)	(3.23)	(4.19)	(0.65)		(2.78)					
2.	-1.19	0.44	0.78	1.24	0.42			0.096			0.99	1.99
	(-0.68)	(3.29)	(3.01)	(3.64)	(0.69)			(2.22)				
3.	-0.83	0.48	0.68	1.13	0.54		0.11			0.018	0.99	2.22
	(-0.57)	(2.82)	(3.25)	(3.20)	(0.91)		(2.47)			(1.14)		
4.	-1.56	0.56	0.75	1.76	0.59			0.08		0.019	0.99	2.17
	(-0.86)	(3.27)	(2.92)	(2.82)	(0.94)			(1.86)		(1.10)		
5.	-0.83	0.48	0.69	1.13	0.59	-0.031	0.12			0.019	0.99	2.21
	(-0.56)	(2.73)	(3.13)	(3.11)	(0.91)	(-0.23)	(2.40)			(1.13)		
6.	1.20	0.41	0.59	1.40	0.78		0.019		-0.13	0.026	0.99	2.28
	(0.45)	(1.51)	(2.97)	(2.95)	(0.63)		(0.13)		(-0.03)	(1.62)		

SOURCE: South African Quarterly Bulletin. Data listings of the variables may be found in Appendix A.19.

NOTES: The equations are estimated in logarithmic form using annual year-end data. Equations 1-5 are estimated for the period 1950-1971 and equation 6 is estimated for the period 1954-1971 due to lack of data for the i_o variable. M_2 = the money supply, C = constant term, B^c = the adjusted monetary base, W/P_w = real wealth, P_Y = the price level, YDIS = income distribution, i_{br} = Bank Rate, F^N = the outstanding stock of government debt, F_2^N = the stock of long-term government debt, i_o = interest rate on non banking sector earning assets, P_8D = a dummy variable for Reserve Bank discounting policy. Figures in parentheses are t-values.

added in Equation 5, and the results are unchanged with respect to Equation 3. Addition of the interest rate on non banking sector earning assets (i_o) in Equation 6 (with Bank Rate excluded), modifies the result substantially, raising the level of autocorrelation and rendering the adjusted base in significant. Our preliminary tests with i_o and Bank Rate together, completely destroy otherwise robust coefficient estimates, and the low level of autocorrelation in the regression equations, and neither of the two variables are ever significant. Using i_o alone minimises the disturbance in the equations, so that we use the coefficient on i_o in Equation 6 as our best estimate, and choose Equation 5 as the estimating equation for the money supply function.[99]

We now discuss the regression results from Equation 5 in terms of the comparative static results derived in Chapter 3 (Section 4), and assess the effects of a change in the exogenous variables on the money supply. The relevant data is arranged in the tables as follows. Table 4.XXX contains the money supply elasticities from regression Equation 5 and 6 (Table 4.XXIX) together with the elasticity formulae (from Table 3.V). Each elasticity expression contains the elasticity of the money multiplier with respect to the exogenous variables as an unknown which can be solved for (the elasticities of the credit market rate with respect to the exogenous variables are known from Table 4.XXVI). These money multiplier elasticities are calculated in Table 4.XXXI, together with the interest elasticity of the money multiplier, $e(m,i_e)$, and the feedback operator K (to be discussed in the text below). Using the regression estimates from Table 4.XXX, the money multiplier elastici-

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99. As noted in Sec. 7.1, we are reluctant to place great faith in the dividend yield on industrial shares as a measure of i_o, since the credit market regression results indicate that it is probably not a true measure of the opportunity cost of holding demand and time deposits.

TABLE 4.XXX

REGRESSION ESTIMATES OF THE MONEY SUPPLY ELASTICITIES WITH RESPECT TO THE EXOGENOUS VARIABLES

1.	$e(M_2,B^a)$	$= 1 + e(m,i_e)e(i_e,B^a)$		$= 0.48$
2.	$e(M_2,r^{d'})$	$= e(m,i_e)e(i_e,r^{d'})$	$+ e(m,r^{d'})$	$= -0.067$
3.	$e(M_2,r^{t'})$	$= e(m,i_e)e(i_e,r^{t'})$	$+ e(m,r^{t'})$	$= -0.021$
4.	$e(M_2,i_{br})$	$= e(m,i_e)e(i_e,i_{br})$	$+ e(m,i_{br})$	$= -0.031$
5.	$e(M_2,i_o)$	$= e(m,i_e)e(i_e,i_o)$	$+ e(m,i_o)$	$= -0.13$
6.	$e(M_2,W/P_w)$	$= e(m,i_e)e(i_e,W/P_w)$	$+ e(m,W/P_w)$	$= 0.69$
7.	$e(M_2,P_y)$	$= e(m,i_e)e(i_e,P_y)$	$+ e(m,P_y)$	$= 1.13$
8.	$e(M_2,YDIS)$	$= e(m,i_e)e(i_e,YDIS)$	$+ e(m,YDIS)$	$= 0.59$
9.	$e(M_2,F^N)$	$= e(m,i_e)e(i_e,F^N)$		$= 0.12$

NOTES: The elasticity formulae are taken from Table 3.VI; the estimates are taken from equations 5, 6 in Table 4.XXIX. $e(M_2,r^{d'})$, $e(M_2,r^{t'})$ are indirect estimates calculated from the elasticity formulae in expressions 2, 3 of this table. $e(m,i_e)$ is calculated in Table 4.XXXI; $e(i_e,r^{d'})$, $e(i_e,r^{t'})$ are given in Table 4.XXVI and $e(m,r^{d'})$, $e(m,r^{t'})$ are explicit expressions evaluated in Table 4.XVII.

TABLE 4.XXXI

ESTIMATES OF THE MONEY MULTIPLIER ELASTICITIES WITH RESPECT TO THE CREDIT MARKET RATE AND THE EXOGENOUS VARIABLES

1.	$e(m,i_e)$	$= e(M_2,B^a) - 1/e(i_e,B^a)$	= 1.33
2.	K	$= e(m,i_e)/e(a,i_e) - e(h,i_e)$	= 0.52
3.	$e(m,r^{d'})$	$= \dfrac{-(1 + P_2)r^{d'}D}{[P_1 + b_1(1 + P_2) - P_8](D + T)}$	= -0.20
4.	$e(m,r^{t'})$	$= \dfrac{-(1 + P_2)r^{t'}T}{[P_1 + b_1(1 + P_2) - P_8](D + T)}$	= -0.064
5.	$e(m,i_{br})$	$= e(M_2,i_{br}) - e(m,i_e)e(i_e,i_{br})$	= -0.44
6.	$e(m,i_o)$	$= e(M_2,i_o) - e(m,i_e)e(i_e,i_o)$	= -0.36
7.	$e(m,W/P_w)$	$= e(M_2,W/P_w) - e(m,i_e)e(i_e,W/P_w)$	= 0.16
8.	$e(m,P_y)$	$= e(M_2,P_y) - e(m,i_e)e(i_e,P_y)$	= -0.19
9.	$e(m,YDIS)$	$= e(M_2,YDIS) - e(m,i_e)e(i_e,YDIS)$	= -0.17

NOTES: The money multiplier elasticities are calculated by solving for the unknowns in Table 4.XXX. K is defined in equation 3 - 23 (Chap. 3) and formulae 3, 4 are given and evaluated in Table 4.XVII.

TABLE 4.XXXII

SUMMARY OF THE ESTIMATES OF THE DIRECT AND SECONDARY EFFECTS ON THE MONEY SUPPLY OF CHANGES IN THE EXOGENOUS VARIABLES

Exogenous Variables (1)		Elasticities (Net Effect) (2)	= Direct Effect (3)	+ Secondary Effect (4)
	x	$e(M_2, x)$	$e(m, x)$	$e(m, i_e)e(i_e, x)$
1.	B^a	0.48	1.0	-0.52
2.	$r^{d'}$	-0.067	-0.20	0.133
3.	$r^{t'}$	-0.021	-0.064	0.043
4.	i_{br}	-0.031	-0.44	0.41
5.	i_o	-0.13	-0.36	0.23
6.	W/P_w	0.69	0.16	0.53
7.	P_y	1.13	-0.19	1.32
8.	YDIS	0.59	-0.17	0.76
9.	F^N	0.12	...	0.12

NOTES: Columns 2 and 3 are taken from Tables 4.XXX and 4.XXXI. In column 4, $e(m, i_e)$ is taken from expression 1 in Table 4.XXXI and $e(i_e, x)$ are the regression coefficients in Table 4.XXVI. In row 9, $e(i_e, x)$ for $x = F^N$, used to estimate the secondary effect, is calculated from expression 9 in Table 4.XXX.

ties from Table 4.XXXI, and the interest rate elasticities from Table 4.XXVI, we calculate (in Table 4.XXXII) the relative contribution of the secondary interest rate effect (Column 4) and the direct effect (Column 3) to changes in the money supply, due to changes in the exogenous variables. Table 4.XXXII provides a convenient summary of the data.

As mentioned above, regression Equation 5 is chosen as the appropriate money supply function. Overall it explains 99 per cent of the variation in the money supply with no autocorrelation in the residuals. All the explanatory variables are highly significant with the exception of income distribution, Bank Rate and the dummy variable, and all the signs are as hypothesised. We do not reject the variables with non significant coefficients given that they are our best estimates. They have the correct signs and our a priori belief in their relevance is strong, particularly in view of the indirect evidence already obtained, that the income distribution variable affects the demand for currency, and Bank Rate is significant in explaining the Reserve Bank's lending ratio.[100] The problem of multicollinearity posed an initial problem, as is to be expected with long-run time series data where all variables increase over time. However, we use variable measures with the lowest degree of inter-correlation,and step-wise tests on the equations indicate that the coefficients are highly stable. On these grounds we find these results satisfactory.

Referring to Table 4.XXX, the adjusted monetary base exerts a positive influence on the money supply of less than unity. The transmission mechanism is summarised in the formla for the elasticity, the separate terms of which , reflect the direct and secondary (interest rate) effects. Initially, an

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[100] See regression equations in Table 4.XXII, and n. 75 above.

increase in the adjusted monetary base raises the money supply proportionately since the direct effect is unity (Table 4.XXXII, Expression 1). The credit market rate declines causing a fall in the money multiplier. A 1 per cent increase in the base lowers the credit market rate by 0.39 per cent and the interest elasticity of the money multiplier is 1.33 (Table 4.XXXI, Expression 1). The product of these two elasticities gives an estimate of the secondary interest rate effect, equal to -0.52 (Table 4.XXXII, Column 4). Thus, the direct effect of a 1 per cent increase in the adjusted monetary base is modified by the secondary interest rate effect which lowers the money multiplier by 0.52 per cent resulting in a net increase in the money supply of 0.48 per cent. The negative secondary interest rate mechanism operates to attenuate the positive direct effect on the money supply of an increase in the adjusted monetary base.

Our estimate of the interest elasticity of the money multiplier is calculated in Table 4.XXXI, and is of general importance for all the elasticities in Tables 4.XXX and 4.XXXII, since it forms the common link between initial changes in the exogenous variables and the ultimate response of the money supply. That $e(m,i_e)$ is positive, is in accordance with the money supply hypothesis and requires that $P_1 > P_8$, $b_1 < 1$ and $r^{d'} > r^{t'}$.[101] Our empirical investigation shows that these inequalities are satisfied.[102] Having established in Section 7.1, that changes in the exogenous variables (excluding the adjusted monetary base) raise the credit market rate, and since

101. See Appendix A.10.2, Equation A.10.2-17, and Equation 3-22 in the text.

102. See notes to Table 4.XVII.

$e(m,i_e)$ is positive, the secondary interest rate mechanism working through the money multiplier attenuates the direct effect on the money stock of a change in the exogenous variables (with the exception of real wealth; see Table 4.XXXII).

The same phenomenon is revealed by referring to variable K, the feedback operator (K is defined in Chapter 3; see Equation 3-23). K summarises the combined interest rate effect on the money and credit market multipliers, and the h function. Since the credit market rate is negatively associated with changes in the adjusted monetary base, K is in fact the elasticity of the money multiplier with respect to changes in the adjusted monetary base, $e(m,B^a)$, and is therefore a measure of the strength of the feedback mechanism or the influence of the credit market rate in the money supply process. Scrutiny of Table 3.IX reveals that K enters all the elasticity expressions multiplicatively. Since $0 < e(m,i_e) < [e(a,i_e) - e(h,i_e)]$, which our empirical estimates support, K is constrained to lie in the interval between zero and unity and is equal to 0.52 (Table 4.XXXI).[103]

In consequence, we conclude that the interest rate mechanism attenuates the impact on the money supply of changes in the exogenous variables, by reducing the impact of the direct effect.[104]

Changes in statutory reserve requirements influence the money supply negatively, with the statutory reserve requirements on demand deposits exerting

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103. See Equation 3-24 in the text. $e(a,i_e) - e(h,i_e) = 2.56$ and $e(m,i_e) = 1.33$ (Tables 4.XXVII and 4.XXXI, resp.).

104. Note that K differs from the secondary effect in Table 4.XXXII, since it includes $e(m,i_e)$ but excludes that part of $e(i_e,x)$ attributable to direct changes in multiplier a and the h function; cf. expressions in Table 4.XXX, Table 3.V and the definition of K (Chap. 3, Sec. 4, Equation 3-23).

a relatively stronger influence than that on time deposits (Table 4.XXX).[105] An increase in the statutory reserve requirement on demand deposits of 1 per cent, lowers the money multiplier by 0.2 per cent directly. The credit market rate rises inducing a secondary positive response in the money multiplier of 0.13 per cent. The net increase in the money supply is therefore 0.07 per cent (Table 4.XXXII). The positive secondary interest rate effect attenuates but does not outweigh the negative direct effect of a change in statutory reserve requirements.

A similar process occurs for Bank Rate, where a 1 per cent increase in Bank Rate lowers the money multiplier directly by 0.44 per cent; the credit market rate rises inducing a secondary increase in the multiplier of 0.41 per cent, and the money supply increases by 0.03 per cent; the sum of the direct and secondary effects. Again we see that the positive secondary interest rate effect incompletely attenuates the positive direct effect on the money supply of a change in Bank Rate (Table 4.XXXII, Expression 4). That Bank Rate is significant in the credit market rate equation but not in the money supply function implies that Bank Rate may be more effective for an interest rate policy designed to protect the balance of payments, rather than for money supply policy. A variable which truly measures the influence of Reserve Bank discounting privileges and the regular supply of Reserve Bank credit to non money market (or banking sector) institutions, may prove more significant in the determination of the money supply.

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105. Estimates of the elasticity of the money supply with respect to changes in statutory reserve requirements are obtained indirectly from the formulae in Table 4.XXX. Given $e(m,i_e)$ in Table 4.XXXI; $e(i_e,r^{d'})$, $e(i_e,r^{t'})$ in Table 4.XXVII and $e(m,r^{d'})$, $e(m,r^{t'})$ in Table 4.XVII, the elasticity of the money supply with respect to changes in statutory reserve requirements can be calculated.

An assessment of the relative efficacy of monetary policy exercised through the adjusted monetary base, statutory reserve requirements and Bank Rate, is now possible. From Table 4.XXXII it is clear that the adjusted monetary base exerts a stronger influence on the money supply than either statutory reserve requirements or Bank Rate. The reason rests with the relative strengths of the direct and secondary effects. In the case of an increase in the adjusted monetary base, the impact effect raises the money supply proportionately by 1 per cent, which is attenuated by the secondary effect equal to -0.52 per cent. In the case of a 1 per cent decline in statutory reserve requirements, the impact raises the money supply by 0.2 per cent and the secondary effect lowers the money supply by 0.13 per cent, leaving a residual increase in the money supply of 0.07 per cent. Similarly, the net increase in the money supply for a 1 per cent fall in Bank Rate is 0.03 per cent.

The superior strength of incluence of the adjusted monetary base over statutory reserve requirements and Bank Rate is revealed for both the credit market rate and the money supply for the same economic reasons. The direct effect of an increase in the adjusted monetary base simultaneously raises the money supply proportionately on impact (the direct effect is unity), as well as generating an equivalent quantity of excess reserves in the banking sector; whereas a reduction in statutory reserve requirements only generates excess reserves in the banking sector with the money supply held constant. Similarly, a reduction in Bank Rate merely lowers the cost of Reserve Bank lending on impact. The banking sector, of course, expands the money supply by purchasing earning assests, reflected by an increase in the money multiplier. However, to obtain a 1 per cent increase in the money supply on impact (equivalent to a 1 per cent increase in the adjusted monetary base), the statutory reserve requirement on demand deposits or Bank Rate must be reduced by more than 2 per cent. Notice in Table 4.XXXII that the secondary effect of a change in the base exceeds that of both statutory reserve requirements and Bank Rate. This is due to the relatively stronger effect of a change in the base on the credit market rate.[106]

Our results for the interest rate on non banking sector earning assets (i_o) and the price level are somewhat less clearcut. In the first instance, we are forced to remain agnostic by rejecting the empirical estimates rather than the hypothesis; and in the second, plausible empirical results indicate that modification of the structure is required.

Referring to Table 4.XXX (Expression 5), the response of the money supply to changes in i_o is negative and contrary to the hypothesis. Now the evidence so far shows that $e(m,i_e)e(i_e,i_o) > 0$.[107] If we accept that $e(M_2,i_o)$ is negative, this implies that $e(m,i_o)$ is negative, which is a reversal of the hypothesis that we find difficult to accept [that $e(m,i_o) > 0$, is shown in Appendix A.8.2). Since the coefficient on i_o in regression Equation 6 (Table 4.XXIX) is less significant than in the credit market rate equation, and since all our tests with this interest rate disturb otherwise stable coefficients, we reject the regression estimate as unsatisfactory and suggest that further investigation is needed to establish the positve elasticity of the money multiplier with respect to the interest rate on non banking sector earning assets. In particular, a more suitable measure is needed. Hence, from the evidence here established, it appears that the second-

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106. See Equation 3-27, where this conclusion is formuated *a priori*.

107. $e(i_e,i_o) > 0$ is obtained from the credit market rate regression Equation 5 (Table 4.XXV). Although the coefficient is not significant, the sign is correct on *a priori* grounds.

ary effect is positive, as postulated, and that we remain agnostic on the influence of the direct effect, and therefore, on the net effect of a change in i_o on the money supply.

In regard to the price level, the influence on the money supply is positive. An increase in the price level, however, appears to lower the money multiplier (which is contrary to the hypothesis), implying that the direct effect is negative (see Table 4.XXXII). The credit market rate and money supply regression coefficients are satisfactory so we accept that an increase in the price level induces an increase in the money supply. The direct effect is negative, the secondary effect is positve and in this case the positive secondary effect outweighs the negative direct effect. Consequently, we suggest that further study of the structure is required to establish that the price elasticity of the money multiplier is negative.

An increase in real wealth exerts a positive influence on the money supply by directly raising the money multiplier and the credit market rate, the latter inducing a secondary increase in the money multiplier. In the case of real wealth, therefore, the direct and secondary effects reinforce each other (Table 4.XXXII, Expression 6).

In the case of income distribution our results are tentative and suggestive. Income distribution is not significant in either the credit market rate regression equation or the money supply equation (the sign is correct). As postulated, a redistribution of income in favour of a low income group, lowers the money multiplier directly by raising the currency ratio (P_1); the credit market rate rises inducing a secondary increase in the money multiplier, which outweighs the negative direct effect resulting in a net increase in the money supply (Table 4.XXII, Expression 8.[108] That the influence of income distribution on the money supply is dominated by the secondary interest rate mechanism is not surprising, in view of the fact that the income distribution variable is relatively more significant in the credit market rate equation. A 1 per cent increase in income distribution in favour of a low income group lowers the money supply by 0.17 per cent, directly, through the money multiplier. The ensuing increase in the credit market rate induces a 0.76 per cent increase in the money multiplier, resulting in a net increase in the money supply of 0.59 per cent. Further implications of the income distribution hypothesis are considered in Section 11.

Finally, the influence of the stock of government debt held by the banking and private sectors (excluding the Public Debt Commissioners) on the money supply, is positive. An increase in the stock of government debt induces no initial direct effect on the money multiplier; it operates directly on the interest rate via the h function, and the interest rate in turn affects the money multiplier. We are able to obtain two different estimates for the money supply elasticity with respect to government debt. The first is the regression coefficient in Table 4.XXXII (Column 2), and the second is obtained by inserting the credit market rate regression coefficient into Expression 9 in Table 4.XXX. In the first case we obtain a regression estimate of 0.12, and in the second the calculated money supply elasticity is 0.023. Since the money supply regression coefficient is highly significant relative to that of the credit market rate equation, we tend to accept the former. Thus, a

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[108] That the elasticity of the money supply is positive with respect to income distribution and that the secondary interest rate effect is positive, implies a negative sign on the elasticity of the money multiplier with respect to income distribution; which, in turn, satisfies the inequality condition, that changes in P_1, in consequence of a change in income distribution, dominate the induced variation in the money multiplier (Appendix A.8.2, Equation A.8.2-3).

1 per cent increase in government debt raises the money supply by approximately 0.1 per cent.[109]

Although the dummy variable is not significant in the money supply function its sign is positive indicating that the special discounting privileges on Treasury bills, extended by the Reserve Bank to the money market and the banking sector, and the supply of Reserve Bank credit to the Land Bank and other financial institutions, serve to raise the money supply. Variations in these privileges change the value of the ratio parameter P_8 and the money multiplier. Additional cash reservers are injected into financial markets and eventually enter the banking sector, permitting a multiple expansion of the money supply. Since the coefficient on the P_8D variable cannot be interpreted as an elasticity, measures of the direct and secondary effects cannot be calculated.

In the following section we summarise the empirical results obtained from the credit market rate and money supply regression equations.

7.3 Summary and Conclusions

In Sections 7.1 and 7.2, we estimate the credit market rate solution function and the money supply function for South Africa, and evaluate the relative impact of the policy and other exogenous variables on the credit market rate and the money supply. We summarise the empirical evidence commencing with the credit market rate.

When estimating the credit market rate solution function, a problem arises, of finding empirical measures for the theoretical variables. For reasons discussed in the text, a measure of real wealth is used as the appropr-

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109. The mean of the two estimates is 0.071 which is close to 1 per cent.

iate budget constraint on the portfolio demand functions, and the stock of government debt held by the Public Debt Commissioners is excluded from the government debt variable. The ratio parameter P_8 is added to the regression equations, as a proxy for open back door operations and discounting privileges of the Reserve Bank, and Reserve Bank lending to non money market financial insitutions. The long-term rate on government debt is used as a proxy for the credit market rate.

In general, the credit market rate regression equation is satisfactory on all criteria; all the coefficients are significant for the most part (the t-statistic on the income distribution variable is not seriously insignnificant), the signs are correct and there is no indication of autocorrelation in the residuals of the equation. Since the interest rate on non banking sector earning assets injects distortions into an otherwise stable set of regression coefficients, we exclude this rate from the credit market rate estimating equation and use the coefficient from another equation as our best estimate.

By inserting the regression coefficients into the credit market rate elasticity formulae, we obtain estimates of the direct and secondary effects of a change in the exogenous variables on the credit market rate. Our results are as follows.

1. The secondary effect of a change in exogenous variables, operating through the credit market multiplier and the h function is positive and greater than unity, thereby, attenuating the positive or negative direct effect on the credit market rate, of a change in the exogenous variables. The data suggests that the secondary effect is dominated by asset portfolio reallocations rather than by debt adjustments (the interest elasticity of

the credit market multiplier exceeds the interest elasticities of the h function in absolute value).

2. Changes in the adjusted monetary base induce an inverse change in the credit market rate, while increases in statutory reserve requirements and Bank Rate exert a positive influence. While a 1 per cent increase in the adjusted monetary base lowers the credit market rate by 0.39 per cent, a 1 per cent reduction in statutory reserve requirements or Bank Rate induces a decline in the credit market rate not exceeding 0.3 per cent. The influence of Bank Rate exceeds that of the statutory reserve requirement on demand deposits with the statutory reserve requirement on time deposits being the least influential. This influence ordering is due to a similar ordering observed in the relative strengths of the direct effect (the secondary effect is the same for all exogenous variables). That the adjusted monetary base dominates the influence of the other policy variables is due to an impact effect on the asset protfolios of the banking and private sectors, whereas, the remaining policy variables only affect the banking sector initially. The direct effect on the credit market rate of a change in the adjusted base is -1 whereas, for the other policy variables, it does not exceed 0.8.

3. The credit market rate responds positively to an increase in real wealth, the price level and the rate on non banking sector earning assets. Our estimates of their direct effects are positive as hypothesised, implying that debt adjustments outweigh asset adjustments.

4. A change in income distribution in favour of a low income group lowers the credit market rate, since, the response of the credit market

multiplier is negative. This supports the hypothesis that the currency ratio dominates variations in the credit market multiplier with respect to changes in income distribution.

5. An increase in the stock of government debt held by the banking and private sectors, raises the credit market rate, and the elasticity of the h function with respect to government debt is positive.

6. Open back door operations, the extension of special discounting privileges, and Reserve Bank lending to non money market financial institutions, appear to exert a negative influence on the credit market rate.

The evidence above supports the major interest rate hypothesis of the model. We focus attention now, on several overall behaviour patterns that emerge in Table 4.XXVIII.

Of the three policy variables (the adjusted monetary base, statutory reserve requirements and Bank Rate), the adjusted monetary base dominates changes in the credit market rate. However, in terms of the hierarchy of elasticity coefficients, real wealth, the price level and income distribution exert a stronger influence than the adjusted base.

The same causal sequence transmits the impact of changes in all the exogenous variables to the credit market rate. All the direct effects are positive (except for the adjusted base), resulting in an increase in the credit market rate at the existing set of asset portfolios (a decrease in the case of the adjusted base). Reacting to the increase in the credit market rate, the banking and private sectors adjust their asset and debt positions, exerting an upward pressure on the credit market rate (the common secondary effect is positive for all exogenous variables), which attenuates the initial direct effect.

The empirical evidence on the money supply process is summarised below. Section 7.2, commences with a specification of the empirical money supply function, the theoretical counterpart of which, is the money supply solution function derived in Chapter 2 (Section 7). All the explanatory variables are identical to those used in the credit market rate regression equations with the exception of a dummy variable used as a proxy for Reserve Bank discounting privileges. A dummy variable is used in preference to other proxy measures, since it provides better statistical results and reflects the influence on the money multiplier of changes in the Reserve Bank's lending ratio. We choose a broad definition of the money supply (including time deposits) as the appropriate test variable, since time deposits are close substitutes for demand deposits and are controllable by the Monetary Authorities, as part of the total liabilities of the banking sector.

The money supply function is estimated in logarithmic form with annual data for the period 1950 to 1971, and the results are satisfactory. The equation explains 99 per cent of the variation in the money supply and is free of autocorrelated residuals. All the signs are correct and the variables are significant with the exception of income distribution, Bank Rate and the dummy variable (the latter is not seriously insignificant). By inserting the regression coefficients into the money supply elasticity expressions and solving for the unknown terms, we obtain estimates of the money multiplier elasticites with respect to the exogenous variables and the credit market rate. With these estimates of the terms in the money supply elasticity expressions, we calcualte estimates of the direct and secondary effects that link changes in the exogenous variables to changes in the money supply. The direct effect is measured by the elasticity of the money multiplier with respect to the exogenous variables, and the secondary effect is measured by the product of the credit market rate response to changes in the exogenous variables and the interest elasticity of the money multiplier (Table 4.XXXII). The results are as follows.

1. A 1 per cent increase in the adjusted monetary base, raises the money supply by 0.48 per cent. The direct effect on the money supply is unity and therefore proportional to the increase in the base. However, the secondary interest rate effect lowers the money multiplier by 0.52 per cent, thereby, attenuating the direct effect.

2. From the elasticity expression for the adjusted monetary base, we calculate the interest elasticity of the money multiplier (and hence, of the money supply) to be 1.33. The direct effect of changes in all the exogenous variables except real wealth and the adjusted monetary base, lowers the money multiplier and raises the credit market rate, which in turn raises the money multiplier. The latter secondary effect, therefore, attenuates the influence of changes in the exogenous variables on the money supply; by modifying the direct effect. In the case of real wealth, the interest rate effect accentuates the direct effect.

3. Since changes in the credit market rate affect both the money and the credit market multipliers, and the h function, we estimate the value of feedback operator K. K captures the combined influence of the credit market rate on both multipliers, and the h function, and takes a value of 0.52, which, as postulated, lies in the range $0 < K < 1$. The influence of

K on the money supply is apparent from Table 3.IX (Chapter 3, Section 5). Since K enters the terms representing the secondary (interest rate) effect multiplicatively, it serves to attenuate the effects of a change in the exogenous variables (except real wealth) on the money supply, this time working through the credit market multiplier and the h function. In the case of the adjusted monetary base, K measures the elasticity of the money multiplier with respect to changes in the base. A 1 per cent increase in the adjusted monetary base induces a fall in the money multiplier of 0.52 per cent.

4. Increases in statutory reserve requirements and Bank Rate, affect the money supply negatively, with the statutory reserve requirement on demand deposits having the strongest effect. The negative direct effect of a change in these policy variables is attenuated by,but not outweighed by the positive interest rate effect.

5. Bank Rate policy appears more significant for an interest rate policy rather than for a money supply policy, being more significant in the credit market rate regression equation than the money supply equation. We suggest that a true measure of the cost of Reserve Bank credit (discounting privileges and lending to non money market and non banking sector financial institutions), may be more relevant for the money supply function.

6. Comparing the money supply elasticities with respect to the adjusted monetary base, statutory reserve requirements and Bank Rate, our results indicate tha the base exerts the strongest effect, followed by the statutory reserve requirement on demand deposits, Bank Rate and statutory reserve

requirements on time deposits, in that order. In each case, the interest rate mechanism attenuates the direct effect incompletely. The dominant position of the adjusted monetary base is due to its direct effect being unity, whereas the elasticities of the money multiplier with respect to changes in statutory reserve requirements and Bank Rate are less than unity. The adjusted monetary base is the only policy variable that raises the money supply proportionately on impact. For the same reasons, the base dominates the influence of statutory reserve requirements and Bank Rate on the credit market rate.

7. The results regarding the influence of the interest rate on non banking sector earning assets, are inconclusive, and we reject the statistical estimates obtained, while maintaining an agnostic position with respect to the hypothesis.

8. An increase in the price level, raises the money supply as postulated. However, the elasticity of the money multiplier with respect to the price level is negative and contrary to our hypothesis. But we find the statistical results satisfactory and suggest that the influence of price changes on the underlying structure requires further study. Thus, in this instance, the direct effect is negative and is outweighed by the positive secondary (interest rate) effect.

9. The money supply responds positively to an increase in real wealth, due to an increase in the money multiplier in both the direct and secondary effects. In contrast to our other results, the secondary effect enhances the influence of the direct effect.

10. A redistribution of income in favour of a low income group, raises the money supply due to a positive secondary effect, which, outweighs a negative direct effect. Since the elasticity of the money multiplier with respect to income distribution is negative, an inequality is satisfied implying that changes in the multiplier are dominated by the currency ratio, which reacts to a change in income distribution.

11. Changes in the stock of outstanding government debt held by the banking and private sectors (excluding the Public Debt Commissioners), induce positive changes in the money supply, and the transmission mechanism operates directly through the interest elasticity of the money multiplier.

12. Special discounting privileges extended to money market institutions and the banking sector, and the flow of Reserve Bank credit to non money market financial institutions, serve to raise the money supply by raising the money multiplier through the ratio parameter P_8. Since a dummy variable is used to capture the influence of these operations, we cannot calculate the separate direct and secondary effects.

The evidence summarised above,confirms the comparative static implications of the model derived in Chapter 3, Section 4. We direct attention to four overall patterns of behaviour implied by the data in Table 4.XXXII.

Firstly, the exogenous variables may be divided into three categories; policy variables (the adjusted monetary base, statutory reserve requirements and Bank Rate), exogenous variables reflecting the pull of the real sector on the money supply (real wealth, the price level, income distribution), and the role of the Government's budget deficit financed by the sale of government debt. Of the three policy variables, the adjusted base is clearly the dominant instrument. But all three real variables exert a relatively stronger influence on the money supply in terms of the hierarchy of elasticity coefficients.

Secondly, the same causal sequence transmits the impact of changes in the policy variables to the money supply. In the case of an increase in statutory reserve requirements and Bank Rate, the direct effect is negative and the money multiplier declines, given the existing set of interest rates. Interest rates rise, inducing a secondary rise in the money multiplier which incompletely attenuates the direct effect. For an increase in the adjusted base, however, the direct effect is unity and the secondary effect is negative and less than unity. In all three cases, the direct effect of a change in policy variables on the money supply, is modified by the interest rate mechanism.

Thirdly, while the causal linkage between the real variables and the money supply is the same as for the policy variables, the interest rate mechanism appears to modify the direct effect of changes in the real variables, in a different pattern. The interest rate mechanism accentuates the positive impact of an increase in real wealth and completely reverses the negative impact of an increase in the price level and of a redistribution of income. Changes in the stock of outstanding government debt are transmitted to the money supply, directly through the credit market via changes in the credit market rate.

Fourthly, the direct effect is negative for all exogenous variables except the adjusted base and real wealth, for which it is positive; and the interest rate mechanism is positive for all exogenous variables except the adjusted monetary base, for which it is negative.

In the following section, we assess the implications of these findings in the context of monetary and fiscal policy in South Africa, and the interest rate stabilization programme pursued by the Monetary Authorities.

8. MONETARY POLICY, FISCAL POLICY AND INTEREST RATE STABILIZATION

At this stage in our empirical analysis, we have evidence that the theoretical process determining the money supply and credit market rate in South Africa resides in the interest rate mechanism. The regression results in Section 7, and accompanying estimates of the direct and secondary effects, explain the transmission mechanism linking the exogenous variables to the money stock and the credit market rate.

In this section, we synthesize the empirical observations in Sections 2 to 6, by using our empirical knowledge of the transmission mechanism to explain the observed behavior of the money supply, the money multiplier, interest rates and the adjusted monetary base during the period 1950 to 1971. Several questions which so far remain unanswered are explicable in terms of the interest rate stabilization programme pursued by the Monetary Authorities. In particular, a consideration of monetary and fiscal policy which underpins the stabilization programme, facilitates an explanation of the contra-cyclical and asymmetric behaviour of the money multiplier, and the consequent pro-cyclical variation in the money supply. We find that interest rate stabilization causes the credit market rate to vary contra-cyclically and asymmetrically, thereby, generating a similar movement in the money multiplier, which prevents the latter from offsetting the pro-cyclical influence of the adjusted base on the money stock. Hence, pro-cyclical variations in the money stock are due, ultimately, to stabilization of the credit market rate.

8.1 The Nature Of Interest Rate Stabilization

We commence by examining the interest rate stabilization process, and provide estimates of the relationships implied by our money supply hypothesis, for such a programme.

The credit market rate is determined, inter alia, by variables that also constitute the sources of finance of the Government's budget deficit viz., the stock of outstanding government debt, and certain source components of the adjusted monetary base. A convenient expression is derived in Chapter 2 (Equation 2-46) relating the deficit to its sources of finance. We write this expression in a slightly modified form as follows:

$$(G - T)_t = \Delta F^o + \Delta[S + (GLOAN - RG) + U] \qquad (4\text{-}26)$$

where:

$(G - T)$ = the value of the deficit in time t

F^o = outstanding stock of government debt

S = Reserve Bank's portfolio of government debt

GLOAN = Reserve Bank loans to the Government

RG = Government's deposit at the Reserve Bank

U = other sources of deficit finance.

The Treasury may obtain funds by selling government debt to the banking and private sectors(ΔF^o), the Reserve Bank (ΔS), borrowing from the Reserve Bank ($\Delta GLOAN$), and reducing its deposit at the Reserve Bank (ΔRG). While an increase in F^o raises the credit market rate, an increase in the remaining terms of the expression (which constitute source components of the adjusted monetary base) lower the credit market rate. Given the size of the deficit and a ceiling on the credit market rate set by the Monetary

Authorities, the adjusted monetary base must vary positively with an increase in the stock of government debt for the ceiling rate to be maintained. Under these conditions, the adjusted base is no longer an independent variable, since its size is determined by the stock of government debt.

In Table 4.XXXIII, we provide data on the terms of Equation 4-26, over the course of the business cycle. It is immediately obvious that F^o exhibits a strong contra-cyclical tendency, rising by a smaller percentage in four out of six contraction phases relative to the previous expansion phase. On an average quarterly basis, the increase in F^o during the expansion and contraction phases is 1.88 per cent and 1.80 per cent respectively. Similarly, the adjusted monetary base rises by 1.8 per cent in the expansion phase but declines by 0.9 per cent in the contraction phase. Thus a differential relationship exists between changes in the stock of government debt and the adjusted monetary base over different phases of the cycle, the relationship being positive in the expansion phase and negative in the contraction phase. Since real wealth, the price level and the stock of government debt exert a positive influence on the credit market rate and fluctuate pro-cyclically, observed contra-cyclical variations in interest rates (Sec. 6.2.4) are explained by the pro-cyclical movements in the adjusted monetary base. The effect of the differential relationship between the stock of government debt and the adjusted monetary base, is to lower the degree of variation in interest rates in the expansion phase relative to the contraction phase.[110]

110.
Contra-cyclical movements may be characterised by an increase in the contraction phase and a decline or a reduced growth rate in the expansion phase. The latter implies a lower variability in the expansion phase relative to the contraction phase. Cf. means and variances in Table 4.XXIII.

TABLE 4.XXXIII

AVERAGE CYCLICAL CHANGES IN THE SOURCES OF THE GOVERNMENT'S DEFICIT FINANCE: 1954-1971 (%)

Business Cycles		$\Delta F^o/F^o$	$\Delta S/S$	$\Delta GLOAN/GLOAN$	$\Delta RG/RG$	$\Delta B^a/B^a$
EXP.	54.I -55.I	4.77	- 1.81	- 55.69	86.76	5.34
CONTR.	55.II-56.III	3.70	48.18	- 16.67	46.69	- 0.77
EXP.	56.IV-57.IV	6.10	24.19	35.11	- 27.53	4.62
CONTR.	58.I -59.I	7.16	36.97	- 22.10	31.77	- 3.18
EXP.	59.II-60.I	20.30	- 42.50	- 25.00	122.14	20.52
CONTR.	60.II-61.III	27.71	16.10	- 16.67	29.23	-11.05
EXP.	61.IV-65.I	14.51	46.35	17.51	79.42	13.81
CONTR.	65.II-65.IV	7.77	112.49	124.59	- 44.00	- 9.86
EXP.	66.I -67.I	16.76	- 3.94	- 14.88	148.06	11.07
CONTR.	67.II-67.IV	8.73	36.13	- 69.24	- 27.80	- 2.23
EXP.	68.I -69.III	12.93	3.32	- 19.35	142.39	16.81
CONTR.	69.IV-71.IV	2.64	24.83	940.09	- 35.53	- 1.81
	54.I -71.IV					
Mean		11.26	25.47	113.87	51.57	4.98
Standard Deviation		12.96	77.99	540.30	126.49	17.78
Mean						
	Expansion	1.88	0.64	...	13.78	1.80
	Contraction	1.80	8.58	...	0.011	- 0.90

SOURCE: South African Reserve Bank Quarterly Bulletin. Basic quarterly data is given in Appendix A.19.

NOTES: See notes to Table 4.XVI for the method of computation of cyclical data. F^o = total outstanding stock of government debt, S = government debt with the Reserve Bank, GLOAN = Reserve Bank loans to the Government, RG = Government's deposit at the Reserve Bank.

During the expansion phase, an increase in the adjusted base attenuates the positive influence on the credit market rate of an increase in the stock of government debt; and in the contraction phase, the negative relationship between changes in the adjusted base and the stock of government debt serves to induce a mutually reinforcing increase in the credit market rate. Thus, the rate of growth of the credit market rate is reduced in the expansion phase relative to the contraction phase.

Reference to certain characteristics of monetary policy in South Africa, rationalizes the above observations.[111] Since open market operations do not form part of the package of monetary policy instruments employed by the Monetary Authorities, the adjusted monetary base is not an aggregate which the Monetary Authorities control; rather, the adjusted base is left free to fluctuate pro-cyclically according to the vicissitudes of international trade. On the interest rate front, the Monetary Authorities seek to maintain, at least for some time, an interest rate ceiling, with the intention of promoting stable conditions in the market for government debt, by minimising the possibility of capital losses. The Monetary Authorities maintain the ceiling by quoting a pattern of rates at which they stand ready to transact in government debt, the ceiling being raised in response to market pressures. An increase in the supply of government debt does not entirely represent an equivalent amount of government expenditures. On occasions the Treasury borrows from the banking and private sectors in excess of its financial requirements, sterilising the proceeds in its account at the Reserve Bank. The Monetary Authorities consistently vary

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111. We mention the main elements of monetary policy here and provide a more detailed discussion in Sec. 2.

their gamut of foreign exchange and import controls to protect the balance of payments in the contraction phase and to lower the adjusted base in the expansion phase.

In Table 4.XXXIII the variables S and RG illustrate the course of open market operations and sterilisation operations over the business cycle. Both these variables exhibit a contra-cyclical pattern indicating that the Monetary Authorities did in fact attempt to dampen the pro-cyclical influence of the balance of payments on the adjusted monetary base (see Sec. 4). Clear evidence of the sterilisation procedure is revealed for the period after 1960 (this method of monetary control was adopted in 1964) where both F^o and RG are pro-cyclical; RG declines in each contraction phase in this period. That percentage changes in the adjusted base are relatively smaller in the contraction phase is indicative of the balance of payments protection policy exercised by the Monetary Authorities through foreign exchange and import controls.

Bearing in mind these aspects of monetary policy, our explanation of observed contra-cyclical variations in the credit market rate proceeds as follows. Given the level of the Government's deficit and the quoted interest rate ceiling, the deficit is financed by an increase in the stock of government debt during the expansion phase. The adjusted base rises due to a balance of payments surplus but not by the full extent of the surplus, since part of the increase is sterilised in the Government's account at the Reserve Bank. Invariably, foreign exchange and import controls are relaxed which attenuates the expansion in the adjusted base. Since both the base and the supply of government debt expand, the ceiling rate is maintained (or the growth rate of the credit market rate is minimised) at the expense of an increase in the money supply. And since the adjusted base is a measure of monetary policy, control of the base and the money supply are subordinate to fiscal policy and the interest rate stabilization programme in the expansion phase of the cycle. In the contraction phase, a different picture emerges. A deficit develops in the balance of payments, causing a decline in the adjusted monetary base, which is incompletely attenuated by open market purchases, a reduction in the Government's account at the Reserve Bank, and a tightening of exchange and import controls. The stock of government debt is increased to finance the Treasury's deficit. In this case both the base and the stock of government debt move in opposite directions, producing a mutually reinforcing upward pressure on the interest rate ceiling. The existence of the balance of payments deficit makes maintenance of the ceiling impossible, and the Monetary Authorities raise the ceiling in response to market pressures to protect the balance of payments. Hence, in the contraction phase, control of the money supply, and the stabilization programme become subordinate to the balance of payments.

Our analysis of the interest rate stabilization process and its collapse is implied by the money supply hypothesis. In Chapter 3 (Section 5), we derive expressions for the responses of the money supply and the adjusted monetary base to changes in the ceiling rate, and for the relationship between the adjusted base and the stock of government debt, given the ceiling rate.

From the credit market rate solution function, maintenance of the ceiling rate requires that the adjusted monetary base varies inversely with an increase in real wealth, the price level and the stock of government debt. This response pattern is supported by our regression results in Section 7. We obtain an estimate of the positive relationship between the adjusted base and the stock of government debt from Equation 3-40, written here as:[112]

$$e(B^a, F^o) = e(h, F^o) = 0.14 \qquad (4\text{-}27)$$

An increase in government debt raises the credit market rate through the h function. To maintain the interest rate ceiling during the expansion phase, a 1 per cent increase in the stock of government debt requires a 0.14 per cent increase in the adjusted monetary base. That the required change in the adjusted base is only about one tenth of the change in government debt, is due to the relatively greater response of the credit market rate to changes in the adjusted base than to changes in government debt.

Collapse of the stabilization policy in the contraction phase is marked by a rise in the ceiling rate, which, in terms of our hypothesis, implies a decline in both the money supply and the adjusted base. From Chapter 3 (Section 5), these relationships are written as:

$$e(M_2, \bar{i}_e) = e(m, \bar{i}_e) - [e(a, \bar{i}_e) - e(h, \bar{i}_e)] = -1.23 \qquad (4\text{-}28)$$

$$e(B^a, \bar{i}_e) = -[e(a, \bar{i}_e) - e(h, \bar{i}_e)] = -2.56 \qquad (4\text{-}29)$$

A 1 per cent increase in the ceiling rate implies a fall in the money supply and the adjusted base of 1.23 per cent and 2.56 per cent respectively. The negative relationship is due to the interest rate mechanism operating through the credit market multiplier, the h function and the money multiplier. The fall in the money supply is less than the adjusted base due to the attenuating effect on the money multiplier of an increase in the ceiling rate, given by $e(m, \bar{i}_e)$. Equation 4-28 is negative since the secondary

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112. The elasticity expressions in Table 4.XXVI and Table 4.XXX provide two methods of calculating $e(h, F^o)$. Since we have greater confidence in the regression coefficient for government debt, in the money supply equation than in the credit market rate equation (the former is more significant than the latter), we use as an approximation, the mean of the two estimates. From the money supply equation, $e(h, F^o) = 0.23$ and from the credit market rate equation, $e(h, F^o) = 0.044$; the mean is therefore, 0.14.

effect (the term in square brackets) exceeds the direct effect (the interest elasticity of the money multiplier).[113] We conclude, therefore, that observed contra-cyclical variations in interest rate are explained by pro-cyclical movements in the adjusted monetary base, while a relatively lower variability in the expansion phase is due to a differential relationship between the adjusted monetary base and the stock of government debt over the phases of the business cycle.

8.2 Bank Rate Policy, Discounting Policy and Interest Rate Stabilization

One question left open in Sections 6.2.3 and 6.2.4, is an explanation of the observed contra-cyclical behaviour of Bank Rate, and the relationship between Bank Rate and the credit market rate. A related issue is the role of Reserve Bank discounting policy in the credit market rate and money supply determination process. These matters are considered below.

In terms of our formal analysis in Chapter 3 (Section 5), the money multiplier may be used by the Monetary Authorities as an instrument of monetary control to maintain the ceiling rate, by variations in statutory reserve requirements, Bank Rate and discounting policy (Equations 3-41, 3-42). The money supply hypothesis implies that Bank Rate and statutory reserve requirements should vary inversely, and Reserve Bank discounting policy directly, with the stock of outstanding government debt, for a given ceiling rate.

The evidence indicates that Reserve Bank discounting policy (open back door operations) and variations in statutory reserves are used to

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113. $0 < e(m, i_e) < [e(a, i_e) - e(h, i_e)]$. See n. 92 and Equation 3-39a in the text (Chap. 3).

influence the money multiplier contra-cyclically, and are therefore geared to money supply policy rather than to maintaining the ceiling rate. Statutory reserve requirements are lowered in the contraction phase and increased in the expansion phase, inducing a pro-cyclical movement in the aggregate reserve ratio (b_1) and a consequent contra-cyclical movement in the money multiplier.[114] In a similar fashion, Reserve Bank discounting policy appears to influence the ratio parameter P_8 (and hence, the money multiplier) contra-cyclically, and is therefore used to counteract pro-cyclical variations in the adjusted monetary base. Our regression results in Section 7 indicate that the proxy variable used to capture discounting policy (P_8D in the money supply equation and P_8 in the credit market rate equation) is more significant in the money supply equation than in the credit market rate equation. The Reserve Bank attempts to insulate the money market in the contraction phase from a decline in the balance of payments and excessive penalty discount rates, by quoting special discount rates for Treasury bills and concluding repurchase agreements on the discounting of Treasury bills.[115] Thus, both statutory reserve requirements and Reserve Bank discounting policy are used to induce contra-cyclical variations in the money multiplier for purposes of monetary control.

On the other hand, Bank Rate is assigned to an interest rate stabilization role in the expansion phase, and participates in the collapse of the stabilization programme in the contraction phase, rising with the ceiling rate in order to protect the balance of payments. The increase in

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114. An increase in statuatory reserve requirements raises b_1 (Sec. 3.4) which induces a decline in the money multiplier--$e(m, b_1) < 0$. The ratio parameter b_1 is an important cause of contra-cyclical variations in the money multiplier (Sec. 6.1). See Sec. 2 for a discussion of variable statutory reserve requirements and monetary policy.

115. Sec. 2.

Bank Rate in the contraction phase serves three purposes: firstly, it acts as a penalty rate on the rediscqunting of eligible commercial bills, thereby, ensuring a proper functioning of the money market; secondly, it acts as a signal device to the business community that monetary policy is more restrictive; and thirdly it attracts short-term foreign capital. In the expansion phase, a reduction of the growth rate in Bank Rate seals the ceiling rate. We conclude that the observed contra-cyclical variation in Bank Rate (Section 6.2.4), is due to the interest rate stabilization policy of the Monetary Authorities in the expansion phase and to the balance of payments deficit in the contraction phase. Bank Rate is therefore, not used for controlling the money supply.

The empirical results in Section 7 show that Bank Rate exerts a stronger and more significant influence on the credit market rate than on the money supply. A 1 per cent increase in Bank Rate raises the credit market rate by 0.31 per cent and lowers the money supply by 0.031 per cent. The direct effect of a 1 per cent increase in Bank Rate lowers the money multiplier by 0.44 per cent. However, the credit market rate rises by 0.31 per cent causing an offsetting increase in the money multiplier of 0.41 per cent. Hence, the weak influence of Bank Rate on the money supply is due to its relatively strong influence on the credit market rate. Furthermore, since Bank Rate exercises a significant negative influence on the ratio parameter P_8 (Section 6.2.3), its contra-cyclical movement attenuates contra-cyclical variations in P_8, and hence, in the money multiplier. This bears out our conclusion in Section 8.1, that monetary policy is subordinate to interest rate stabilization policy in the expansion phase and to the balance of payments in the contraction phase of the business cycle.

8.3 Differential Variability of the Money Multiplier in the Short-Run and the Long-Run

In Section 5, we observe that the money multiplier displays a different pattern of behaviour in the long-run and the short-run, accentuating the positive influence of the base in the former and attenuating the influence of the base in the latter. The cause of this phenomenon is explained by the money supply hypothesis and supported by the evidence (in Section 7).

Functioning as the link between the adjusted base and the money supply, the money multiplier accentuates or attenuates the effects of a change in the adjusted base on the money supply, according to the strength and direction of influence of the elasticity of the money multiplier with respect to changes in the adjusted monetary base (the feedback operator, K). This elasticity is the product of the elasticity of the money multiplier with respect to changes in the adjusted base and the interest elasticity of the money multiplier.[116] A 1 per cent increase in the adjusted base lowers the credit market rate by 0.39 per cent, and since the interest elasticity of the money multiplier is 1.23, the multiplier declines by 0.52 per cent. Since the direct effect on the money supply of an increase in the adjusted base is unity, the net increase in the money supply is 0.48 per cent, with the money multiplier attenuating over 50 per cent of the positive direct effect.[117] Hence, the cause of the attenuating influence of the money multiplier over shorter periods rests with the interest rate mechanism; the negative relationship between the adjusted base and the credit market rate, and the positive interest elasticity of the money

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116. From Tables 4.XXX and 4.XXXI; $e(M_2, B^a) = 1 + e(m, i_e)e(i_e, B^a)$. Since $e(i_e, B^a) = -1/[e(a, i_e) - e(h, i_e)]^2$ (Table 4.XXVI), and $K = e(m, i_e)/e(a, i_e) - e(h, i_e)$, therefore, $e(M_2, B^a) = 1 - K$.

117. Cf. Tables 4.XXX and 4.XXXI.

multiplier.

Over the long-run, the influence of the feedback operator is reduced. Changes in the adjusted base appear to exert a positive influence on the multiplier in the long-run and a negative influence in the short-run. Over long periods of time, the trend growth in real wealth, the price level and the outstanding stock of government debt exert a positive influence on the credit market rate which outweighs the negative influence of the trend increase in the adjusted base.[118] Over the period 1950 to 1971, the trend increase in the credit market rate explains the trend rise in the money multiplier.[119]

In the short-run, the interest rate mechanism is of the essence, causing a decline in the multiplier in response to an increase in the adjusted base. We observe that the money multiplier and the adjusted base vary inversely in 90 per cent of quarterly periods and 75 per cent of annual periods. However, complete attenuation occurs in 35 per cent of annual and in only 28 per cent of quarterly periods (Table 4.XIV). Although we have no quarterly elasticity estimates, our knowledge of the interest rate stabilization programme together with the data in Table 4.XXXIV appear sufficient to explain this phenomenon. To be sure, the interest rate stabilization policy of the Monetary Authorities is likely to impart a greater rigidity to interest rate movements over quarters than over years. In Table 4.XXXIV we provide the means and standard deviations of percentage changes in four selected interest rates, calculated for quarterly changes and annual changes (quarterly changes at an annual

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118. Cf. Sec. 7, Table 4.XXVI. The elasticities of the credit market rate with respect to the adjusted monetary base, real wealth and the price level, are -0.39, 0.4 and 0.99 respectively.

119. Cf. the money multiplier time series in Table 4.XII and Fig. 4.II.

TABLE 4.XXXIV

MEANS AND STANDARD DEVIATIONS OF QUARTERLY AND ANNUAL CHANGES IN INTEREST RATES:1954-1971 (%)

	ANNUAL		QUARTERLY	
Interest Rates	Mean	Standard Deviation	Mean	Standard Deviation
$\Delta i_{br}/i_{br}$	3.27	12.90	0.82	5.49
$\Delta i_{LT}/i_{LT}$	3.86	9.06	0.95	3.70
$\Delta i_{OD}/i_{OD}$	2.64	8.73	0.69	4.08
$\Delta i_{cal}/i_{cal}$	10.64	26.71	2.33	11.67

SOURCE: Basic quarterly interest rate data is listed in Table A.19.VI

NOTES: Quarterly percentage changes are claculated for quarterly intervals and annual percentage changes are calculated by using quarterly data with changes taken between corresponding quarters in adjacent years.

rate) over the period 1954.I to 1971.IV. It is evident that for all the interest rates, both the mean percentage change and the standard deviation for annual periods is in excess of those for quarterly periods by far. As a result, the stabilization programme serves to partially paralyse the interest rate mechanism in the shorter period, imparting a relatively stronger link between the adjusted base and the money stock over quarters than over years. As we have mentioned (Section 5), this result is contrary to those obtained in studies for many other countries.[120]

Over the course of the business cycle, the consistently contra-cyclical behaviour of the money multiplier is due to pro-cyclical variations in the adjusted base, which induces contra-cyclical variations in the credit market rate. In the expansion phase, the money multiplier declines and in the contraction phase, it rises. However, the contra-cyclical behaviour of the multiplier attenuates the pro-cyclical influence of the base incompletely, so that the money stock mirrors the pro-cyclical movement in the adjusted base. That the multiplier fails to induce a contra-cyclical movement in the money supply is due to an asymmetric contra-cyclical motion; in every expansion phase the percentage change in the multiplier is less than that of the adjusted base, while in every contraction phase, the converse is true. Pro-cyclical variations in the money stock are consequently due to the relatively weak influence of the multiplier in the expansion phase.

This asymmetric behaviour is due to, and consistent with the interest rate stabilization policy of the Monetary Authorities in the expansion phase, and its collapse in the contraction phase. We have seen, that in general the contra-cyclical behaviour of the credit market rate is

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[120] See n. 61.

characterised by a decline in its growth rate during the expansion phase, which implies a lower degree of variation relative to the contraction phase. As a result, the attenuating influence of the money multiplier is dampened in the expansion phase when the credit market rate is increased. Ultimately, the asymmetric behaviour of the money multiplier is due to the positive relationship between the stock of government debt and the adjusted base in the expansion phase, and the negative relationship in the contraction phase, thereby, preserving the pro-cyclical behaviour of the money stock, which is necessary to maintain the ceiling rate during expansions and to cure a balance of payments of deficit during contractions.

We may now explain the single aberration observed in the expansion phase of 1956.IV to 1957.IV, during which, the money multiplier deviates from its contra-cyclical path by accentuating the influence of the adjusted monetary base (Table 4.XVI). Rather than declining, the multiplier increases by 4 per cent, which, together with an increase in the adjusted base of 4.6 per cent, causes a rise in the money supply of 8.6 per cent. The reason is to be found not only in the operation of the interest rate mechanism but also within the general framework of monetary policy and economic events.

During the typical expansion phase, the decline in the money multiplier is caused by a fall in the Reserve Bank's lending ratio (P_8), which outweighs the positive influence on the multiplier of an increase in the private sector's time deposit ratio (P_2) and a decline in the banking sector's aggregate reserve ratio (b_1) [Table 4.XIX]. This pattern does not emerge for the period in question; P_2 experiences its largest percentage increase of all expansion phases after 1955 (Table 4.XX), raising the money multiplier by 2.5 per cent, while the decline in b_1 causes the multiplier to rise by 2.2 per cent (see Table 4.XIX). The contribution of P_8 is the smallest of all expansion phase causing a fall in the multiplier of 0.8 per cent.

Our perusal of the events in this period reveals three factors which in combination prevented the usual decline in P_8. Firstly, this expansion phase is the only one accompanied by an expansion of the monetary base and a balance of payments deficit; secondly, the interest rate ceiling was raised in response to an increase in London rates and to protect the balance of payments; and thirdly, the Reserve Bank used open back door operations and discounting privileges to insulate the money market from the stringent effects of dwindling international reserves.[121] All three factors induced an increase in P_8 or lowered its rate of decline. Hence, the collapse of the stabilization policy and the application of special discounting privileges by the Reserve Bank accounts for the reversal of the behaviour of the multiplier during the expansion phase in question.

8.4 Summary and Conclusions: The Anatomy of Monetary Policy

In Sections 3 to 6 of this chapter, we gather together a set of observations bearing on the profile of monetary events in South Africa. We observe that over the long-run, the adjusted monetary base, interest rates, the money supply, and the money multiplier increase secularly.

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121. The balance of payments deficit was due primarily to the relaxation of import controls accompanied by a capital outflow, the first since 1946 [85]. The rise in the long-term rate on government debt was the first of only two increases that occurred in six expansion phases (Table 4.XXIV and Fig. 4.II). During the expansion phase in question, the money market had not yet become fully operational. The Reserve Bank discounted Treasury bills at rates below Bank Rate and entered into special repurchase arrangements with the National Finance Corporation, the banking sector and the newly established private discount house. It was still policy of the Monetary Authorities to stabilize interest rates in the money market in order to encourage its development [81] and [34].

The money multiplier accentuates the positive influence of the adjusted base and both are important in determining the growth rate of the money supply. In the shorter-run, the money multiplier attenuates the influence of the adjusted base and both are of almost equal relevance in explaining fluctuations in the money supply. Recurring periods of expansion and contraction are accompanied by balance of payments surpluses and deficits respectively. The money supply is dominated by, and therefore mirrors the pro-cyclical variations in the adjusted base, while the money multiplier fluctuates contra-cyclically and asymmetrically with interest rates. This image is inextricably bound up with the actions of the Monetary Authorities; the instruments and objectives of policy, and the means of achieving those objectives.

In this section of the chapter, we synthesize the profile of monetary events and the actions of the Monetary Authorities in terms of our empirical knowledge of the money supply and interest rate determination process (Section 7).

An examination of the interest rate stabilization policy of the Monetary Authorities rationalises the pro-cyclical variations of the adjusted monetary base and contra-cyclical variations in interest rate. The Monetary Authorities do exert a weak contra-cyclical influence on the base through open market operations, Reserve Bank lending policy and manipulation of the Treasury's account at the Reserve Bank.[122] However, these influences are insufficient to outweigh the pro-cyclical influence

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[122] Sec. 4. Exchange and import controls are also used to dampen pro-cyclical movement in the monetary base through control of the demand for foreign exchange.

of the balance of payments. In the expansion phase of the business cycle, control of the money supply is subservient to fiscal policy and interest rate stabilization, while in the contraction phase, the stabilization programme breaks down and money supply control is subordinate to the balance of payments deficit. Contra-cyclical fluctuations in interest rates are explained by pro-cyclical variations in the adjusted base.

A differential relationship between the adjusted base and the stock of government debt over the phases of the cycle, induces a differential degree of variation in interest rates between expansion and contraction phases. Thus, interest rates are determined exogenously by the balance of payments and vary relatively less in the expansion phase due to the stabilization programme.

Having relinquished control of the adjusted monetary base, the Monetary Authorities are left with the money multiplier as the remaining path of money supply control. This too, is abrogated in favour of interest rate stabilization in the expansion phase and necessitated by the balance of payments deficit in the contraction phase. The money multiplier is dominated by the ratio parameter P_8, which is controlled by Bank Rate and Reserve Bank discounting policy. Bank Rate is assigned to the stabilization programme in the expansion phase and to the protection of the balance of payments in the contraction phase. In consequence, Bank Rate varies contra-cyclically exerting a pro-cyclical influence on the money multiplier. Reserve Bank discounting policy is geared to control of the money supply, however, by inducing contra-cyclical movements in the multiplier; and variations in statutory reserve requirements influence the multiplier contra-cyclically through the ratio parameter b_1. The strongest single influence on the money multiplier is the credit market rate,which explains the contra-cyclical and asymmetric behaviour of the multiplier.[123] Since interest rate stabilization policy serves to attenuate interest rate variations in the expansion phase, so also is the contra-cyclical movement in the multiplier attenuated in this phase of the cycle. As a result, the money multiplier dampens the pro-cyclical influence of the adjusted base on the money supply but fails to outweigh it. The multiplier fortuitously exerts an ineffective contra-cyclical influence on the money supply, being exogenously determined by the credit market rate and being prevented from dominating the money supply by the stabilization policy. Indeed, this asymmetric behaviour is necessary for the success of the stabilization policy in the expansion phase.

The profile of monetary policy in South Africa presents a modern version of the Classical Gold Standard mechanism. Control of the money supply is abandoned in favour of a link to the balance of payments. In the expansion phase,a balance of payments surplus and the expansion of the money supply ensures the success of the interest rate stabilization programme. In the contraction phase, we find a typical Keynsian dilemma between internal and external balance in a fixed exchange rate system. Economic contraction and a balance of payments deficit requires abandonment of the stabilization programme and a contraction in the money supply. Contra-cyclical stabilization policy is, therefore, abandoned by the Monetary Authorities in favour of stabilizing the rate on government debt.

123. Table 4.XXXI.

Under the existing regime, a more vigorous use of Bank Rate and variable statutory reserve requirements in the expansion phase, would lower the value of the multiplier. However, our estimates imply that in order to offset the influence on the money supply of a 1 per cent increase in the adjusted base, the statutory reserve requirement on demand deposits would have to be raised by 7.16 per cent, or Bank Rate would have to be increased by 15.5 per cent. Alternatively, the Treasury could employ fiscal policy for monetary purposes in the expansion phase, by reducing the value of the deficit and the stock of outstanding government debt and allowing the credit market rate to fall. This would remove the asymmetric constraints on the multiplier in the expansion phase. The influence of a 1 per cent increase in the adjusted base on the money supply, is offset by a 4 per cent reduction in the stock of government debt. An unwillingness on the part of the Government to render fiscal policy subordinate to monetary policy, leaves one path of escape. If the money supply is to be controlled, the Monetary Authorities must assert control over the adjusted monetary base and abandon the interest rate stabilization programme.[124]

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124. The estimates in this paragraph are based on the money supply elasticity estimates in Table 4.XXX.

9. THE INTEREST RATE EFFECT OF OPEN MARKET OPERATIONS, GOVERNMENT DEFICIT FINANCE, AND CHANGES IN THE ADJUSTED MONETARY BASE FROM OTHER SOURCES

An implication of the money supply hypothesis is that the effect on the credit market rate of a change in the adjusted monetary base through open market operations, or a shift in the financing of the Government's deficit from the banking and private sectors to the Reserve Bank, is greater, than for either a change in the adjusted base from other sources, or the issue or retirement of government debt (Chapter 3, Section 6).

In the first case, an open market purchase or a shift in deficit finance from the banking and private sectors to the Reserve Bank, does not change the stock of Government generated wealth in the banking and private sectors, but merely its composition; interest-bearing government debt is replaced by non interest-bearing claims on the Government (the adjusted monetary base), in the balance sheets of the banking and private sectors. An increase in the adjusted base, initially lowers the credit market rate, causing a shift in the h function and an increase in the credit market multiplier. An accompanying decline in the stock of government debt, in addition, lowers the h function directly, causing a further fall in the credit market rate. These effects are apparent in Equation 4-30 below (see Equation 3-44):

$$\frac{\Delta i_e}{i_e} = e(i_e, B^a)\ [1 + e(h, F^N)\frac{B^a}{F^N}]\frac{\Delta B^a}{B^a} \qquad (4\text{-}30)$$

An additional element which raises the response of the credit market rate is the increase in the scale factor $B^a/_F N$. By inserting into Equation

4-30 the appropriate elasticity estimates from Section 7, the mean value for the scale factor, and the discrete change in the adjusted base, we obtain an estimate of the change in the credit market rate due to an open market purchase or a shift in deficit finance from the banking and private sectors to the Reserve Bank.[125] If, as a result of these actions, the adjusted base rises by 4.98 per cent, the credit market rate declines by 2.05 per cent.[126]

Now consider the case where the adjusted monetary base is increased by some other source component such as an increase in international reserves held by the Reserve Bank or a reduction in the Government's deposit at the Reserve Bank. The credit market rate falls by an amount equal to the elasticity of the credit market rate with respect to the adjusted monetary base, and the h function stays put.[127] The change in the credit market rate is then given by:

$$\frac{\Delta i_e}{i_e} = e(i_e, B^a) \frac{\Delta B^a}{B^a} = -1.94 \qquad (4\text{-}31)$$

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125. The values of the terms in Equation 4-30 are: $e(i_e, B^a) = -0.39$ (Table 4.XXX), $e(h, F^N) = 0.14$ (n.112). $B^a/F^N = 0.40$ is the mean value calculated from annual data for the period 1950 - 1971 and $\Delta B^a/B^a = 4.98$ is the mean value calculated from quarterly percentage changes at an annual rate for the period 1954.I - 1971.IV.

126. For instance, using year-end annual data for 1971, an increase in the adjusted monetary base of R24.9 mill. from an open market purchase will lower the interest rate on long-term government securities from 8.31 per cent to 8.14 per cent.

127. Typically, a reduction in the Government's deposit at the Reserve Bank may occur for the purpose of deficit finance or for monetary control. The Stabilization account at the Reserve Bank may be reduced.

(see Equation 3-44). An increase in the adjusted base of 4.98 per cent lowers the credit market rate by 1.94 per cent.[128]

The issue or retirement of government debt, ceteris paribus, merely changes the stock of government debt in the banking and private sectors, causing a shift in the h function; and the credit market rate response is 0.14.[129]

Comparing the results in Equations 4-30 and 4-31, the differential effect on the credit market rate of an open market operation and a change in the adjusted base from other sources, is small, due to the low elasticity of the h function with respect to changes in the stock of government debt. That this is so, is probably due to the underdeveloped nature of the secondary market for long-term government debt, most of which is held by the Public Debt Commissioners (Chapter 2,Section 6.2).[130]

We conclude that open market operations have a greater effect on the credit market rate, than either a change in the adjusted base from other sources or, ceteris paribus, the issue or retirement of government debt. However, the differential is slight. If the Monetary Authorities wish to use open market operations as a policy instrument to control the credit market rate, they should attempt to raise the elasticity of the h function with respect to the stock of government debt, by establishing a broader based market for long-term government debt in the banking and private sectors, and should abandon reliance on the Public Debt Commissioners for

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128. The same data used to evaluate Equation 4-30 are used to evaluate Equation 4-31 (see n.125). Using year-end data for 1971, an increase in the adjusted base of R24.9 mill., lowers the interest rate on long-term government debt from 8.31 per cent to 8.14 per cent.

129. $e(h, F^N)$ - o.14, (n.112).

130. Most transactions in government debt occur at the short end of the maturity spectrum in the short-term money marked ([33], p. 26).

deficit finance.[131] Of course, this implies an abandonment of the interest rate stabilization policy (the role of the Public Debt Commissioners is discussed in Section 10).

131. The successful development of a broad market for short-term government debt in the money market, by 1960, increased the control of the Monetary Authorities over the short-term rate on government debt. An analogous procedure appears applicable to the rate on long-term government debt.

10. THE ROLE OF THE PUBLIC DEBT COMMISSIONERS IN THE CREDIT MARKET RATE AND MONEY SUPPLY DETERMINATION PROCESS

An analysis of the activities of the Public Debt Commissioners in the market for government debt provides us with important empirical information bearing on the influence of the stock of government debt in the credit market rate and money supply determination process, discussed in Section 7.

In Chapter 2, Section 6.2, we provide a brief description of the activities of the Public Debt Commissioners. In order to interpret the regression results below, we review the method of, and conditions surrounding the issue and redemption of government debt in South Africa.[132]

It is essential to distinguish between the issue of long-term and short-term government debt and the distribution of ownership between the secondary market and the Public Debt Commissioners.[133] Long-term government debt is supplied by the Treasury to the Public Debt Commissioners and to the secondary market by infrequent new issues. After closure of the subscription to the general public, the Public Debt Commissioners obtain additional tap supplies by special arrangements.[134] Since the maturity structure of government debt shortens over time, long-term investors obtain additional supplies of long-term debt by selling short-term debt in the money market or to the Public Debt Commissioners and purchasing

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132. The two sources of information on the activities of the Public Debt Commissioners and the issue and redemption of government debt are provided by de Swardt and Steenkamp([32] and [33]).

133. The secondary market constitutes the banking and private sectors excluding the Public Debt Commissioners.

134. de Swardt and Steenkamp [33], p. 18.

long-term debt from the Commissioners. Since the secondary market for long-term debt is thin, the Commissioners are the main holders of long-term debt, and source of supply to the secondary market. In contrast, however, the market for short-term debt is well developed and active, and the major portion of short-term debt is held by the money market institutions and the banking sector. The Public Debt Commissioners strive to maintain the long end of their portfolio structure by selling short-term debt to the secondary market as the maturity date on government debt is approached.[135]

Thus, as prime investors in long-term government debt, the Public Debt Commissioners act as jobbers in the secondary market, enabling investors to adjust their portfolios by switching between maturities. As net sellers, the Public Debt Commissioners keep the secondary market continuously supplied with its needs both from their own portfolio and through the tap system. Due to the thin market in long-term government debt, it seems that jobbing by the Commissioners is concentrated, (but not exclusively) at the short end of the debt spectrum.[136] We should note that the Monetary Authorities constitute a sporadic source of supply of short-term debt to the banking and private sectors.[137]

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135. The discount houses are the chief transactors in short-term government debt, purchasing securities from the Public Debt Commissioners and the banking sector and selling securities to the banking sector and the private sector ([33], p. 26, [32], p. 25).

136. de Swardt and Steenkamp stress that the activities of the Public Debt Commissioners are confined primarily to investment management and that their jobbing activities should be regarded as incidental. They state that "... it is not a function of the Commissioners to operate extensively in the market to promote increased holdings of long-term securities by the private sector." ([33], p. 29).

137. See Sec. 2 and n. 20.

The significant analytical point for our purposes is that the supply of government debt to the secondary market is demand determined, which means that changes in the supply of government debt should not have a significant influence on the credit market rate. We discover, however, that the jobbing activities of the Commissioners are significant in the determination of the money supply.

Interpretation of the regression equations below, requires a synthesis of our knowledge of the transmission mechanism linking changes in the supply of government debt to the credit market rate and the money stock, and the institutional environment surrounding the debt issue. An increase in the aggregate stock of outstanding government debt cannot affect the credit market rate (through the h function) or the money supply (through the interest rate mechanism) in so far as it represents an acquisition by the Public Debt Commissioners. The h function is only affected to the extent that a change in the supply of government debt is passed on to the secondary market through the jobbing activities of the Commissioners. From the point of view of the Commissioners, jobbing may appear to be a process of optimum portfolio allocation (an allocative process), whereas, transactions in the secondary market by the Commissioners are allocative certainly, but also aggregative in that the secondary market substitutes not only between short-term and long-term government debt, but also between government debt and other financial claims.[138] Thus, the h function is affected to the extent that jobbing by the Commissioners alters

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138. See K. Brunner [11], pp. 14-16, for a discussion of the separation of aggregative and allocative forces in economic analysis.

the aggregate stock of government debt in the secondary market. We have mentioned that the supply of government debt to the secondary market is demand determined, in which case, the credit market rate should remain relatively unaffected. However, it is unlikely that either the Public Debt Commissioners or the Monetary Authorities have knowledge of the exact extent of the shift in demand for government debt in the secondary market; so that jobbing operations should cause a shift in the h function.[139] In Table 4.XXXVI and 4.XXXVII we provide regression equations for the credit market rate and the money supply. We test the equations using the aggregate stock of outstanding government debt (F^o), the aggregate stock of long-term debt (F_2^o) and the stock of long-term and total government debt held by the Public Debt Commissioners (F_2^{DC}, F^{DC} resp.). The test results are given in Equations 1 to 4 in the tables. Equations 5 and 6 in Table 4.XXXVI and Equation 5 in Table 4.XXXVII are taken from the credit market rate and money supply estimating equations in Tables 4.XXV and 4.XXIX and are repeated here for ease of comparison. The characteristics of the equations in specification and performance are fundamentally the same as for the equations in Section 7, where a full discussion is provided; so we pass directly to a comparison of the results on the various government debt variables.[140] For convenience, the coefficients and t-statistics on

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139. The Reserve Bank and the Public Debt Commissioners often respond to an excess demand or supply in the secondary market with a lag so that stabilization of the interest rate is not complete ([33], p. 22).

140. The positive signs on the Bank Rate variable (i_{br}) in equations 2, 3, 4 and 6 of Table 4.XXXVII are not of importance, since omitting i_{br} leaves the results unchanged. We include i_{br} here for consistency of comparison with the money supply and credit market rate estimating equations. The omission of a dummy variable (P_8D) in Equations 3 and 4, improves the performance of these equations.

the government debt variables are listed in Table 4.XXXV.

Changes in the stock of government debt held by the Commissioners exert a negative influence on the credit market rate which is in accordance with our hypothesis. Net sales by the Commissioners raise the supply of government debt in the secondary market and the credit market rate rises. Hence, the signs on the secondary market coefficients are positive.

Three factors may account for the low values of the F^{DC} and F_2^{DC} coefficients and the insignificant t-values: firstly; these variables are measures not only of the jobbing operations of the Public Debt Commissioners, but also transactions with the Treasury with respect to new issues, secondly; that changes in these variables are to an extent demand determined will reduce the variation in the credit market rate, and thirdly; jobbing operations occur predominantly in short-term government debt, of which, the Public Debt Commissioners hold less than 20 per cent of the total stock. In the latter regard, notice that the coefficient on F^{DC} is both greater in value and more significant than on F_2^{DC}. This complies with the profit maximising behaviour of the Public Debt Commissioners. As investment nominees, the Commissioners are reluctant to deal in long-term debt since losses may be incurred when interest rates are rising.[141]

We conclude that the negative signs and low coefficient values on the F^{DC} and F_2^{DC} variables suggest that the jobbing operations of the Commissioners help to stabilize the credit market rate by responding to variations in the

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141. de Swardt and Steenkamp [33],Pp. 26, 29 and [32],Pp. 25, 26. It may well be the case that the stock of short-term government debt held by the Public Debt Commissioners will have a stronger and more significant effect on the rate on short-term government securities. In this respect, further research is required.

TABLE 4.XXXV

SUMMARY OF THE REGRESSION COEFFICIENTS ON THE GOVERNMENT DEBT VARIABLES IN THE CREDIT MARKET RATE AND MONEY SUPPLY EQUATIONS, INCORPORATING THE ROLE OF THE PUBLIC DEBT COMMISSIONERS

	Government Debt					
			Secondary Market		Public Debt Commissioners	
	Total Out-Outstanding (F^{o})	Long-Term (F_2^{o})	Total (F^{N})	Long-Term (F_2^{N})	Total (F^{DC})	Long-Term (F_2^{DC})
Dependent Variable = i_{LT}						
Regression Coefficient	-0.064	-0.039	0.0087	0.017	-0.0054	-0.0019
t-statistic	(-0.49)	(-0.26)	(0.23)	(0.51)	(-0.90)	(-0.32)
Dependent Variable = M_2						
Regression Coefficient	0.63	0.67	0.12	0.083	-0.0068	-0.017
t-statistic	(5.50)	(4.90)	(2.40)	(1.81)	(-0.75)	(-2.06)

NOTES: The data in this table are taken from Tables 4.XXXVI and 4.XXXVII

TABLE 4.XXXVI

REGRESSION ESTIMATES OF THE CREDIT MARKET RATE INCORPORATING THE ROLE OF THE PUBLIC DEBT COMMISSIONERS

Dependent Variable = i_{LT}

	C	B^a	W/P_w	P_Y	YDIS	i_{bc}
1.	1.35 (1.22)	-0.33 (-2.01)	0.35 (1.85)	1.11 (3.29)	0.66 (1.21)	0.31 (3.02)
2.	2.08 (1.58)	-0.29 (-2.03)	0.21 (1.31)	1.04 (2.77)	0.79 (1.47)	0.33 (3.02)
3.	1.53 (1.30)	-0.35 (-2.95)	0.29 (1.62)	0.95 (3.33)	0.82 (1.62)	0.32 (3.00)
4.	1.81 (1.55)	-0.33 (-2.65)	0.23 (1.30)	0.99 (3.35)	0.73 (1.41)	0.33 (3.04)
5.	1.08 (0.93)	-0.38 (-2.58)	0.35 (1.75)	1.02 (3.40)	0.60 (1.11)	0.31 (2.89)
6.	0.73 (0.54)	-0.39 (-2.73)	0.40 (1.78)	0.99 (3.30)	0.57 (1.03)	0.31 (2.99)

	F^O	F_2^O	F^{DC}	F_2^{DC}	F^N	F_2^N	$P_g D$	$\bar{R}^2$	DW
1.	-0.064 (-0.49)						-0.018 (-1.07)	0.96	1.82
2.		-0.039 (-0.26)					-0.0098 (-0.71)	0.95	1.93
3.			-0.0054 (-0.90)				-0.013 (-0.97)	0.96	2.03
4.				-0.0019 (-0.32)			-0.011 (-0.85)	0.95	2.03
5.					0.0087 (0.23)		-0.017 (-1.04)	0.96	1.89
6.						0.017 0.51)	-0.018 (-1.08)	0.96	1.93

SOURCE: South African Reserve Bank Quarterly Bulletin. Basic data on the government debt variables are listed in Appendix A.19.

NOTES: The equations are estimated in logarithmic form using annual year-end data for the period 1950-1971. Equations 5 and 6 are repeated from equations 3 and 4, respectively, in Table 4.XXV. F^O = the total outstanding stock of government debt, F_2^O = outstanding long- term government debt, F^{DC} = government debt with the Public Debt Commissioners, F_2^{DC} = long- term government debt with the Public Debt Commissioners. The remaining variables are defined in Table 4.XXV.

TABLE 4.XXXVII

REGRESSION ESTIMATES OF THE MONEY SUPPLY INCORPORATING THE ROLE OF THE PUBLIC DEBT COMMISSIONERS

Dependent Variable = M_2

	C	B^a	W/P_w	P_y	YDIS	i_{br}
1.	-0.79 (-0.79)	0.22 (1.69)	0.31 (2.30)	0.50 (1.84)	0.29 (0.66)	-0.0077 (-0.085)
2.	-2.60 (-2.20)	0.33 (2.49)	0.43 (3.05)	0.11 (0.33)	0.15 (0.31)	0.045 (0.46)
3.	0.77 (0.45)	0.55 (3.80)	0.52 (1.87)	1.37 (3.49)	0.71 (0.94)	0.033 (0.21)
4.	0.26 (0.18)	0.47 (3.43)	0.65 (2.69)	1.51 (4.33)	0.46 (0.69)	0.032 (0.23)
5.	-0.83 -(0.56)	0.48 (2.73)	0.69 (3.13)	1.13 (3.11)	0.50 (0.91)	-0.031 (-0.23)
6.	-1.55 (-0.84)	0.55 (3.14)	0.75 (2.80)	1.06 (2.71)	0.55 (0.77)	0.023 (0.16)

	F^O	F_2^O	F^{DC}	F_2^{DC}	F^N	F_2^N	P_tD	$\bar{R}^2$	DW
1.	0.63 (5.50)						0.014 (1.28)	0.99	1.7
2.		0.67 (4.90)					0.011 (0.92)	0.99	1.5
3.			-0.0068 (-0.75)					0.98	1.8
4.				-0.017 (-2.06)				0.98	2.1
5.					0.12 (2.40)		0.019 (1.10)	0.99	2.2
6.						0.083 (1.81)	0.018 (1.01)	0.98	2.1

SOURCE: South African Reserve Bank Quarterly Bulletin. Basic data on the government debt variables are listed in Appendix A.19.

NOTES: The equations are estimated in logarithmic form using annual year-end data for the period 1950-1971. Equation 5 is repeated from Table 4.XXIX. F^O = the total outstanding stock of government debt, F_2^O = outstanding long- term government debt, F^{DC} = government debt with the Public Debt Commissioners, F_2^{DC} = long- term government debt with the Public Debt Commissioners. The remaining variables are defined in Table 4.XXV. That the coefficients on i_{br} in equations 2-4,6 are positive, is of no significance since the coefficients and t-values on the government debt variables remain unchanged when i_{br} is omitted.

demand for government debt by the secondary market.

The signs on the coefficients of the secondary market variables (F_N and F_2^N) are positive and the coefficient values are small, indicating that changes in the stock of government debt in the secondary market exert a weak positive influence on the credit market rate through the h function. Again, this weak effect is due to the fact that these variables in part, measure the increase in the supply of government debt called forth by an increase in demand, thereby stabilizing the credit market rate. The non significant t-values may be due to the fact that F^N is predominantly a measure of variation in the stock of short-term government debt in the secondary market. The influence of short-term debt on the credit market rate (measured by the long-term rate on government securities) is through the cross substitution effect which is invariably weaker than the direct substitution effect.[142]

Notice that the coefficients on the secondary market variables are larger than those for the Public Debt Commissioners, indicating that the combined effect of jobbing operations by the Commissioners and direct sales of government debt by the Treasury to the secondary market exerts a greater influence on the credit market rate than the jobbing effect alone. Our results for the secondary market variables appear to support the notion that the Public Debt Commissioners, in their role as intermediaries between the Treasury and the secondary market, stabilize the credit market rate. The signs on the aggregate debt variables are negative, reflecting the intermediary function of the Commissioners and their jobbing operations in

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142. See Chap. 2 Sec. 4.5 and esp. n. 48. It may well be, that F^N is more significant in explaining the rate of interest on short-term government securities.

the secondary market. For reasons mentioned above, the coefficients are low in magnitude and not significant.

Turning now to the money supply regression coefficients, some enlightening differences emerge. Changes in the stock of government debt influence the money supply through the interest rate mechanism: the product of the interest elasticity of the money multiplier and the elasticity of the credit market rate with respect to changes in the stock of government debt.[143]

The signs on the variables representing the portfolio of the Commissioners are negative, the coefficients are greater in magnitude than for the credit market rate and the stock of long-term debt held by the Commissioners is significant. A decline in the Commissioners' portfolio, and especially of long-term debt, raises the money supply by raising the stock of debt in the secondary market (notice that the signs on the secondary market coefficients are positive). That the response of the money supply exceeds the response of the credit market rate, is due to the relatively high interest elasticity of the money multiplier [recall that $e(m, i_e) = 1.33$].[144] Hence, jobbing operations by the Commissioners seem to be of greater significance for the determination of the money supply than for the credit market rate.

Not surprisingly, the secondary market coefficients for the money supply are correct in sign, significant and substantially larger in value than the credit market rate coefficients. These more satisfactory results for the money supply, partly reflect the direct sales of short-term government debt to the banking and private sectors by the Treasury.[145]

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143. Table 4.XXX, Equation 9.

144. Table 4.XXXI.

145. Sec. 2.

Provided that the interest elasticity of the money multiplier is sufficiently large relative to the elasticity of the h function with respect to government debt, the influence of government debt on the money supply is not negated.

Finally, the aggregate stock of government debt held by the Public Debt Commissioners and the secondary market (F^O), and the stock of long-term government debt (F_2^O) provide the largest and most significant coefficients indicating a positive relationship between the stock of government debt and the money supply.[146]

In summary, it appears that we are able to explain the influence of the Public Debt Commissioners on the credit market rate and the money supply in terms of the money supply hypothesis. Given our knowledge of the institutional framework within which government debt is issued, and empirical information obtained in previous sections of this chapter, we conclude that the jobbing activities of the Commissioners serve to stabilize the credit market rate and are more significant for the determination of the money supply.

A word of reservation is warranted. The empirical results for the credit market rate must be interpreted with some care, since, as indicated, the aggregate debt variables (F^O, F^N and F^{DC}) also incorporate transactions with the Monetary Authorities directly. Bear in mind that F^{DC} measures predominantly long-term debt, F^N mainly short-term debt and the credit

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146. In the money supply regression equations, F^N is used (rather than F^O) to maintain consistency with the credit market rate equations. Changes in F^O partially reflect changes in the portfolio of the Public Debt Commissioners through acquisitions from new subscriptions directly. For this reason, F^O is less appropriate in the money supply equations.

market rate proxy variable is the long-term rate on government securities. Further, according to de Swardt and Steenkamp, jobbing activities occur mainly in short-term government debt.[147] However, the consistency of our results with a priori notions, with evidence on the institutional structure, and with our other empirical results, preserves our confidence. The results for the money supply are not affected by the problems mentioned above and are consistent with those for the credit market rate.

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147. See n. 136. Further research in this area is needed to improve the government debt measures used for empirical testing and a more appropriate interest rate is desirable. Additional information on the activities of the Commissioners would be helpful.

11. THE EFFECTS OF INCOME DISTRIBUTION ON THE CREDIT MARKET RATE AND THE MONEY SUPPLY

The influence of income distribution on the demand for money has received scant attention in the standard empirical literature. We postulate in Chapter 2, Section 4.3, that the distribution of income is relevant in explaining the money supply and the credit market rate in South Africa; its importance arising from the observed strong association between low income earners and a relatively high marginal propensity to hold currency. One feature of the politically contrived racial stratification in South Africa is the clear difference in payments habits between low income black labour and the high income white population. We elaborate briefly on these observations.

The South African economy, like all developing economies is dualistic in nature and may be dichotomised into two sectors: the developed industrial sector and the traditional sector. Almost all white labour is employed in the industrial sector while the traditional sector comprises those areas established as ethnic homelands for the black population, as part of the South African Government's policy of Separate Development.

A distinction must be made between urban and rural black labour. In the rural areas, transactions are concluded through barter or the exchange of currency, and liquid wealth is accumulated in the form of cash hoards, which are not responsive to changes in interest rates.

Urban black labour may be either temporary migrants or permanent residents; the former periodically transfer physical cash wealth back to the homelands, and the latter hold transactions balances as savings deposits in the Post Office Savings Bank, commercial banks, building societies and general savings banks, seldom using cheques as a means of payment. Wage payments are made in currency, which seldom return directly to the banking sector. Associated with the payments habits of black labour is the prevailing skewed income distribution in favour of the white population.[148] Consequently, a redistribution of income in favour of black labour will raise the demand for currency, causing an increase in the credit market rate and the money supply.

In Table 4.XXXVIII, we provide regression equations for the demand and supply of money (M_2^D and M_2, resp.), and for the demand for currency (C_p), demand deposits (D) and time deposits (T). With the exception of Equation 1, all the equations have been encountered previously (Equations 2, 3 and 4 are taken from Table 4.XXII; Equations 5 and 6 are from Tables 4.XXV and 4.XXIX, resp.) and are repeated here for ease of comparison. We refer the reader to Sections 6 and 7 for a discussion of the general performance of the relevant equations.

Referring to the money demand function (Equation 1), several points should be noted. There is no indication of autocorrelated residuals, and 98 per cent of the variation in the demand for money is explained by the equation.[149]

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148. Two major factors confine black labour to the bottom rung of the income ladder; firstly, blacks are prohibited by law from entering relatively highly paid skilled jobs, and secondly, black labour is paid a lower wage rate than white labour, for similar jobs.

149. Preliminary tests generated unacceptably low Durbin-Watson statistics. We have used a Hildreth-Lu procedure to raise the Durbin-Watson statistics, and the coefficient of autocorrelation that minimises the standard error of the equation is 0.89 ([57]). Similar autocorrelation problems are encountered by Maxwell who successfully solves the problem with a time trend variable. We avoid this procedure due to the injection of a high degree of multicollinearity. Since a trend does not explain anything in particular, the Hildreth-Lu procedure is preferred. As it happens, our results are very similar to those of Maxwell (T. Maxwell[74]). See also Chap. 2 Sec. 4.3 for a discussion of Maxwell's results.

TABLE 4.XXXVIII

REGRESSION EQUATIONS TO TEST THE INCOME DISTRIBUTION HYPOTHESIS

Dependent Variable	C	i_{12CB}	YDIS	Y/N	ρ	$\bar{R}^2$	DW
1. M_2^d	0.14 (0.10)	-0.030 (-0.74)	0.35 (0.71)	1.05 (5.73)	0.89	0.98	1.76
2. Cp	-0.96 (-0.88)	-0.016 (-0.42)	0.56 (1.24)	0.95 (6.53)	0.85	0.98	2.15
3. D	2.91 (1.41)	-0.034 (-0.67)	-0.073 (-0.11)	0.56 (1.98)	0.96	0.94	1.36
4. T	-7.38 (-3.75)	0.91 (3.27)	-1.27 (-0.89)	1.61 (5.78)		0.97	1.04

Dependent Variable	C	B^a	YDIS	W/P_w	P_Y	i_{br}	F_2^N	P_g	$P_g D$	$\bar{R}^2$	DW
5. i_{LT}	0.73 (0.54)	-0.39 (-2.73)	0.57 (1.03)	0.41 (1.78)	0.99 (3.30)	0.31 (2.99)	0.017 (0.51)	-0.018 (-1.08)		0.96	1.93
6. M_2	-0.83 (-0.56)	0.48 (2.73)	0.59 (0.91)	0.69 (3.13)	1.13 (3.11)	-0.031 (-0.23)	0.12 (2.40)		0.019 (1.13)	0.99	2.21

SOURCE: South African Reserve Bank Quarterly Bulletin. Basic data used in the regression equations are listed in Appendix. A19.

NOTES: Equations 2 to 4 are repeated from Table 4.XXII, and equations 5,6 are repeated from Tables 4.XXV and 4.XXIX respectively. Equations 1 to 6 are estimated in logarithmic form using annual year-end data for the period 1950-1971. Data points for 1965,1966 are excluded from equations 1 to 4 due to missing data on the i_{12CB} variable. M_2^d = the demand for money; the remaining variables have been defined previously. ρ = the coefficient of autocorrelation that minimises the standard error of the equations using an Hildreth-Lu [57] procedure.

The coefficient on the interest rate variable is not significant but contains the correct sign. Since this result is not very different from the more extensive study undertaken by Maxwell, we do not regard the insignificant coefficient as serious (Maxwell never attains a coefficient on the interest rate greater than 0.11).[150] Nominal wealth is used as the budget constraint on the demand for money to avoid the problem of inter-correlation between real wealth and the price level.

Accepting the overall results of the test as satisfactory, it appears that income distribution exerts a positive influence on the demand for money, as we hypothesise. The t-statistic is not seriously insignificant and its relatively low value may be due to our measure of income distribution.[151]

Of more important consequence, is the effect of income distribution on the demand for currency. In Equation 2, we observe an increase in both the coefficient value and the degree of significance, relative to Equation 1, and the sign is correctly positive. Income distribution is less significant in Equations 3 and 4 with the appropriate negative signs. Notice that time deposits are more responsive to changes in income distribution than are demand deposits.

Considering Equations 1 to 4 overall, it seems that a redistribution of income in favour of a low income group raises the demand for currency and lowers the demand for time deposits, indicating the existence of economies of scale in money holdings; an hypothesis derived from the Tobin-Baumal theory of the transaction demand for money.[152]

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150. Our interest rate variable is the same as that used by Maxwell (ibid.).

151. Income distribution is measured as the ratio of wage income to nominal net national income. The wage income proxy does not differentiate between the remuneration of black and white wage earners, a distinction crucial to the income distribution hypothesis.

152. D. Laidler 70 .

In Section 7.1, we discuss the influence of income distribution on the credit market rate and notice that the elasticity of the credit market multiplier with respect to income distribution is -1.46. Hence, income distribution exerts a strong influence on the credit market multiplier directly, which is modified by the secondary interest rate response. In Euqtion 5, the effect of a change in income distribution on the credit market rate exceeds that of all the exogenous variables in the equation, except the price level.

Similar results are observed for the money supply function (Equation 6), where the influence of a change in income distribution on the money supply exceeds that of all the exogenous variables except real wealth and the price level. Although the elasticity of the money multiplier with respect to changes in income distribution is substantially less than that of the credit market multiplier--e(m, YDIS) = -0.17 (Table 4.XXXI)--a change in income distribution has a greater effect on the money supply than on the credit market rate due to the strong accentuating influence of the secondary (interest rate) response. Since the currency ratio (P_1) influences the money multiplier negatively (Section 6.1), a redistribution of income in favour of a low income group raises the currency ratio and lowers the money multiplier. The credit market rate rises, causing a net increase in the money supply. Contrary to the more simple money supply models that predict a decline in the money supply due to currency drains from the banking sector, we find that when the credit market is incorporated into the model, this result is reversed.

In summary, our results indicate that the distribution of income plays an important role in the determination of the money supply and the credit market rate, which means that the Monetary Authorities must take note of endogenous reallocative forces as well as the income redistribution effects resulting from taxation policy, incomes policy and trade union activity (to mention but a few).[153] A redistribution exerts a stronger influence on the money supply than on the credit market rate and is more powerful than any of the policy variables (the adjusted base, statutory reserve requirements and Bank Rate). Economies of scale in money holding appear to be present in South Africa, a phenomenon yet to be substantiated in other countries. Since differential transactions habits exist between high and low income groups, a transfer of income in favour of the low income group with a relatively high marginal currency demand, raises the aggregate demand for currency and lowers the demand for time deposits. Our results show that currency drains from the banking sector raise the money supply when we take account of activities in the credit market. The results may well be improved with the use of a better income distribution measure. A cross-section study of the demand for money and its components may prove fruitful in further research.

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153. It is a commonly held belief that we should take care of the macroeconomic variables and leave the microeconomic variables to take care of themselves.

12. A SUMMARY OF THE EMPIRICAL EVIDENCE ON THE MONEY SUPPLY AND INTEREST RATE DETERMINATION PROCESS IN SOUTH AFRICA: 1950 to 1971

We summarise the focal points of our empirical investigation into the forces that determine the money supply and credit market rate in South Africa. More detailed summaries of the empirical results and conclusions are furnished at the end of each section of this chapter.

The transition from theoretical discourse to empirical evaluation inevitably requires a more detailed consideration of the institutional environment confronting economic units and the actions of the Monetary Authorities. Accordingly, the chapter commences with a discussion of the course of monetary policy pursued by the Monetary Authorities, in terms of the goals sought and the instruments used to achieve them.

Throughout the period 1950 to 1971, the South African Monetary Authorities have concentrated on three goals of monetary policy; stabilization of the rate of interest on government debt, control of the supply of banking sector credit, and the maintenance of an optimum stock of international reserves (protection of the balance of payments). Financial evolution in the period was marked by the proliferation of near banks and the maturation of a money market designed on the basis of the London discount market.

Stabilization of the long-term rate on government debt abrogated contra-cyclical control of the money supply through the adjusted monetary base, and open market operations were never used as an instrument of money supply control. Bank Rate policy was directed towards protection of the stock of international reserves and to controlling the demand for Reserve Bank credit, with the emphasis on the former rather than the latter; while a special discounting policy in the market for Treasury bills was used to nurture the development of the money market, by protecting the discount houses from undue losses during tight money conditions. The Monetary Authorities continuously attempted to control the supply of banking sector credit, by means of variations in the supplementary statutory reserve requirements (and variable liquid asset ratios from 1965 onwards), moral suasion and the imposition of credit ceilings. In the face of exogenous fluctuations in the adjusted monetary base, National Debt management was adopted as an instrument of monetary control, whereby, the proceeds of open market operations by the Treasury were transferred between the Reserve Bank and financial markets according to the state of liquidity in the financial system. The demand for foreign exchange was controlled by the Monetary Authorities, who tightened or relaxed the structure of import and exchange controls according to movements in the balance of payments. This structure of monetary policy should be borne in mind in the discussion of the empirical results.

We commence our empirical study with an investigation of the banking sector's aggregate reserve ratio (b_1). Theoretically, b_1 is defined as the sum of the excess and statutory reserve ratios, and is therefore determined, inter alia, by interest rates and changes in statutory reserve requirements. We are concerned at the outset with the aggregate reserve ratio in order to establish that our theoretical simplification adopted in the comparative statis analysis of the money supply model is empirically justifiable. The statistical tests support the hypothesis that the excess reserve ratio is unimportant for monetary analysis in South Africa, due to the establishment and growth of the South African money market, which enables the banking sector to reduce its excess reserve ratio to an historically low optimum level and then to stabilize the excess reserve ratio against fluctuations in the adjusted base, by varying the stock of money market liquid assets in its portfolio. On the basis of this evidence, we treat the excess reserve ratio as a constant and simplify the comparative static analysis by using b_1 as the synthetic representation of banking sector behaviour for the purpose of defining the money and credit market multipliers. The evidence indicates that the observed decline in b_1 over the sample period is explained by the secular increase in the private sector's time deposit ratio and the secular decline in statutory reserve requirements, both of which, explain the secular decline in the statutory reserve ratio (b_{11}). Thus, the aggregate reserve ratio mirrors variations in the statutory reserve ratio.

From the point of view of monetary policy, the results show that an endogenous increase in the money supply resulting from a 1 per cent increase in time deposits, given that the statutory reserve requirement on demand deposits exceeds the statutory reserve requirement on time deposits, may be offset by an increase in the statutory reserve requirement on demand deposits of less than 1 per cent. In contrast, the Monetary Authorities concentrated on varying the liquid asset ratios in the banking sector, when in fact statutory cash reserves would have sufficed. The stability of the excess reserve ratio indicates that the money market performs efficiently as the banking sector's first line of defence during periods of economic stability; but in times of uncertainty, the money market is less efficient as a cushioning mechanism, and the banking sector's optimum excess reserve ratio rises in value and variability.

The monetary base rests at the centre of the non linear money supply hypothesis, being in principle controllable by the Monetary Authorities. From our empirical analysis of its source component, we find that the base is exogenously determined by the balance of payments, with Reserve Bank lending and open market operations contributing positively but weakly to the trend growth rate in the base.

The Government's deposit at the Reserve Bank exerts a strong negative effect on the base, outweighing the positive effect of open market operations and Reserve Bank lending over the trend. Over the course of the business cycle, the base is dominated by pro-cyclical variations in the stock of international reserves held by the Reserve Bank. Open market operations, Reserve Bank lending and the Government's deposit vary contra-cyclically but insufficiently to offset the pro-cyclical influence of the balance of payments. Both cyclically and secularly therefore, the base is dominated by the balance of payments, which is consistent with the interest rate stabilization policy of the Monetary Authorities (to be discussed further, below). The adjusted monetary base is a mirror image of the monetary base adjusted for Reserve Bank lending to the banking and private sectors.

The non linear money supply hypothesis attributes all changes in the money supply to the adjusted monetary base and the money multiplier, the latter reflecting the endogenous component of the money supply process as well as certain policy variables of the Monetary Authorities (statutory reserve requirements, Bank Rate, discount policy). The money multiplier is not a constant, varying directly with the credit market rate, which responds to changes in the exogenous variables. Our analysis of the relative contributions of the money multiplier and the adjusted base to the growth rate of the money supply, both cyclically and secularly, generates crucial information bearing on the interest rate mechanism in the money supply process, and the effect of the interest rate stabilization policy pursued by the Monetary Authorities.

We identify three different behaviour patterns of the money multiplier: over the long-run, over shorter periods, and over the course of the business cycle. Over the long-run, the multiplier accentuates the positive influence of the adjusted base on the growth rate of the money supply. In the medium-run (year to year) and short-run (quarter to quarter), the trend pattern of behaviour is reversed; the multiplier attenuates the influence of the base on the growth rate of the money stock. So far, these results are similar to those obtained in money supply studies for other countries. However, contrary to these studies (and especially for Canada and Italy) we find that the multiplier is more likely to strongly modify the influence of the adjusted monetary base over yearly periods than over quarterly periods. A shortening of the time period from years to quarters raises the relative importance and reliability of the adjusted base as a determinant of the money supply.

The relative contributions of the money multiplier and the adjusted base to changes in the money stock over the business cycle, provides a third distinct pattern of behaviour. The multiplier fluctuates contra-cyclically, dampening but not outweighing the pro-cyclical influence of the base on the money supply. Hence, the adjusted base retains its dominant influence reflected in the pro-cyclical variations of the money supply. That the multiplier fails to reverse the pro-cyclical variations in the money supply, is due to asymmetric behaviour of the multiplier in the expansion phase relative to the contraction phase of the cycle. In the former, the multiplier declines, thereby, attenuating (incompletely) the increase in the money supply due to an expansion of the adjusted base, while in the latter, the multiplier increases and completely attenuates the effects of the adjusted base on the money stock. An absolute decline in the money stock during the contraction phase is negated in favour of a reduced growth rate. We show below, that the contra-cyclical and differential behaviour of the multiplier in the long-run and over shorter periods are attributable to the pro-cyclical behaviour of the adjusted monetary base and the interest rate mechanism, and that the asymmetry is a manifestation of the interest rate stabilization policy of the Monetary Authorities.

The above results imply that in the long-run, the Monetary Authorities may achieve a desired growth rate in the money stock through variations in the adjusted monetary base of just over 50 per cent of the target rate; while over shorter periods, the target rate is more likely to be achieved over quarterly periods than over yearly periods.

Having obtained valuable information on the observed relationships between the adjusted monetary base, the money multiplier and the money supply, we investigate the determinants of the money multiplier in terms of its constituent ratio parameters, and the determinants of the ratio parameters themselves. In terms of the ratio parameters, the money multiplier responds positively to a change in the time deposit ratio (P_2) and the Reserve Bank's lending ratio (P_8) and negatively to changes in the currency ratio (P_1) and the aggregate reserve ratio (b_1). Over the trend, the money multiplier is dominated by P_1 and b_1. An endogenous increase in the multiplier due to a 1 per cent rise in P_2 may be offset by an increase in the statutory reserve requirement on demand deposits of approximately 1 per cent, whereas, the increase in the statutory reserve requirement on demand deposits must be greater than 2 per cent to offset the positive effect on the money multiplier of a 1 per cent decline in P_1.

Over the course of the business cycle, contra-cyclical fluctuations in the multiplier are dominated by similar movements in P_8, weaker contributions being provided by P_2 and b_1. The asymmetry is caused by a similar asymmetric movement in P_2, P_8 and b_1, with P_8 again dominating the asymmetric variation of the multiplier.

Our attempts to test the ratio demand functions P_1 and P_2, fail on statistical grounds, providing insufficient cause for rejecting the theoretical hypothesis. Moreover, satisfactory tests of the non ratio demand functions for currency, demand and time deposits, mitigate in favour of not rejecting the hypothesis. Interest rates, wealth and income distribution appear to be important determinants of these demand functions. From our results, we conclude that P_8 responds positively to the credit market rate and negatively to Bank Rate and international reserves, suggesting that contra-cyclical variations in interest rates are responsible for the observed contra-cyclical movement in the money multiplier, operating mainly through P_8. Bank Rate policy is clearly an important determinant of P_8, manifesting the concern of the Monetary Authorities with the development of the money market. That Bank Rate and other interest rates move contra-cyclically, is clearly visible from scrutiny of the time series, providing broad support for the view that Bank Rate was geared to protection of the balance of payments and that the interest rate mechanism explains the cyclical behaviour of the money multiplier.

Estimation of the credit market rate solution function and the money supply function, furnishes the empirical relationships necessary to explain the observed behaviour of the money multiplier and interest rates, as well as facilitating an assessment of the relative efficacy of the policy variables of the model, in controlling the money supply and in determining the credit market rate. We also obtain estimates of the transmission mechanism linking changes in the exogenous variables to changes in the credit market rate and the money supply.

Turning first to the credit market rate, a common causal pattern emerges for all the exogenous variables. All the direct effects are positive as hypothesised and are attenuated by a factor of 0.39 depicting the secondary interest rate effect. An increase in the exogenous variables induces an initial adjustment of asset and debt portfolios, which raises the credit market rate, resulting in a secondary round of balance sheet adjustments, during which, the interest rate effect of asset adjustments dominates the interest rate effects of debt adjustments.

Isolating the three policy variables; the adjusted monetary base, statutory reserve requirements and Bank Rate, we find that the credit market rate responds negatively to changes in the adjusted monetary base and positively to changes in statutory reserve requirements and Bank Rate, with the adjusted base exerting the strongest influence followed by Bank Rate and the statutory reserve requirement on demand deposits, in that order.

The effects on the credit market rate of a change in real wealth, the price level and the interest rate on non banking sector earning assets are all positive, as hypothesised, and the direct effects are positive, implying that during the initial adjustment process, the interest rate effect of debt adjustments outweigh the interest rate effect of asset adjustments. The credit market rate varies directly with an increase in the stock of government debt, and inversely with the extension of open back door operations and discounting privileges by the Reserve Bank. These results support the interest rate hypotheses of the model and are used to calculate the elasticities of the money multiplier with respect to changes in the exogenous variables.

Similarly, our money supply function supports the comparative static hypotheses of the model and provides estimates of the transmission mechanism linking the exogenous variables to the money stock. Three critical results emerge immediately: firstly, the elasticity of the money supply with respect to changes in the adjusted monetary base is 0.48; secondly, the interest elasticity of the money multiplier is 1.33; and thirdly, the value of the feedback operator (the elasticity of the money multiplier with respect to changes in the adjusted base) is 0.52. A 1 per cent increase in the adjusted base raises the money supply on impact equiproportionately (the direct effect is unity). Balance sheet adjustments cause the credit market rate to fall (the elasticity of the credit market rate with respect to the adjusted base is -0.39) and the money multiplier declines by 1.33 per cent for a 1 per cent fall in the credit market rate. Thus, the money multiplier incompletely attenuates the direct effect, causing a net increase in the money supply of 0.48 per cent. Alternatively, a 1 per cent increase in the adjusted base lowers the money multiplier by 0.52 per cent through the feedback interest rate effect. Since the credit market rate responds negatively and the money supply positively to changes in the adjusted base, and since the interest elasticity of the money multiplier (and hence the money supply) is positive, we conclude that the observed contra-cyclical variations in interest rates are due to pro-cyclical movements in the adjusted base and that contra-cyclical fluctuations in the money multiplier result from the interest rate mechanism. We discuss this conclusion further in our assessment of the interest rate stabilization policy and the asymmetric behaviour of the money multiplier, below.

In accordance with our hypothesis, the direct effect on the money supply of a change in the exogenous variables is modified by the interest rate mechanism operating through the credit market. The hierarchy of money supply elasticities with respect to the policy variables reveal that the adjusted monetary base exerts the strongest influence on the money supply, followed by statutory reserve requirements on demand deposits and Bank Rate. While the direct effect of an increase in the adjusted base is unity, the direct effect of the remaining policy variables are less than unity. An increase in statutory reserve requirements and Bank Rate lowers the money multiplier on impact causing an increase in the credit market rate and a secondary increase in the money multiplier, which incompletely attenuates the direct effect. The net effect on the money supply is therefore negative. That Bank Rate exerts a stronger influence on the credit market rate than on the money stock supports our initial view that Bank Rate policy has been geared to interest rate policy rather than to money supply policy. An increase in real wealth and the stock of government debt raises the money supply as hypothesised; open back door operations and Reserve Bank discounting policy cause an increase in the money supply by raising P_8

and the money multiplier. In general, of all the policy variables, the adjusted monetary base exerts the strongest influence on the money stock. The transmission mechanism linking the money stock to changes in the policy variables exhibit the same causal sequence; the direct effects are negative and are incompletely attenuated by the positive secondary (interest rate) effect.

Using the empirical evidence from the money supply and credit market rate equations in conjunction with an assessment of the interest rate stabilization programme pursued by the Monetary Authorities, we are able to explain the observed differential behaviour of the money multiplier over the trend, for shorter periods and over the course of the business cycle. In the long-run, both the adjusted base and interest rates increase secularly, the latter causing a secular rise in the money multiplier, which accounted for almost 50 per cent of the trend growth rate in the money supply. Over shorter periods, however, and over the course of the business cycle, the multiplier attenuates the effect of a change in the adjusted base, due to the secondary interest rate mechanism. The stronger attenuating effect observed for yearly changes relative to quarterly changes is due to a higher degree of variability in the credit market rate in longer periods relative to shorter periods.

Over the course of the business cycle, pro-cyclical movements in the adjusted base induce contra-cyclical variations in the credit market rate and hence the money multiplier. We explain the observed asymmetric behaviour of the money multiplier as follows. In the expansion phase, the adjusted base and the stock of government debt are positively related, facilitating stabilization of the credit market rate. Maintenance of the interest rate ceiling requires that a 1 per cent increase in the stock of government debt is accompanied by a 0.14 per cent increase in the money supply (achieved by the expansion of the adjusted base). The Monetary Authorities permit the adjusted base to exert a positive influence on the money stock by exercising a weak and inadequate contra-cyclical monetary policy through open market operations, changes in statutory reserve requirements and the Government's deposit at the Reserve Bank. In the expansion phase, therefore, monetary policy is subservient to interest rate stabilization.

In the contraction phase the stabilization programme collapses, the adjusted base and the stock of government debt vary inversely (the adjusted base declines with the onset of a balance of payments deficit and government debt is issued to finance the Government's budget deficit) and the ceiling rate rises to protect the balance of payments. We find that a 1 per cent increase in the ceiling rate requires a fall in the money supply and the adjusted base of 1.23 per cent and 2.56 per cent respectively. Consequently, in the contraction phase of the cycle, control of the money supply is subordinate to the balance of payments. The money supply varies pro-cyclically, rising in the expansion phase to stabilize the credit market rate and rising less in the contraction phase to protect the balance of payments. Pro-cyclical variations in the money supply are due to the asymmetric behaviour of the money multiplier, which is caused ultimately by the differential relationship between the adjusted base and the stock of government debt, as between expansion and contraction phases. The Monetary Authorities do not apply contra-cyclical monetary policy through the money multiplier. Bank Rate is varied contra-cyclically to seal the ceiling rate in the expansion phase and to protect the balance of payments in the contraction phase, thereby, attenuating contra-cyclical fluctuations in P_8. Open back door operations and discounting policy prove insufficient to alter the asymmetric behaviour of the money multiplier. Hence, the money multiplier is determined primarily by the credit market rate, which exerts the strongest single influence through the ratio parameter P_8. The interest elasticity of the money multiplier is 1.33 and exceeds the elasticities of the money multiplier with respect to the exogenous variables of the model. These latter elasticities are all less than zero.

Our empirical analysis furnishes evidence on three further hypotheses: the relative interest rate effect of open market operations, a shift in the source of the Government's deficit finance, a change in the adjusted base from sources other than variations in the Reserve Bank's portfolio of government securities, and the issue or retirement of government debt; the role of the Public Debt Commissioners in the money supply and credit market rate determination process; and the income distribution hypothesis.

The non linear money supply hypothesis implies that the interest rate effect of open market operations, or a shift in sources of deficit finance from the banking and private sectors to the Reserve Bank, exceeds that of a change in the adjusted base from other sources or the issue or retirement of government debt. In the first instance, the quantity of Government generated wealth is unchanged, only the distribution between interest-bearing and non interest-bearing claims on the Government is varied; whereas in the second instance, the stock of Government generated wealth changes. Our empirical results support the above hypotheses but the differential interest rate effect is small due mainly to the low elasticity of the h function with respect to changes in the stock of government debt.

From our investigation of the activities of the Public Debt Commissioners and the institutional procedure for the issue of government debt, we find that the jobbing operations of the Commissioners in the secondary market serve to stabilize the credit market rate. In accordance with our hypothesis, open market purchases by the Public Debt Commissioners lower the credit market rate and the money supply. As intermediaries between the Treasury and the secondary market for government debt, the Public Debt Commissioners exert a stronger influence on the money supply than on interest rates.

Finally, the empirical evidence supports our hypothesis about the relevance of income distribution in the money supply and credit market rate determination process. A redistribution of income in favour of a low income group having a relatively higher marginal propensity to hold currency, causes a rise in the aggregate demand for currency and a fall in the aggregate demand for demand and time deposits. In the case of the credit market rate, the direct effect is positive and is attenuated by the secondary (interest rate) effect, so that the net effect of a 1 per cent redistribution of income in favour of a low income group, raises the credit market rate by 0.57 per cent. In the case of the money supply, the direct effect is negative but the money supply response is positive since the positive secondary effect outweighs the negative direct effect. A 1 per cent redistribution of income lowers the money multiplier by 0.17 per cent and raises the credit market rate by 0.57 per cent; and since the interest elasticity of the money multiplier is 1.33 per cent, the secondary effect is decisive.

These results reverse the traditional predictions deduced from more simple money supply models, that currency drains from the banking sector will lower the money supply. Once the credit market and the interest rate mechanism are incorporated into the model, the currency drain will raise the money supply by raising the money multiplier through the interest rate mechanism.

In conclusion, we direct attention to various aspects of this study. Several of these, do not in general emerge from similar studies for other countries, due to the institutional processes and policy actions of the Monetary Authorities, which are peculiar to South Africa.

1. We show, in accordance with numerous money supply studies for other countries, that the adjusted monetary base is indispensable for an understanding of the money supply and credit market rate determination process in South Africa. That the South African Monetary Authorities have chosen to disguise the role of the adjusted base by a statistical consolidation procedure in their statistical bulletin, which precludes the base from monetary analysis, is evidence of their lack of concern for money supply control, but is consistent with their policy goal of stabilizing the interest rate on government debt. However, an interest rate stabilization policy does not remove the causal link between the money supply and the adjusted base; it merely negates use of the adjusted base as a policy instrument. So much is evident in this study. To ignore the influence of the adjusted base appears to be a serious analytical omission.

2. Our theoretical formulation of the P_8 variable based on the modus opperandi of the South African money market, appears to be of substantial relevance for the determination of the money supply and credit market rate. The evidence pertaining to the aggregate reserve ratio substantiates that the money market has succeeded in the task expected of it. Excess reserves in the banking sector are stabilized, permitting the behaviour of the banking sector to be synthesized by the single ratio parameter b_1 (or b_{11}), which

provides us with a convenient device for symplifying our theoretical analysis. P_8 is the dominant determinant of the money multiplier, transmitting the effects of Bank Rate policy, open back door operations, as well as the endogenous interest rate mechanism to the multiplier and hence the money supply. The money market must be incorporated into a money supply model for South Africa.

3. In contrast to the evidence for Great Britain and Canada, the currency ratio is not an important determinant of the money supply in South Africa.

4. Analysis of the relative contributions of the money multiplier and the adjusted base to changes in the money supply, reveal two aspects of the money supply and interest rate determination process peculiar to South Africa. Firstly, contrary to the empirical evidence for many other countries and in particular for Canada and Italy, the money multiplier is less likely to controvert the effect on the money supply of changes in the adjusted base, in shorter periods (quarters), than longer periods (years); and secondly, the consistent contra-cyclical but assymetric variation of the multiplier over the course of the business cycle, perpetuates the pro-cyclical dominance of the adjusted base on the money supply. Both these results stem from the interest rate stabilization policy of the South African Monetary Authorities.

5. The money supply and credit market rate determination process in South Africa constitutes a classical Gold Standard adjustment mechanism.

Control of the money supply by the Reserve Bank is abrogated in favour of a link to the balance of payments. Since the balance of payments varies pro-cyclically, the money supply is permitted to vary pro-cyclically, rising in the expansion phase to stabilize the credit market rate and declining in the contraction phase to protect the balance of payments. In the contraction phase of the cycle, a typical Keynesian dilemma emerges between internal and external balance in a fixed exchange rate system, with the simultaneous occurrence of a balance of payments deficit and a decline in real income. Persistent inflationary pressures accompanied by periodic recessions in South Africa, is characteristic of the stabilization program and the Gold Standard framework.

Under the existing regime, the Monetary Authorities could remove the assymetric behaviour of the multiplier by more vigorous variations in statutory cash reserve requirements and Bank Rate policy, in the expansion phase. However, the statutory reserve requirement on demand deposits and Bank Rate would have to be changed by 7.16 per cent and 15.5 per cent, respectively, to just offset the influence of the adjusted base on the money supply. Alternatively, fiscal policy could be adopted for monetary control, by a reduction in the Government's deficit and a decline in the stock of government debt in the expansion phase, thereby, permitting the credit market rate to fall, which would lower the value of the multiplier and attenuate more completely the pro-cyclical influence of the adjusted monetary base. A 1 per cent increase in the adjusted base accompanied by a 4 per cent decline in the stock of government debt would keep the money supply constant. An unwillingness on the part of the Monetary Authorities to render fiscal policy subordinate to monetary policy, and to tolerate large changes in statutory reserve requirements or Bank Rate, leaves one remaining course of action open. Money supply control requires control of the adjusted base and an abondonment of the stabilization programme.

6. If open market operations are to be effective in controlling the credit market rate, the Monetary Authorities must raise the elasticity of the h function with respect to changes in government debt, by developing a broad secondary market for long-term government debt. This involves an abandonment by the Monetary Authorities of their traditional reliance on the Public Debt Commissioners for fiscal funds, and of the stabilization program.

7. Income distribution plays an important role in the money supply and credit market rate determination process, and economies of scale in money holdings appear to be present; a phenomenon yet to be established for other countries. The Monetary Authorities must, therefore, take note of income redistribution effects arising from endogenous forces, as well as tax policies, incomes policies and trade union activity. Money supply control cannot be determined independently of microeconomic variables.

8. The non linear money supply hypothesis permits an assessment of the role of the Public Debt Commissioners, and the evidence suggests that their actions are relevant to the money supply process.

9. Our empirical evidence supports all the comparative static implications of the model. We find that the transmission mechanism linking

changes in the exogenous variables to the money supply and credit market rate, performs as hypothesized. The interest rate mechanism is a partial element in the process, modifying the direct effect on the money supply of changes in the exogenous variables.

10. Finally, the money multiplier, accounts for almost 50 per cent of the observed average growth rate in the money supply, and is vital in explaining the money supply process, both cyclically and secularly.

Appendix A.1

Derivation of the Monetary Base Identity

The monetary influence of the Monetary Authorities may be summarised by the consolidated balance sheets of the South African Reserve Bank and the South African Mint,[1] given in Table A.1.III (the separate balance sheets appear in Tables A.1.I and A.1.II).

Let $$o = 0 - FCO \qquad \text{(Table A.1.III)}. \qquad (A.1-1)$$

Consolidating the balance sheets and cancelling contra items yields the identity:

$$C + IR + GLOAN + AFI + S + OLOAN = -(R_{CB} + N_c + C_c + N_o = C_o + RFI = RG^*) + o \qquad (A.1-2)$$

Define total cash reserves (R) of the commercial banks as:

$$R = N_c + C_c + R_{CB} \qquad (A.1-3)$$

Define currency in the hands of the private sector (C_p) as:

$$C_p = N_o + C_o \qquad (A.1-4)$$

Finally, define the monetary base in terms of its uses:

$$B = R + C_p$$

$$= N_c + C_c + R_{CB} + N_o + C_o \qquad (A.1-5)$$

Substituting (A.1-5) into (A.1-2) defines the monetary base in terms of its source components:

$$B = C + IR + GLOAN + AFI + S + OLOAN + o - (RFI + RG + F^*) \qquad (A.1-6)$$

The adjusted monetary base (B^a) is defined as:

$$B^a = B - AFI$$

$$= C + IR + GLOAN + S + OLOAN + o - (RFI + RG + F^*) \qquad (A.1-7)$$

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[1] An hypothetical version of the Mint's balance sheet is used. A balance sheet for the South African Reserve Bank appears in the South African Reserve Bank Quarterly Bulletin.

TABLE A.1.I

BALANCE SHEET OF THE SOUTH AFRICAN MINT

Assets		Liabilities	
C	Total Minted Coin	Coin Held by :	
GCB	Gold Coin and Bullion		
		Reserve Bank	C_b
		Commercial Banks	C_c
		Private Sector	C_o
		Gold Coin and Bullion	GCB

TABLE A.1.II

BALANCE SHEET OF THE SOUTH AFRICAN RESERVE BANK

Assets		Liabilities	
IR	Gold and Foriegn Exchange Reserves	Note Issue Held by :	
C_b+N_b	Notes and Coin	Reserve Bank	N_b
GLOAN	Loans to the Government	Commercial Banks	N_c
AFI	Loans to Financial Institutions	Private Sector	N_o
S	Government Securities	Deposits :	
OLOAN	Other Loans		
O	Other Assets	Commercial Banks	R_{CB}
		Other Financial Institutions	RFI
		Government	RG
		Other	F^*
		Foreign Loans, Capital and Reserves and Other Liabilities	FCO

SOURCE: South African Reserve Bank Quarterly Bulletin: Balance Sheet of the Reserve Bank.

NOTES: Government deposits are comprised of the Exchequer and Post Master General account(REX), Other Government Deposits(ROG), Provincial Administraton Deposits(RPA). Other Deposits(F^*) consist of domestic and foreign deposits.

TABLE A.1.III

CONSOLIDATED BALANCE SHEET OF THE SOUTH AFRICAN RESERVE BANK AND THE SOUTH AFRICAN MINT

	Assets	Liabilities	
C	Total Minted Coin	Currency Held by the Private Sector	C_p
IR	Gold and Foreign Exchange Reserves	Commercial Bank Reserves	R
GLOAN	Loans to Government	Deposits of Other Financial Institutions	RFI
AFI	Loans to Financial Institutions	Government Deposits	RG
S	Government Securities	Other Deposits	F^*
OLOAN	Other Loans	Foreign Loans, Capital and Reserves and Other Liabilities	FCO
O	Other Assets		

Appendix A.2

Derivation of the Statutory Reserves Equation

The quantity of statutory reserves held against a particular class of deposits is equal to the product of the statutory reserve requirement on that class of deposits and the quantity of deposits. Total statutory reserves (R_S) are given by the sum of the statutory reserves held against each class of deposits, thus:

$$R_s = r^{d'} D + r^{t'} T \qquad \text{(A.2-1)}$$

where:

$r^{d'}$ = statutory reserve requirement on demand deposits

$r^{t'}$ = statutory reserve requirement on time deposits

D = demand deposits

T = time deposits .

Dividing A.2-1 through by D + T, we obtain the banking sector's statutory reserve ratio (b_{11}) :

$$R_s = \left(\frac{r^{d'} D + r^{t'} T}{D + T}\right) (D + T) \qquad \text{(A.2-2)}$$

where:

$$b_{11} = r^{d'} \frac{D}{D + T} + r^{t'} \frac{T}{D + T}$$

Statutory reserves held against time deposits $(r^{t'}T)$ is given by:

$$r^{t'}T = r^{s'}S_d + r^{f'}F \qquad \text{(A.2-3)}$$

where:

$r^{s'}$ = statutory reserve requirement on savings deposits

$r^{f'}$ = statutory reserve requirement on fixed deposits

S_d = savings deposits

F = fixed deposits

T = S_d + F .

Therefore, the statutory reserve requirement on time deposits is a weighted sum of the statutory reserve requirements on savings and fixed deposits, with the ratios of savings deposits and fixed deposits to total deposits as weights:

$$r^{t'} = r^{s'} \frac{S_d}{T} + r^{f'} \frac{F}{T} \qquad \text{(A.2-4)}$$

Similarly, since fixed deposits are divisible into short-term, medium-term and long-term fixed deposits, the statutory reserve requirement on fixed deposits $(r^{t'})$ is a weighted sum of the statutory reserve requirements on the various maturities with the ratios of short-term and medium plus long-term fixed deposits to total fixed deposits as weights, thus:

$$r^{f'} = r^{fst'} \frac{F_{st}}{F} + r^{fm\ell t'} \frac{F_{m\ell t}}{F} \qquad \text{(A.2-5)}$$

where:

$r^{fst'}$ = statutory reserve requirement on short-term fixed deposits

$r^{fm\ell t'}$ = statutory reserve requirement on medium plus long-term fixed deposits .

We introduce a set of new notation for mathematical convenience and rewrite equations A.2-2, A.2-4 and A.2-5 as follows:

let

$$\gamma = \frac{D}{D + T}$$

$$1 - \gamma = \frac{T}{D + T}$$

$$\delta = \frac{S_d}{T}$$

$$1 - \delta = \frac{F}{T}$$

$$\alpha = \frac{F_{st}}{F}$$

$$1 - \alpha = \frac{F_{m\ell t}}{F}$$

then,

$$R_s = [r^{d'}\gamma + r^{t'}(1 - \gamma)](D + T) \tag{A.2-6}$$

$$r^{t'} = r^{s'}\delta + r^{f'}(1 - \delta) \tag{A.2-7}$$

$$r^{f'} = r^{fst'}\alpha + r^{fm\ell t'}(1 - \alpha) \tag{A.2-8}$$

and,

$$b_{11} = r^{d'}\gamma + r^{t}(1 - \gamma) \tag{A.2-9}$$

Equation A.2-9 is more easily differentiable in the comparative static analysis than is equation A.2-2 (see Appendix A.6).

Appendix A.3

The Response of the Time Deposit Ratio to Changes in Interest Rates

---

Equations 2-27 and 2-28 (Chap. 2 Sec. 4.5) are:

$$P_2 = P_2(i_t, i_o, \ldots)$$

$$i_t = i_t(i_o, i_e, \ldots)$$

The total differentials of P_2 and i_t are:

$$dP_2 = \frac{\partial P_2}{\partial i_t} di_t + \frac{\partial P_2}{\partial i_o} di_o \qquad \text{(A.3-1)}$$

$$di_t = \frac{\partial i_t}{\partial i_o} di_o + \frac{\partial i_t}{\partial i_e} di_e \qquad \text{(A.3-2)}$$

Substitute for di_t in A.3-1 from A.3-2 and solve for $\frac{dP_2}{di_e}$ and $\frac{dP_2}{di_e}$.

$$dP_2 = \frac{\partial P_2}{\partial i_t}\frac{\partial i_t}{\partial i_o} di_o + \frac{\partial P_2}{\partial i_t}\frac{\partial i_t}{\partial i_e} di_e + \frac{\partial P_2}{\partial i_o} di_o$$

$$= \left[\frac{\partial P_2}{\partial i_t}\frac{\partial i_t}{\partial i_o} + \frac{\partial P_2}{\partial i_o}\right] di_o + \frac{\partial P_2}{\partial i_t}\frac{\partial i_t}{\partial i_e} di_e \qquad \text{(A.3-3)}$$

Therefore:

$$\frac{dP_2}{di_e} = \frac{\partial P_2}{\partial i_t}\frac{\partial i_t}{\partial i_e} \qquad \text{(A.3-4)}$$

$$\frac{dP_2}{di_o} = \frac{\partial P_t}{\partial i_t}\frac{\partial i_t}{\partial i_o} + \frac{\partial P_2}{\partial i_o} \qquad \text{(A.3-5)}$$

In elasticity form, equations A.3-4 and A.3-5 are:[1]

$$e(P_2, i_e) = e(P_2, i_t)e(i_t, i_e) > 0 \qquad \text{(A.3-6)}$$

---

[1]Equation A.3-6 is obtained by multiplying both sides of equation A.3-4 by i_e/P_2; multiplying the right-hand side by i_e/i_e and regrouping the right-hand side. Equation A.3-7 is obtained by multiplying both sides of equation A.3-5 by i_o/P_2; multiplying the first term on the right-hand side by i_tP_2/i_tP_2 and regrouping.

$$e(P_2,i_o) = e(P_2,i_t)e(i_t,i_o) + e(P_2,i_o) > 0 \qquad (A.3\text{-}7)$$

if

$$|e(P_2,i_t)e(i_t,i_o)| > |e(P_2,i_o)| \quad .$$

Appendix A.4

Derivation of the Exchequer Balance Sheet Identity

An hypothetical balance sheet for the Exchequer may be constructed as follows. The Exchequer account is a conventional flow account recording receipts and expenditures of the Treasury per time period.

The deficit in time period t, may be expressed as a change in stocks derived from the income-expenditure flow account in Table A.4.I:

$$(G-T)_t = \Delta(FFGN + F^N + F^{DC} + S + C + GLOAN - REX)_t \qquad (A.4\text{-}1)$$

Rewriting the righthand side in stock form, yields an estimate of the accumulated deficit from some time i in the past; $\sum_i^t (G-T)$.

This expression is the identity describing the Exchequer balance sheet in Table A.4.II.

$$\sum_i^t (G-T) = (FFGN + F^N + F^{DC} + S + C + GLOAN - REX) \qquad (A.4\text{-}2)$$

TABLE A.4.I

INCOME AND EXPENDITURE ACCOUNT OF THE EXCHEQUER
FOR THE PERIOD ENDED t

	Income	Expenditures
	Net Issue of Government Debt to :	Government Deficit $(G-T)_t$
$\Delta(F^N)_t$	Banking and Private Sectors	
$\Delta(FFGN)_t$	Foreigners	
$\Delta(S)_t$	Reserve Bank	
$\Delta(F^{DC})_t$	Public Debt Commissioners	
$\Delta(GLOAN-REX)_t$	Net Indebtedness to the Reserve Bank	
$\Delta(C)_t$	Net Issue of Mint Coin	

TABLE A.4.II

EXCHEQUER BALANCE SHEET AT t

	Assets	Liabilities	
$\Sigma(G-T)$	Accumulated Government Deficit	Outstanding Government Debt Held by :	
REX	Balance at Reserve Bank	Banking and Private Sectors	F^N
		Public Debt Commissioners	F^{DC}
		Foreigners	FFGN
		Reserve Bank	S
		Loans from Reserve Bank	GLOAN
		Outstanding Minted Coin	C

Appendix A.5

Derivation of the Semi-Reduced Forms for the Credit Market Rate, the Supply of Bank Credit and the Money Supply

---

Definition of Identities for the adjusted monetary base (B^a), the money supply (M_2) and the demand for earning assets (EA^b) by the banking sector:

$$B^a = C_p + R - AFI \tag{A.5-1}$$

$$M_2 = C_p + D + T \tag{A.5-2}$$

$$EA^b = D + T - R \tag{A.5-3}$$

where:

C_p = currency in the hands of the private sector

R = aggregate banking sector deposits

AFI = Reserve Bank lending to the banking and private sectors

D = demand deposits

T = time deposits .

Banking and private sector portfolio equations:

$$R = b_1(D + T) \tag{A.5-4}$$

$$C_p = P_1D \tag{A.5-5}$$

$$T = P_2D \tag{A.5-6}$$

$$AFI = P_8D \tag{A.5-7}$$

$$EA^P = h(i, W/P_w, P_y, F^o) \tag{A.5-8}$$

where:

EA^p = supply of earning assets by the private sector to the banking sector

i = vector of interest rates

W/P_w = real wealth

P_y = price level

F^o = stock of government debt in the banking and private sectors .

Equilibrium in the bank credit market is given by:

$$EA^p = EA^b \tag{A.5-9}$$

Substituting A.5-5 to A.5-7 into A.5-3, A.5-4 yields the banking sectors demand functions in terms of P_1, P_2 and b_1 :

$$R = b_1(1 + P_2)D \tag{A.5-10}$$

$$EA^b = (1 + P_2)(1 - b_1)D \tag{A.5-11}$$

Rewriting the equilibrium condition in the bank credit market in terms of A.5-8 and A.5-11 :

$$h(i,W/P_w,P_y,F^o) = (1 + P_2)(1 - b_1)D \tag{A.5-12}$$

Substituting the relevent equations into identities A.5-1 and A.5-2, we obtain the money supply and the adjusted monetary base in terms of the portfolio ratios and demand deposits.

$$B^a = [P_1 + b_1(1 + P_2) - P_8]D \tag{A.5-13}$$

$$M_2 = (1 + P_1 + P_2)D \tag{A.5-14}$$

Solve for the semi-reduced forms for the money supply and banking sector earning assets in terms of the portfolio ratios and the adjusted monetary base by solving for D in A.5-13 and substituting for D in A.5-11 and A.5-14.

$$M_2 = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_8} B^a \qquad \text{(A.5-15}$$

$$EA^b = \frac{(1 + P_2)(1 - b_1)}{P_1 + b_1(1 + P_2) - P_8} B^a \qquad \text{(A.5-16)}$$

The money multiplier m and credit market multiplier a are defined as:

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_8} \qquad \text{(A.5-17)}$$

$$a = \frac{(1 + P_2)(1 - b_1)}{P_1 + b_1(1 + P_2) - P_8} \qquad \text{(A.5-18)}$$

Appendix A.6

Analysis of the Statutory Reserve Ratio*

Note that in all expressions in this Appendix, the statutory reserves ratio (b_{11}) can be replaced by the total reserves ratio (b_1) since excess reserves are assumed constant (see Chap. 3 Sec. 2.3).

*In all cases $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ is the elasticity of x with respect to y.

Appendix A.6.1

Derivatives of the Statutory Reserve Ratio with respect to Statutory Reserve Requirements

The ratio of statutory reserves to deposits (b_{11}) is the weighted sum of reserve requirements on demand and time deposits with the ratio of demand and time deposits to total deposits (γ, $1 - \gamma$, respectively) as weights.

From Chapter 2, equations 2-14 to 2-17 and Appendix A.2,

$$R_s = b_{11}(D + T) \qquad \text{(A.6.1-1)}$$

$$b_{11} = r^{d'}\gamma + r^{t'}(1 - \gamma) \qquad \text{(A.6.1-2)}$$

$$r^{t'} = r^{d'}\delta + r^{f'}(1 - \delta) \qquad \text{(A.6.1-3)}$$

$$r^{f'} = r^{fst'}\alpha + r^{fm\ell t'}(1 - \alpha) \qquad \text{(A.6.1-4)}$$

$$\frac{\partial b_{11}}{\partial r^{d'}} = \gamma = \frac{D}{D + T} > 0 \qquad \text{(A.6.1-5)}$$

$$\frac{\partial b_{11}}{\partial r^{t'}} = 1 - \gamma = \frac{T}{D + T} > 0 \qquad \text{(A.6.1-6)}$$

$$\frac{\partial b_{11}}{\partial r^{s'}} = \frac{\partial b_{11}}{\partial r^{t'}}\frac{\partial r^{t'}}{\partial r^{s'}} = (1 - \gamma)\delta = \frac{S_d}{D + T} > 0 \qquad \text{(A.6.1-7)}$$

$$\frac{\partial b_{11}}{\partial r^{f'}} = \frac{\partial b_{11}}{\partial r^{t'}}\frac{\partial r^{t'}}{\partial r^{f'}} = (1 - \gamma)(1 - \delta) = \frac{F}{D + T} > 0 \qquad \text{(A.6.1-8)}$$

$$\frac{\partial b_{11}}{\partial r^{fst'}} = \frac{\partial b_{11}}{\partial r^{t'}}\frac{\partial r^{t'}}{\partial r^{f'}}\frac{\partial r^{f'}}{\partial r^{fst'}} = (1 - \gamma)(1 - \delta)\alpha = \frac{FST}{D + T} > 0 \qquad \text{(A.6.1-9)}$$

Appendix A.6.2

Derivatives of the Statutory Reserve Ratio with respect to the weights γ, $1-\gamma$, δ, $1-\delta$, α, $1-\alpha$

Rewriting expressions A.6.1-2 to A.6.1-4 from Appendix A.6.1,

$$b_{11} = (r^{d'} - r^{t'})\gamma + r^{t'} \tag{A.6.2-1}$$

$$r^{t'} = (r^{s'} - r^{f'})\delta + r^{f'} \tag{A.6.2-2}$$

$$r^{f'} = (r^{fst'} - r^{fm\ell t'})\alpha + r^{fm\ell t'} \tag{A.6.2-3}$$

$$\frac{\partial b_{11}}{\partial \gamma} = r^{d'} - r^{t'} > 0 \quad \text{if } r^{d'} > r^{t'} \tag{A.6.2-4}$$

$$\frac{\partial b_{11}}{\partial (1-\gamma)} = \frac{\partial b_{11}}{\partial \gamma}\frac{\partial \gamma}{\partial (1-\gamma)} = -\ (r^{d'} - r^{t'}) < 0 \quad \text{if } r^{d'} > r^{t'} \tag{A.6.2-5}$$

$$\frac{\partial b_{11}}{\partial \gamma} = \frac{\partial b_{11}}{\partial r^{t'}}\frac{\partial r^{t'}}{\partial \gamma} = (1-\gamma)(r^{s'} - r^{f'}) > 0 \quad \text{if } r^{s'} > r^{f'} \tag{A.6.2-6}$$

$$\frac{\partial b_{11}}{\partial (1-\delta)} = \frac{\partial b_{11}}{\partial r^{t'}}\frac{\partial r^{t'}}{\partial (1-\delta)} = \frac{\partial b_{11}}{\partial \delta}\frac{\partial \delta}{\partial (1-\delta)} = -\ (1-\gamma)(r^{s'} - r^{f'}) < 0 \quad \text{if } r^{s'} > r^{f'} \tag{A.6.2-7}$$

$$\frac{\partial b_{11}}{\partial \alpha} = \frac{\partial b_{11}}{\partial r^{t'}}\frac{\partial r^{t'}}{\partial r^{f'}}\frac{\partial r^{f'}}{\partial \alpha} = (1-\gamma)(1-\delta)(r^{fst'} - r^{fm\ell t'}) > 0 \quad \text{if } r^{fst'} > r^{fm\ell t'} \tag{A.6.3-8}$$

$$\frac{\partial b_{11}}{\partial(1-\alpha)} = \frac{\partial b_{11}}{\partial r^{t'}} \frac{\partial r^{t'}}{\partial r^{f'}} \frac{\partial r^{f'}}{\partial(1-\alpha)} = \frac{\partial b_{11}}{\partial \alpha} \frac{\partial \alpha}{\partial(1-\alpha)}$$

$$= -(1-\gamma)(1-\delta)(r^{fst'} - r^{fm\ell t'}) < 0 \qquad \text{(A.6.2-9)}$$

$$\text{if} \quad r^{fst'} > r^{fm\ell t'} \quad .$$

Appendix A.6.3

The Effect on the Statutory Reserve Ratio (b_{11}) of a Change in Demand Deposits (D) and Time Deposits (T) assuming (a) D + T varies and (b) D + T is constant.

From Appendix A.6.1, equation A.6.1-2

$$b_{11} = r^{d'}\gamma + r^{t'}(1-\gamma)$$

$$= (r^{d'} - r^{t'}) \frac{D}{D+T} + r^{t'}$$

where

$$\gamma = \frac{D}{D+T} \quad .$$

The total differential of γ is:

$$d\gamma = \frac{\partial \gamma}{\partial D} dD + \frac{\partial \gamma}{\partial T} dT \qquad \text{(A.6.3-1)}$$

$$= \frac{T}{(D+T)^2} dD - \frac{D}{(D+T)^2} dT \qquad \text{(A.6.3-2)}$$

(a) Assume variations in D with T constant (D + T varies).

$$\frac{d\gamma}{dD} = \frac{T}{(D+T)^2} = (1-\gamma) \frac{1}{D+T} > 0 \qquad \text{(A.6.3-3)}$$

(b) Assume variations in D with D + T constant (T varies).

Let $-dD = dT$, then from A.6.3-2

$$\frac{d\gamma}{dD} = \frac{1}{D+T} > 0 \quad . \qquad \text{(A.6.3-4)}$$

The Effect on b_{11} of an Exogenous Change in D, holding T constant.

$$\frac{\partial b_{11}}{\partial D} = \frac{\partial b_{11}}{\partial \gamma}\frac{\partial \gamma}{\partial D} = (r^{d'} - r^{t'})(1 - \gamma)\frac{1}{D + T} > 0 \qquad (A.6.3\text{-}5)$$

if $r^{d'} > r^{t'}$

The Effect on b_{11} of a Transfer of Deposits Between Demand and Time Deposits (i.e. holding D + T constant).

$$\frac{\partial b_{11}}{\partial D} = \frac{\partial b_{11}}{\partial \gamma}\frac{\partial \gamma}{\partial D} = (r^{d'} - r^{t'})\frac{1}{(D + T)} > 0 \qquad (A.6.3\text{-}6)$$

if $r^{d'} > r^{t'}$

Hence, $$(r^{d'} - r^{t'})\frac{1}{D + T} > (r^{d'} - r^{t'})(1 - \gamma)\frac{1}{D + T} \qquad (A.6.3\text{-}7)$$

since $$(1 - \gamma) < 1 . \qquad (A.6.3\text{-}8)$$

Similarly, from A.6.3-2

(a) Assume variations in T holding D constant (D + T varies).

$$\frac{d\gamma}{dT} = -\frac{D}{(D + T)^2} = -\gamma\frac{1}{D + T} < 0 \qquad (A.6.3\text{-}9)$$

(b) Assume variations in T with D + T constant (D varies).

Let $dD = - dt$, then

$$\frac{d\gamma}{dT} = -\frac{1}{(D + T)^2} < 0 \qquad (A.6.3\text{-}10)$$

The derivatives of b_{11} with respect to T holding D constant and holding D + T constant are given in A.6.3-11 and A.6.3-12 respectively.

$$\frac{\partial b_{11}}{\partial T} = \frac{\partial b_{11}}{\partial \gamma}\frac{\partial \gamma}{\partial t} = -(r^{d'} - r^{t'})\gamma\frac{1}{D + T} < 0 \qquad (A.6.3\text{-}11)$$

if $r^{d'} > r^{t'}$

$$\frac{\partial b_{11}}{\partial T} = \frac{\partial b_{11}}{\partial \gamma}\frac{\partial \gamma}{\partial T} = -(r^{d'} - r^{t'})\frac{1}{D+T} < 0 \qquad \text{(A.6.3-12)}$$

$$\text{if} \quad r^{d'} > r^{t'}$$

Hence, $$\left| -(r^{d'} - r^{f'})\frac{1}{D+T}\right| > \left|(r^{d'} - r^{t'})\gamma\frac{1}{D+T}\right| \qquad \text{(A.6.3-13)}$$

since $$\gamma < 1 .$$

The Effect on b_{11} of a Reallocation of Deposits Between Demand, Savings and Fixed Deposits.

From Appendix A.6.2 equations A.6.2-1 and A.6.2-2 the statutory reserves ratio (b_{11}) is written in terms of statutory reserve requirements on demand, fixed and savings deposits ($r^{d'}$, $r^{s'}$, $r^{f'}$ respectively) and the ratio of demand, fixed and savings deposits to total deposits.

$$b_{11} = r^{d'}\gamma + [r^{s'}\delta + r^{f'}(1-\delta)](1-\gamma) \qquad \text{(A.6.3-14)}$$

$$= r^{d'}\gamma + r^{s'}\delta(1-\gamma) + r^{f'}(1-\delta)(1-\gamma)$$

$$= r^{d'}\frac{D}{D+S_d+F} + r^{s'}\frac{S_d}{D+S_d+F} + r^{f'}\frac{F}{D+S_d+F}$$

where

$$\gamma = \frac{D}{D+T}$$

$$1-\gamma = \frac{T}{D+T}$$

$$\delta = \frac{S_d}{T}$$

$$1-\delta = \frac{F}{T}$$

$$T = S_d + F .$$

Totally differentiating equation A.6.3-14 with respect to j, $j = D, S_d, F$:

$$db_{11} = \sum_j \left\{ \left[\frac{\partial b_{11}}{\partial \gamma} \frac{\partial \gamma}{\partial j} \right] + \left[\frac{\partial b_{11}}{\partial [\delta(1-\gamma)]} \frac{\partial [\delta(1-\gamma)]}{\partial j} \right] + \left[\frac{\partial b_{11}}{\partial [(1-\delta)(1-\gamma)]} \frac{\partial [(1-\delta)(1-\gamma)]}{\partial j} \right] \right\} dj \quad \text{(A.6.3-15)}$$

$$= \left[r^{d'} \frac{S_d + F}{(D + S_d + F)^2} - r^{s'} \frac{S_d}{(D + S_d + F)^2} - r^{f'} \frac{F}{(D + S_d + F)^2} \right] dD +$$

$$\left[- r^{d'} \frac{D}{(D + S_d + F)^2} + r^{s'} \frac{D + F}{(D + S_d + F)^2} - r^{f'} \frac{F}{(D + S_d + F)^2} \right] dS_d +$$

$$\left[- r^{d'} \frac{D}{(D + S_d + F)^2} - r^{s'} \frac{S}{(D + S_d + F)^2} + r^{f'} \frac{D + S}{(D + S_d + F)^2} \right] dF$$

$$= \frac{1}{(D + S_d + F)^2} \left\{ \left[r^{d'} S_d + r^{d'} F - r^{s'} S_d - r^{f'} F \right] dD + \left[- r^{d'} D + r^{s'} D + r^{s'} F - r^{f'} F \right] dS_d + \left[- r^{d'} D - r^{s'} S_d + r^{f'} D + r^{f'} S \right] dF \right\}$$

Assume a reallocation of deposits between demand and savings deposits, $-dD = dS_d$ and $dF = 0$.

$$\frac{db_{11}}{dD} = (r^{d'} - r^{s'}) \frac{1}{D + T} \gtrless 0 \quad \text{(A.6.3-16)}$$

$$\text{if} \quad r^{d'} \gtrless r^{s'}$$

Assume a reallocation of deposits between demand and fixed deposits, $-dD = dF$ and $dS = 0$.

$$\frac{\partial b_{11}}{\partial D} = (r^{d'} - r^{f'})\frac{1}{D + T} \gtreqless 0 \qquad \text{(A.6.3-17)}$$

$$\text{if} \quad r^{d'} \gtreqless r^{f'}$$

Assume a reallocation of deposits between savings and fixed deposits, $-dS_d = dF$ and $dD = 0$.

$$\frac{\partial b_{11}}{\partial S_d} = (r^{s'} - r^{f'})\frac{1}{D + T} \gtreqless 0 \qquad \text{(A.6.3-18)}$$

$$\text{if} \quad r^{d'} \gtreqless r^{f'}$$

Appendix A.6.4

Derivation of the Elasticities of the Statutory Reserve Ratio (b_{11}) with respect to Statutory Reserve Requirements and the Ratios of Demand and Time Deposits to Total Deposits

---

From Appendix A.6.1 equations A.6.1-1 to A.6.1-4,

$$R_s = b_{11}(D + T) \qquad \text{(A.6.4-1)}$$

where

$$b_{11} = r^{d'}\gamma + r^{t'}(1 - \gamma) \qquad \text{(A.6.4-2)}$$

$$= r^{d'}\frac{D}{D + T} + r^{t'}\frac{T}{D + T}$$

and

$$r^{t'} = r^{s'}\delta + r^{f'}(1 - \delta)$$

$$r^{f'} = r^{fst'}\alpha + r^{fm\ell t'}(1 - \alpha)$$

Let $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ be the elasticity of x with respect to y and Δ_1 = denominator of the elasticity expressions.

$$e(b_{11},r^{d'}) = \frac{r^{d'}D}{\Delta_1} > 0 \qquad (A.6.4-3)$$

$$e(b_{11},r^{t'}) = \frac{r^{t'}T}{\Delta_1} > 0 \qquad (A.6.4-4)$$

$$e(b_{11},r^{s'}) = \frac{r^{s'}S_d}{\Delta_1} > 0 \qquad (A.6.4-5)$$

$$e(b_{11},r^{f'}) = \frac{r^{f'}F}{\Delta_1} > 0 \qquad (A.6.4-6)$$

$$e(b_{11},r^{fst'}) = \frac{r^{fst'}FST}{\Delta_1} > 0 \qquad (A.6.4-7)$$

$$e(b_{11},\gamma) = \frac{(r^{d'} - r^{t'})D}{\Delta_1} > 0 \qquad (A.6.4-8)$$

if $r^{d'} > r^{t'}$

$$e(b_{11},1 - \gamma) = \frac{(r^{d'} - r^{t'})T}{\Delta_1} > 0 \qquad (A.6.4-9)$$

if $r^{d'} > r^{t'}$

where: $\Delta_1 = r^{d'}D + r^{t'}T$

Appendix A.6.5

Derivation of the Elasticities of the Statutory Reserve Ratio (b_{11}) with respect to the Credit Market Rate Index (i_e), Real Wealth (W/P_w), the Price Level (P), Income Distribution (YDIS), and the Rate on Non Banking Sector Earning Assets (i_o)

From Chapter 2, equation 2-10,

$$\gamma = \gamma(i,W/P_w,P,YDIS) \qquad (A.6.5-1)$$

Using elasticity expression A.6.4-8 in Appendix A.6.4, $e(b_{11},j) = e(b_{11},\gamma)e(\gamma,j)$, $j = i_e, i_o, W/P_w, P, YDIS$.

$$e(b_{11},i_e) = \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,i_e) < 0 \qquad (A.6.5-2)$$

$$e(b_{11},i_o) = \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,i_o) < 0 \qquad (A.6.5-3)$$

$$e(b_{11},W/P_w) = \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,W/P_w) < 0 \qquad (A.6.5-4$$

$$e(b_{11},P) = \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,P) < 0 \qquad (A.6.5-5)$$

$$e(b_{11},YDIS) = \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,YDIS) < 0 \qquad (A.6.5-6)$$

where $\Delta_1 = r^{d'}D + r^{t'}T$

All elasticities are < 0 if $r^{d'} > r^{t'}$.

Appendix A.7

Derivation of the Credit Market Multiplier Elasticities*

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*In all cases $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ is the elasticity of x with respect to y .

Appendix A.7.1

The Elasticities of the Credit Market Multiplier (a) with respect to the Ratio Parameters and Statutory Reserve Requirements

The credit market multiplier (a) is defined in Appendix A.5 as,

$$a = \frac{(1 + P_2)(1 - b_1)}{P_1 + b_1(1 + P_2) - P_8}$$

All elasticity expression are obtained as follows;

$e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ where $e(x,y)$ = elasticity of x with respect to y .

Summary of Elasticity Expressions and Derivations.

$$e(a,P_1) = -\frac{P_1}{\Delta_2} < 0 \quad \text{(A.7.1-1)}$$

$$e(a,P_2) = \frac{(P_1 - P_8)P_2}{\Delta_2(1 + P_2)} > 0 \quad \text{(A.7.1-2)}$$

$$e(a,P_8) = \frac{P_8}{\Delta_2} > 0 \quad \text{(A.7.1-3)}$$

$$e(a,b_1) = -\frac{(1 + P_1 + P_2 - P_8)b_1}{\Delta_2(1 - b_1)} < 0 \quad \text{(A.7.1-4)}$$

$$e(a,r^{d'}) = -\frac{(1 + P_1 + P_2 - P_8)r^{d'}}{\Delta_2(1 - b_1)} \cdot \frac{D}{D + T} < 0 \quad \text{(A.7.1-5)}$$

$$e(a,r^{t'}) = -\frac{(1 + P_1 + P_2 - P_8)r^{t'}}{\Delta_2(1 - b_1)} \cdot \frac{T}{D + T} < 0 \quad \text{(A.7.1-6)}$$

where $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$.

Derivations and Sign Patterns.

Let

$$\Delta_2 = P_1 + b_1(1 + P_2) - P_8$$

$$e(a,P_1) = \frac{\partial a}{\partial P_1} \cdot \frac{P_1}{a}$$

$$= \frac{-(1 - b_1)(1 + P_2)}{\Delta_2^2} \cdot \frac{P_1\Delta_2}{(1 - b_1)(1 + P_2)}$$

$$= -\frac{P_1}{\Delta_2} < 0$$

if $P_1 > P_8 (\Delta_2 > 0)$.

$$e(a,P_2) = \frac{\partial a}{\partial P_2} \cdot \frac{P_2}{a}$$

$$= \frac{\Delta_2(1 - b_1) - (1 - b_1)(1 + P_2)b_1}{\Delta_2^2} \cdot \frac{P_2\Delta_2}{(1 - b_1)(1 + P_2)}$$

$$= \frac{(P_1 - P_8)P_2}{\Delta_2(1 + P_2)} > 0$$

if $P_1 > P_8 (\Delta_2 > 0)$.

$$e(a,P_8) = \frac{\partial a}{\partial P_8} \cdot \frac{P_8}{a}$$

$$= \frac{(1 - b_1)(1 + P_2)}{\Delta_2^2} \cdot \frac{P_8\Delta_2}{(1 - b_1)(1 + P_2)}$$

$$= \frac{P_8}{\Delta_2} > 0$$

if $P_1 > P_8 (\Delta_2 > 0)$.

$$e(a,b_1) = \frac{\partial a}{\partial b_1} \cdot \frac{b_1}{a}$$

$$= \frac{-\Delta_2(1 + P_2) - (1 - b_1)(1 + P_2)^2}{\Delta_2^2} \cdot \frac{b_1\Delta_2}{(1 - b_1)(1 + P_2)}$$

$$= \frac{-(1 + P_1 + P_2 - P_8)b_1}{\Delta_2(1 - b_1)} < 0$$

$$\text{if} \quad P_1 > P_8 (\Delta_2 > 0) \; .$$

From Appendix A.6.4, equation A.6.4-3 is rewritten as

$$e(b_{11}, r^{d'}) = \frac{r^{d'}}{b_{11}} \frac{D}{D + T} \qquad \text{(A.7.-7)}$$

where $b_{11} = \frac{\Delta_1}{D + T}$ (see equation A.6.4-2). Similarly, equation A.6.4-3 is rewritten as

$$e(b_{11}, r^{t'}) = \frac{r^{t'}}{b_{11}} \frac{T}{D + T} \qquad \text{(A.7.1-8)}$$

In Chapter 2, Section 3, b_1 is defined as $b_1 = b_{11} + e$ (see equation 2-20 of text). Assuming that $e \approx 0$, then $b_1 \approx b_{11}$. Thus, the elasticities of b_1 are approximated by the elasticities of b_{11} and bearing this in mind, we may substitute b_1 for b_{11} in Appendix A.6.4 and equations A.7.1-7, A.7.1-8, above.

Using equations A.7.1-4, A.7.1-7 and A.7.1-8,

$$e(a, r^{d'}) = e(a, b_1) e(b_1, r^{d'})$$

$$= \frac{-(1 + P_1 + P_2 - P_8)}{\Delta_2(1 - b_1)} \cdot \frac{r^{d'} D}{D + T} < 0$$

$$e(a, r^{t'}) = \frac{-(1 + P_1 + P_2 - P_8)}{\Delta_2(1 - b_1)} \cdot \frac{r^{t'} T}{D + T} < 0$$

The signs are < 0 if $P_1 > P_8(\Delta_2 > 0)$. For all elasticities, $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$..

Summary

$$e(a, P_1) = -\frac{P_1}{\Delta_2} < 0$$

$$e(a, P_2) = \frac{(P_1 - P_8)P_2}{\Delta_2(1 + P_2)} > 0$$

$$e(a,P_8) = \frac{P_8}{\Delta_2} > 0$$

$$e(a,b_1) = \frac{-(1 + P_1 + P_2 - P_8)b_1}{\Delta_2(1 - b_1)} < 0$$

$$e(a,r^{d'}) = \frac{-(1 + P_1 + P_2 - P_8)}{\Delta_2(1 - b_1)} \cdot \frac{r^{d'}D}{D + T} < 0$$

$$e(a,r^{t'}) = \frac{-(1 + P_1 + P_2 - P_8)}{\Delta_2(1 - b_1)} \cdot \frac{r^{t'}T}{D + T} < 0$$

where $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$. All signs require the empirical condition that $\Delta_2 > 0$; i.e., $P_1 > P_8$.

Appendix A.7.2

The Elasticities of the Credit Market Multiplier (a) with respect to the Rate on Non Banking Sector Earning Assets (i_o), Bank Rate (i_{br}), Real Wealth (W/P_w), the Price Level (P) and Income Distribution (YDIS)

The expressions are followed by derivations and sign conditions.

$$e(a,i_o) = e(a,P_2)e(P_2,i_o) + e(a,P_8)e(P_1,i_o)$$

$$+ e(a,b_1)e(b_1,\gamma)e(\gamma,i_o) \qquad \text{(A.7.2-1)}$$

$$= \frac{1}{\Delta_2}\left[\frac{(P_1 - P_8)P_2}{1 + P_2} e(P_2,i_o) + P_8\, e(P_8,i_o) - \frac{(1 + P_1 + P_2 - P_8)b_1}{1 - b_1} \cdot \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,i_o)\right] > 0$$

if $P_1 > P_8$ and $r^{d'} > r^{t'}$.

$$e(a,i_{br}) = e(a,P_8)e(P_8,i_{br}) \qquad \text{(A.7.2-2)}$$

$$= \frac{P_8}{\Delta_2} e(P_8,i_{br}) < 0 \qquad \text{if } P_1 > P_8 .$$

$$e(a,x) = e(a,P_1)e(P_1,x) + e(a,P_2)e(P_2,x) + e(a,b_1)e(b_1,\gamma)e(\gamma,x) \qquad \text{(A.7.2-3)}$$

$$= \frac{1}{\Delta_2}\left[- P_1 e(P_1,x) + \frac{(P_1 - P_8)P_2}{1 + P_2} e(P_2,x) - \frac{(1 + P_1 + P_2 - P_8)b_1}{1 - b_1} \cdot \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,x)\right] > 0$$

if $P_1 > P_8$ and $r^{d'} > r^{t'}$, for $x = W/P_w$, P . For x = YDIS, the sign is < 0 if the above inequalities hold and if the first term on the right-hand side of equation A.7.2-3 exceed the sum of the second and third in absolute value (see summary below).

$$\Delta_1 = r^{d'}D + r^{t'}T$$

$$\Delta_2 = P_1 + b_1(1 + P_2) - P_8$$

Derivations.

Substitute for $e(a,x)$, $x = P_1, P_2, P_8, b_1$ from Appendix A.7.1; $e(b_1,\gamma)$ from Appendix A.6.4; all of which are explicit expressions.

Signs Patterns.

The signs on expressions A.7.2-1 to A.7.2-3 depend on the signs and inequalities specified in Appendices A.7.1 and A.6.4 and on the a priori signs attached to the structural equations P_1, P_2, P_8, γ - (see equations 2-25, 2-26, 2-30, 2-44 and 3-10b). Since $e(a,b_1) < 0$, $e(b_1,\gamma) > 0$, $e(\gamma,x) < 0$, for $x = i_o$, W/P_w, P, YDIS, the product of these three elasticities > 0 . That $e(P_2,i_o) > 0$ is shown in Appendix A.3.

Summary.

$e(a,i_{br}) < 0$ if $P_1 > P_8$

$e(a,i_o) > 0$ if $P_1 > P_8$ and $r^{d'} > r^{t'}$

$e(a,W/P_w) > 0$ if $P_1 > P_8$ and $r^{d'} > r^{t'}$

$$e(a,P) > 0 \quad \text{if} \quad P_1 > P_8 \quad \text{and} \quad r^{d'} > r^{t'}$$

$$e(a,YDIS) < 0 \quad \text{if} \quad P_1 > P_8 \quad \text{and} \quad r^{d'} > r^{t'}$$

and if

$$\left| - P_1 e(P_1,YDIS) \right| > \left| \frac{(P_1 - P_8)P_2}{1 + P_2} e(P_2,YDIS) - \frac{(1 + P_1 + P_2 - P_8)b_1}{1 - b_1} \cdot \frac{(r^{d'} - r^{t'})D}{r^{d'}D + r^{t'}T} e(\gamma,YDIS) \right|$$

[The inequality on e(a,YDIS) arises due to the a priori sign that $e(P_1,YDIS) > 0$] .

Appendix A.8

Derivation of the Money Multiplier Elasticities*

*In all cases $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ is the elasticity of x with respect to y.

Appendix A.8.1

The Elasticities of the Money Multiplier (m) with respect to the Ratio Parameters and Statutory Reserve Requirements

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The money multiplier is defined in Appendix A.5. as,

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_8}$$

All elasticity expressions are obtained as follows: $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$
where $e(x,y)$ = elasticity of x with respect to y .

Summary of Elasticity Expressions and Derivations.

$$e(m,P_1) = P_1\left[\frac{1}{1 + P_1 + P_2} - \frac{1}{\Delta_2}\right] < 0 \qquad \text{(A.8.1-1)}$$

$$e(m,P_2) = P_2\left[\frac{1}{1 + P_1 + P_2} - \frac{b_1}{\Delta_2}\right] > 0 \qquad \text{(A.8.1-2)}$$

$$e(m,P_8) = \frac{P_8}{\Delta_2} > 0 \qquad \text{(A.8.1-3)}$$

$$e(m,b_1) = \frac{-(1 + P_2)b_1}{\Delta_2} < 0 \qquad \text{(A.8.1-4)}$$

$$e(m,r^{d'}) = \frac{-(1 + P_2)r^{d'}}{\Delta_2} \cdot \frac{D}{D + T} < 0 \qquad \text{(A.8.1-5)}$$

$$e(m,r^{t'}) = \frac{-(1 + P_2)r^{t'}}{\Delta_2} \cdot \frac{T}{D + T} < 0 \qquad \text{(A.8.1-6)}$$

where $\Delta_2 = P_1 + b_1(1 + P_2) - P_8$.

Derivations and Sign Conditions.

Let

$$\Delta_2 = P_1 + b_1(1 + P_2) - P_8$$

$$e(m,P_1) = \frac{\partial m}{\partial P_1} \cdot \frac{P_1}{m}$$

$$= \frac{\Delta_2 - (1 + P_1 + P_2)}{\Delta_2^2} \cdot \frac{P_1\Delta_2}{(1 + P_1 + P_2)}$$

$$= P_1\left[\frac{1}{1 + P_1 + P_2} - \frac{1}{\Delta_2}\right] < 0$$

if $b_1 < 1$ and $P_1 > P_8(\Delta_2 > 0)$.

$$e(m,P_2) = \frac{\partial m}{\partial P_2} \cdot \frac{P_2}{m}$$

$$= \frac{\Delta_2 - (1 + P_1 + P_2)b_1}{\Delta_2^2} \cdot \frac{P_2\Delta_2}{(1 + P_1 + P_2)}$$

$$= P_2\left[\frac{1}{1 + P_1 + P_2} - \frac{b_1}{\Delta_2}\right] > 0$$

if $b_1 < 1$ and $P_1 > P_8(\Delta_2 > 0)$.

$$e(m,P_8) = \frac{\partial m}{\partial P_8} \cdot \frac{P_8}{m}$$

$$= \frac{(1 + P_1 + P_2)}{\Delta_2^2} \cdot \frac{P_8\Delta_2}{(1 + P_1 + P_2)}$$

$$= \frac{P_8}{\Delta_2} > 0$$

if $P_1 > P_8(\Delta_2 > 0)$.

$$e(m,b_1) = \frac{\partial m}{\partial b_1} \cdot \frac{b_1}{m}$$

$$= \frac{-(1 + P_1 + P_2)(1 + P_2)}{\Delta_2^2} \cdot \frac{b_1\Delta_2}{(1 + P_1 + P_2)}$$

$$= -\frac{(1 + P_2)b_1}{\Delta_2} < 0$$

if $P_1 > P_8 (\Delta_2 > 0)$.

$$e(m, r^{d'}) = e(m, b_1)e(b_1, r^{d'})$$

$$= \frac{-(1 + P_2)r^{d'}}{\Delta_2} \cdot \frac{D}{D + T} < 0$$

if $P_1 > P_8 (\Delta_2 > 0)$.

$$e(m, r^{t'}) = e(m, b_1)e(b_1, r^{t'})$$

$$= \frac{-(1 + P_2)r^{t'}}{\Delta_2} \cdot \frac{T}{D + T} < 0$$

if $P_1 > P_8 (\Delta_2 > 0)$.

[$e(b_1, r^{d'}) = \frac{r^{d'}}{b_1} \frac{D}{D + T}$, $e(b_1, r^{t'}) = \frac{r^{t'}}{b_1} \frac{T}{D + T}$. See equations A.7.1-7 and A.7.1-8 and related discussion in Appendix A.7.1 for further elaboration of $e(m, r^{d'})$ and $e(m, r^{t'})$. These elasticities are exactly analogous with $e(a, r^{d'})$ and $e(a, r^{t'})$].

All the signs depend on $\Delta_2 = P_1 + b_1(1 + P_2) - P_8 > 0$, i.e., $P_1 + b_1(1 + P_2) > P_8$, which is satisfied if $P_1 > P_8$.

Summary.

$$e(m, P_1) = P_1\left[\frac{1}{1 + P_1 + P_2} - \frac{1}{P_1 + b_1(1 + P_2) - P_8}\right] < 0$$

if $P_1 > P_8$ and $b_1 < 1$.

$$e(m, P_2) = P_2\left[\frac{1}{1 + P_1 + P_2} - \frac{b_1}{P_1 + b_1(1 + P_2) - P_8}\right] > 0$$

if $P_1 > P_8$ and $b_1 < 1$.

$$e(m,P_8) = \frac{P_8}{P_1 + b_1(1 + P_2) - P_8} > 0$$

if $P_1 > P_8$.

$$e(m,b_1) = \frac{-(1 + P_2)b_1}{P_1 + b_1(1 + P_2) - P_8} < 0$$

if $P_1 > P_8$.

$$e(m,r^{d'}) = \frac{-(1 + P_2)r^{d'}}{P_1 + b_1(1 + P_2) - P_8} \cdot \frac{D}{D + T} < 0$$

if $P_1 > P_8$.

$$e(m,r^{t'}) = \frac{-(1 + P_2)r^{t'}}{P_1 + b_1(1 + P_2) - P_8} \cdot \frac{T}{D + T} < 0$$

if $P_1 > P_8$.

Appendix A.8.2

The Elasticities of the Money Multiplier (m) with respect to the Rate on Non Banking Sector Earning Assets (i_o), Bank Rate (i_{br}), Real Wealth (W/P_w), the Price Level (P) and Income Distribution (YDIS)

The expressions are followed by derivations and sign conditions.

$$e(m,i_o) = e(m,P_2)e(P_2,i_o) + e(m,P_8)e(P_8,i_o)$$

$$+ e(m,b_1)e(b_1,\gamma)e(\gamma,i_o)$$

$$= \frac{1}{\Delta_2}\left[\frac{[\Delta_2 - b_1(1 + P_1 + P_2)]P_2}{1 + P_1 + P_2} e(P_2,i_o) + P_8 e(P_8,i_o) \right.$$

$$\left. - (1 + P_2)b_1 \cdot \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,i_o) \right] > 0 \qquad \text{(A.8.2-1)}$$

$$e(m,i_{br}) = e(m,P_8)e(P_8,i_{br})$$

$$= \frac{P_8}{\Delta_2} e(P_8,i_{br}) < 0 \qquad \text{(A.8.2-2)}$$

$$e(m,x) = e(m,P_1)e(P_1,x) + e(m,P_2)e(P_2,x)$$

$$+ e(m,b_1)e(b_1,\gamma)e(\gamma,x)$$

$$= \frac{1}{\Delta_2}\left[\frac{[\Delta_2 - (1 + P_1 + P_2)]P_1}{1 + P_1 + P_2} e(P_1,x) + \frac{[\Delta_2 - b_1(1 + P_1 + P_2)]P_2}{1 + P_1 + P_2} e(P_2,x)\right.$$

$$\left. - [(1 + P_2)b_1] \frac{(r^{d'} - r^{t'})D}{\Delta_1} e(\gamma,x)\right] > 0 \qquad \text{(A.8.2-3)}$$

for $x = W/P_w, P$. The sign is < 0 for $x = YDIS$ if the first term on the right-hand side of equation A.8.2-3 exceeds the sum of the second and third in absolute value (see summary below).

$$\Delta_1 = r^{d'}D + r^{t'}T$$

$$\Delta_2 = P_1 + b_1(1 + P_2) - P_8$$

<u>Derivations.</u>

Substitute for $e(a,x)$, $x = P_1, P_2, P_8, b_1$, from Appendix A.8.1; $e(b_1,\gamma)$ from Appendix A.6.4; all of which are explicit expressions.

<u>Signs.</u>

The signs on expressions A.8.2-1 to A.8.2-3 depend on the signs and inequalities specified in Appendix A.8.1 and on the a priori signs attached to the structural equations P_1, P_2, P_8, γ (see equations 2-25, 2-26, 2-30, 2-44, 3-10b).

Since $e(m,b_1) < 0$, $e(b_1,\gamma) > 0$, $e(\gamma,x) < 0$ for $x = i_o, W/P_w,$ P, YDIS, the product of these three elasticities > 0 . That $e(P_2,i_o) > 0$ is shown in Appendix A.3.

Summary.

$$e(m,i_{br}) < 0 \quad \text{if} \quad P_1 > P_8$$

$$e(m,i_o) > 0 \quad \text{if} \quad P_1 > P_8, \quad b_1 < 1, \quad r^{d'} > r^{t'}$$

$$e(m,W/P_w) > 0 \quad \text{if} \quad P_1 > P_8, \quad b_1 < 1, \quad r^{d'} > r^{t'}$$

$$e(m,P) > 0 \quad \text{if} \quad P_1 > P_8, \quad b_1 < 1, \quad r^{d'} > r^{t'}$$

$$e(m,YDIS) < 0 \quad \text{if} \quad P_1 > P_8, \quad b_1 < 1, \quad r^{d'} > r^{t'}$$

and if

$$|e(m,P_1)e(P_1,YDIS)| > |e(m,P_2)e(P_2,YDIS) + e(m,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$$

[The inequality on $e(m,YDIS)$ arises due to the a priori sign that $e(P_1,YDIS) > 0$] .

Appendix A.9

Derivation of the Credit Market Rate Solution Function and the Elasticities of the Credit Market Rate with respect to the Exogenous Variables*

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*In all cases, $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ is the elasticity of x with respect to y .

Appendix A.9.1

The Credit Market Rate Solution Function

Equilibrium in the bank credit market is given by equation 2-51 in the text as:

$$h(i_e, x, F^o) = a(i_e, x, YDIS, r^{d'}, r^{t'}, i_{br})B^a \qquad (A.9.1\text{-}1)$$

for $$x = i_o,\ W/P_w,\ P\ .$$

Writing A.9.1-1 in logarithmic form,

$$e(h,i_e)\log i_e + e(h,x)\log x + e(h,F^o)\log F^o = e(a,i_e)\log i_e + e(a,x)\log x + e(a,YDIS)\log YDIS + e(a,r^{d'})\log r^{d'} + e(a,r^{t'})\log r^{t'} + e(a,i_{br})\log i_{br} + \log B^a \qquad (A.9.1\text{-}2)$$

Solving A.9.1-2 for $\log i_e$ and collecting terms,

$$e(a,i_e)\log i_e - e(h,i_e)\log i_e = [e(h,x) - e(a,x)]\log x + e(h,F^o)\log F^o - e(a,YDIS)\log YDIS - e(a,r^{d'})\log r^{d'} - e(a,r^{t'})\log r^{t'} - e(a,i_{br})\log i_{br} - \log B^a \qquad (A.9.1\text{-}3)$$

$$\log i_e = \frac{1}{e(a,i_e) - e(h,i_e)}\{-\log B^a + [e(h,x) - e(a,x)]\log x + e(h,F^o)\log F^o - e(a,YDIS)\log YDIS - e(a,r^{d'})\log r^{d'} - e(a,r^{t'})\log r^{t'} - e(a,i_{br})\log i_{br}\} \qquad (A.9.1\text{-}4)$$

Appendix A.9.2

The Elasticities of the Credit Market Rate Index with respect to the Exogenous Variables

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Differentiating the credit market rate solution function (equation A.9.1-4) yields the elasticities listed below. Let $\Delta_3 = e(a,i_e) - e(h,i_e)$.

$$e(i_e,B^a) = -\frac{1}{\Delta_3} \quad \text{(A.9.2-1)}$$

$$e(i_e,r^{d'}) = \frac{-e(a,r^{d'})}{\Delta_3} \quad \text{(A.9.2-2)}$$

$$e(i_e,r^{t'}) = \frac{-e(a,r^{t'})}{\Delta_3} \quad \text{(A.0.2-3)}$$

$$e(i_e,i_{br}) = \frac{-e(a,i_{br})}{\Delta_3} \quad \text{(A.9.2-4)}$$

$$e(i_e,x) = \frac{e(h,x) - e(a,x)}{\Delta_3} \quad \text{(A.9.2-5)}$$

$$x = i_o,\ W/P_w,\ P$$

$$e(i_e,YDIS) = \frac{-e(a,YDIS)}{\Delta_3} \quad \text{(A.9.2-6)}$$

$$e(i_e,F^o) = \frac{e(h,F^o)}{\Delta_3} \quad \text{(A.9.2-7)}$$

Expressions A.9.2-2 to A.9.2-7 are rewritten in terms of $e(i_e,B^a)$ by substituting $-e(i_e,B^a) = \frac{1}{\Delta_3}$ where Δ_3 is defined above.

$$-e(i_e,B^a) = \frac{1}{e(a,i_e) - e(h,i_e)} \quad \text{(A.9.2-8)}$$

$$e(i_e,r^{d'}) = e(i_e,B^a)e(a,r^{d'}) \quad \text{(A.9.2-9)}$$

$$e(i_e,r^{t'}) = e(i_e,B^a)e(a,r^{t'}) \quad \text{(A.9.2-10)}$$

$$e(i_e,i_{br}) = e(i_e,B^a)e(a,i_{br}) \quad \text{(A.9.2-11)}$$

$$e(i_e,x) = -e(i_e,B^a)[e(h,x) - e(a,x)] \qquad \text{(A.9.2-12)}$$

$$e(i_e,YDIS) = e(i_e,B^a)e(a,YDIS) \qquad \text{(A.9.2-13)}$$

$$e(i_e,F^o) = -e(i_e,B^a)e(h,F^o) \qquad \text{(A.9.2-14)}$$

where $x = i_o, W/P_w, P$.

Sign Patterns.

Explicit expressions for $e(a,r^{d'})$, $e(a,r^{t'})$ [derived in Appendix A.7.1], and expressions for $e(a,i_{br})$, $e(a,i_o)$, $e(a,W/P_w)$, $e(a,P)$, $e(a,YDIS)$ [derived in Appendix A.7.2], may be substituted into equations A.9.2-9 to A.9.2-14 above. These expressions are summarised below with appropriate sign conditions.

From the summaries to Appendices A.7.1 and A.7.2

$$e(a,r^{d'}) < 0$$

$$e(a,r^{t'}) < 0$$

$$e(a,i_{br}) < 0$$

if $P_1 > P_8$

$$e(a,i_o) > 0$$

$$e(a,W/P_w) > 0$$

$$e(a,P) > 0$$

$$e(a,YDIS) < 0$$

if $P_1 > P_8$ and $r^{d'} > r^{t'}$.

$e(a,YDIS) < 0$ requires the additional inequality that

$$|e(a,P_1)e(P_1,YDIS)| > |e(a,P_2)e(P_2,YDIS) + e(a,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$$

The sign on equation A.9.2-8 is crucial since the remaining expressions contain the term $-e(i_e,B^a)$ and hence the common denominator $e(a,i_e) - e(h,i_e)$.

$$e(a,i_e) = e(a,P_2)e(P_2,i_e) + e(a,P_8)e(P_8,i_e) + e(a,b_1)e(b_1,\gamma)e(\gamma,i_e) > 0 \qquad (A.9.2\text{-}15)$$

From Appendix A.7.1,

$$e(a,P_2) = \frac{(P_1 - P_8)P_2}{[P_1 + b_1(1 + P_2) - P_8](1 + P_2)} > 0$$

$$e(a,P_8) = \frac{P_8}{P_1 + b_1(1 + P_2) - P_8} > 0$$

$$e(a,b_1) = \frac{-(1 + P_1 + P_2 - P_8)b_1}{[P_1 + b_1(1 + P_2) - P_8](1 - b_1)} < 0$$

all these signs require that $P_1 > P_8$.

From Appendix A.6.4,

$$e(b_1,\gamma) = \frac{(r^{d'} - r^{t'})D}{r^{d'}D - r^{t'}T} > 0$$

if $r^{d'} > r^{t'}$.

From Chapter 2, section 4.5 equation 2-49

$$e(P_2,i_e) = e(P_2,i_t)e(i_t,i_e) > 0 .$$

From Chapter 2, section 5.2.7

$$e(P_8,i_e) > 0 .$$

From Chapter 3, section 2.2

$$e(\gamma,i_e) < 0 .$$

Using this information,

$$e(a,i_e) > 0 \text{ if } P_1 > P_8 \text{ and } r^{d'} > r^{t'} . \qquad (A.9.2\text{-}16)$$

Since, by a priori hypothesis $e(h,i_e) < 0$ (Chapter 2, section 4.6 equation 2-31),

$$e(a,i_e) - e(h,i_e) > 0 \qquad (A.9.2\text{-}17)$$

if $P_1 > P_8$ and $r^{d'} > r^{t'}$.

In the following summary, the sign patterns on equations A.9.2-8 to A.9.2-14 are derived using the above information.

Summary.

$$e(i_e, B^a) < 0$$

$$e(i_e, r^{d'}) > 0$$

$$e(i_e, r^{t'}) > 0$$

$$e(i_e, i_{br}) > 0$$

$$e(i_e, i_o) > 0$$

$$e(i_e, W/P_w) > 0$$

$$e(i_e, P) > 0$$

$$e(i_e, YDIS) > 0$$

$$e(i_e, F^o) > 0$$

All the signs depend on the empirical inequalities that $P_1 > P_8$, $r^{d'} > r^{t'}$. In addition, $e(i_e, YDIS) > 0$ requires that

$$|e(a,P_1)e(P_1,YDIS)| > |e(a,P_2)e(P_2,YDIS) + e(a,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$$

With respect to i_o, W/P_w, P, the condition that $e(h,x) - e(a,x) > 0$ must be satisfied.

Appendix A.10

Derivation of the Money Supply Solution Function and the Elasticities of the Money Supply with respect to the Exogenous Variables*

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*In all cases, $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ is the elasticity of x with respect to y .

Appendix A.10.1

The Money Supply Solution Function

The money supply semi-reduced form is given by equations 2-53 and 2-54 in the text as,

$$M_2 = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_8} B^a \qquad \text{(A.10.1-1)}$$

where

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_8}$$

(This equation is derived in Appendix A.5). Writing A.10.1-1 in logarithmic form,

$$\log M_2 = \log m + \log B^a \qquad \text{(A.10.1-2)}$$

Since m is a function of the variables determining its constituent ratio parameters, A.10.1-2 is written in terms of the credit market rate and exogenous variables.

$$\log M_2 = e(m,i_e)\log i_e + e(m,x)\log x + e(m,r^{d'})\log r^{d'} + e(m,r^{t'})\log r^{t'} + e(m,i_{br})\log i_{br} + e(m,YDIS) \log YDIS + \log B^a \qquad \text{(A.10.1-3)}$$

where $x = i_o, W/P_w, P$.

Substituting for $\log i_e$ from the credit market rate solution function (Appendix 9.1 equation A.9.1-4) yields the solution function for the equilibrium money stock.

$$\log M_2 = \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)} \{- \log B^a + [e(h,x) - e(a,x)]\log x + e(h,F^o)\log F^o - e(a,YDIS)\log YDIS - e(a,r^{d'})\log r^{d'} - e(a,r^{t'})\log r^{t'} - e(a,i_{br})\log i_{br}\} + e(m,x)\log x + e(m,r^{d'})\log r^{d'} + e(m,r^{t'})\log r^{t'} + e(m,i_{br})\log i_{br} + e(m,YDIS)\log YDIS + \log B^a \qquad \text{(A.10.1-4)}$$

Defining $K = \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)}$ and collecting terms,

$$\log M_2 = (1 - K)\log B^a + \{K[e(h,x) - e(a,x)] + e(m,x)\}\log x + Ke(h,F^o)\log F^o + [- Ke(a,YDIS) + e(m,YDIS)]\log YDIS + [- Ke(a,r^{d'}) + e(m,r^{d'})]\log r^{d'} + [- Ke(a,r^{t'}) + e(m,r^{t'})]\log r^{t'} + [- Ke(a,i_{br}) + e(m,i_{br})]\log i_{br}$$

(A.10.1-5)

Appendix A.10.2

The Elasticities of the Money Supply with respect to the Exogenous Variables

Differentiating the money supply solution function, (equation A.10.1-5) yields the elasticities listed below.

$$e(M_2,B^a) = 1 - K \qquad \text{(A.10.2-1)}$$

$$e(M_2,r^{d'}) = - Ke(a,r^{d'}) + e(m,r^{d'}) \qquad \text{(A.10.2-2)}$$

$$e(M_2,r^{t'}) = - Ke(a,r^{t'}) + e(m,r^{t'}) \qquad \text{(A.10.2-3)}$$

$$e(M_2,i_{br}) = - Ke(a,i_{br}) + e(m,i_{br}) \qquad \text{(A.10.2-4)}$$

$$e(M_2,x) = K[e(h,x) - e(a,x)] + e(m,x) \qquad \text{(A.10.2-5)}$$

$$x = i_o,\ W/P_w,\ P$$

$$e(M_2,YDIS) = - Ke(a,YDIS) + e(m,YDIS) \qquad \text{(A.10.2-6)}$$

$$e(M_2,F^o) = Ke(h,F^o) \qquad \text{(A.10.2-7)}$$

where $K = \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)}$.

The Money Supply Elasticities in terms of the Credit Market Rate Elasticities and the Money Multiplier Elasticities

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Substituting for $K = \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)}$ into equations A.10.2-1 to A.10.2-7 reveals that the first product term on the right-hand side of these equations is the elasticity of the money multiplier with respect to the credit market rate, $e(m,i_e)$, multiplied by a ratio of elasticities which are the elasticities of the credit market rate with respect to the corresponding exogenous variables (Appendix A.9.2 equations A.9.2-1 to A.9.2-7). Hence, the money supply elasticities are rewritten in terms of the money multiplier and credit market rate elasticities: e.g. substitute K into equation A.10.2-2, so that

$$e(M_2,r^{d'}) = - e(m,i_e) \frac{e(a,r^{d'})}{e(a,i_e) - e(h,i_e)} + e(m,r^{d'})$$

From equation A.9.2-2

$$e(i_e,r^{d'}) = \frac{- e(a,r^{d'})}{e(a,i_e) - e(h,i_e)}$$

Therefore,

$$e(M_2,r^{d'}) = e(m,i_e)e(i_e,r^{d'}) + e(m,r^{d'})$$

and similarly for the remaining money supply elasticities.

$$e(M_2,B^a) = 1 + e(m,i_e)e(i_e,B^a) \qquad \text{(A.10.2-8)}$$

$$e(M_2,r^{d'}) = e(m,i_e)e(i_e,r^{d'}) + e(m,r^{d'}) \qquad \text{(A.10.2-9)}$$

$$e(M_2,r^{t'}) = e(m,i_e)e(i_e,r^{t'}) + e(m,r^{t'}) \qquad \text{(A.10.2-10)}$$

$$e(M_2,i_{br}) = e(m,i_e)e(i_e,i_{br}) + e(m,i_{br}) \qquad \text{(A.10.2-11)}$$

$$e(M_2,i_o) = e(m,i_e)e(i_e,i_o) + e(m,i_o) \qquad \text{(A.10.2-12)}$$

$$e(M_2,W/P_w) = e(mi_e)e(i_e,W/P_w) + e(m,W/P_w) \qquad \text{(A.10.2-13)}$$

$$e(M_2,P) = e(m,i_e)e(i_e,P) + e(m,P) \qquad \text{(A.10.2-14)}$$

$$e(M_2,YDIS) = e(m,i_e)e(i_e,YDIS) + e(m,YDIS) \quad \text{(A.10.2-15)}$$

$$e(M_2,F^o) = e(m,i_e)e(i_e,F^o) \quad \text{(A.10.2-16)}$$

Sign Patterns

$$e(m,i_e) = e(m,P_2)e(P_2,i_e) + e(m,P_8)e(P_8,i_e) +$$

$$e(m,b_1)e(b_1,\gamma)e(\gamma,i_e) > 0 \quad \text{(A.10.2-17)}$$

The summary in Appendix A.8.1 provides explicit expressions, sign patterns and inequality conditions for $e(m,P_2)$, $e(m,P_8)$ and $e(m,b_1)$, such that

$$e(m,P_2) > 0 \quad \text{if} \quad P_1 > P_8 \quad \text{and} \quad b_1 < 1$$

$$e(m,P_8) > 0 \quad \text{if} \quad P_1 > P_8$$

$$e(m,b_1) < 0 \quad \text{if} \quad P_1 > P_8$$

From Appendix A.6.4, equation A.6.4-8

$$e(b_1,\gamma) > 0 \quad \text{if} \quad r^{d'} > r^{t'} .$$

From the a priori sign patterns attached to behaviour equations 2-25 and 2-26 in Chapter 2, section 4.4 and equation 3-10b in Chapter 3, section 2.2,

$e(P_2,i_e) > 0$ (see especially equation 2-29 in Chapter 2 section 4.5)

$$e(P_8,i_e) > 0$$

$$e(\gamma,i_e) < 0$$

Hence $\qquad e(m,i_e) > 0 \qquad$ (A.10.2-18)

if $P_1 > P_8$, $b_1 < 1$ and $r^{d'} > r^{t'}$.

The elasticities of the credit market rate with respect to the exogenous variables are derived in Appendix A.9.2 together with sign patterns which depend on the empirical inequalities that $P_1 > P_8$, $r^{d'} > r^{t'}$. In addition $e(i_e,YDIS) > 0$ requires that

$$|e(a,P_1)e(P_1,YDIS)| > |e(a,P_2)e(P_2,YDIS) + e(a,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$$

Signs on $e(i_e,x)$, $x = i_o$, W/P_w, P require that $e(h,x) - e(a,x) > 0$.

From Appendix A.8.1 and A.8.2, the sign patterns and inequalities on the money multiplier elasticities are listed below:

$e(m,r^{d'}) < 0$ if $P_1 > P_8$

$e(m,r^{t'}) < 0$ if $P_1 > P_8$

$e(m,i_{br}) < 0$ if $P_1 > P_8$

$e(m,i_o) > 0$ if $P_1 > P_8$, $b_1 < 1$, $r^{d'} > r^{t'}$

$e(m,W/P_w) > 0$ if $P_1 > P_8$, $b_1 < 1$, $r^{d'} > r^{t'}$

$e(m,P) > 0$ if $P_1 > P_8$, $b_1 < 1$, $r^{d'} > r^{t'}$

$e(m,YDIS) < 0$ if $P_1 > P_8$, $b_1 < 1$, $r^{d'} > r^{t'}$, and if

$$|e(m,P_1)e(P_1,YDIS)| > |e(m,P_2)e(P_2,YIDS) + e(m,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$$

In the following summary, use is made of the above information to attach sign patterns and inequality conditions to the money supply elasticities.

Summary

$e(M_2,B^a) > 0$ (A.10,2-19)

$e(M_2,r^{d'}) < 0$ (A.10.2-20)

$e(M_2,r^{t'}) < 0$ (A.10.2-21)

$e(M_2,i_{br}) < 0$ (A.10.2-22)

$e(M_2,i_o) > 0$ (A.10.2-23)

$$e(M_2, W/P_w) > 0 \qquad (A.10.2\text{-}24)$$

$$e(M_2, P) > 0 \qquad (A.10.2\text{-}25)$$

$$e(M_2, F^o) > 0 \qquad (A.10.2\text{-}26)$$

$$e(M_2, YDIS) > 0 \qquad (A.10.2\text{-}27)$$

The sign patterns on all the above expressions require that $P_1 > P_8$, $r^{d'} > r^{t'}$, $b_1 < 1$. In addition, equations A.10.2-20 to A.10.2-22 and A.10.2-27 require that $|e(m,i_e)e(i_e,x)| < |e(m,x)|$ for $x = r^{d'}$, $r^{t'}$, i_{br}, YDIS, and equations A.10.2-23 to A.10.2-25 require that $e(h,x) - e(a,x) > 0$ for $x = i_o$, W/P, P . Equation A.10.2-27 requires in addition that the following inequalities are satisfied;

$$|e(a,P_1)e(P_1,YDIS)| > |e(a,P_2)e(P_2,YDIS) + e(a,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$$

and

$$|e(m,P_1)e(P_1,YDIS)| > |e(m,P_2)e(P_2,YDIS) + e(m,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$$

The first inequality is required for $e(a,YDIS) < 0$ so that $e(i_e,YDIS) > 0$ and the second is required for $e(m,YDIS) < 0$. If $|e(m,i_e)e(i_e,YDIS)| < |e(m,YDIS)|$, $e(M_2,YDIS) > 0$.

Appendix A.11

Derivation of the Earning Asset Solution Function and the Elasticities with respect to the Exogenous Variables*

NOTE: In this study, we do not explicity analyse comparative static effects on the stock of earning assets. This appendix is included for completeness. Changes in the equilibrium credit market rate implies a change in the equilibrium stock of earning assets.

*In all cases, $e(x,y) = \frac{\partial x}{\partial y} \cdot \frac{y}{x}$ is the elasticity of x with respect to y .

Appendix A.11.1

The Earning Asset Solution Function

The earning asset semi-reduced form is given by equations 2-48 and 2-49 in the text as,

$$EA^b = \frac{(1 + P_1)(1 - b_1)}{P_1 + b_1(1 + P_2) - P_8} B^a \qquad \text{(A.11.1-1)}$$

where

$$a = \frac{(1 + P_1)(1 + b_1)}{P_1 + b_1(1 + P_2) - P_8}$$

[See Appendix A.5 for the derivation of (a)]. Writing A.11.1-1 in logarithmic form,

$$\log EA^b = \log a + \log B^a \qquad \text{(A.11.1-2)}$$

Since (a) is a function of the variables determing its constituent ratio parameters, A.11.1-2 is written in terms of the credit market rate and exogenous variables.

$$\log EA^b = e(a,i_e)\log i_e + e(a,x)\log x + e(a,r^{d'})\log r^{d'} + e(a,r^{t'})\log r^{t'} + e(a,i_{br})\log i_{br} + e(a,YDIS)\log YDIS + \log B^a \qquad \text{(A.11.1-3)}$$

where $x = i_o, W/P_w, P$.

Substituting for $\log i_e$ from the credit market rate solution function (Appendix 9.1-4) and solving for the equilibrium stock of earning assets (E), yields:

$$\log E = \frac{e(a,i_e)}{e(a,i_e) - e(h,i_e)} \{- \log B^a + [e(h,x) - e(a,x)]\log x + e(h,F^o)\log F^o - e(a,YDIS)\log YDIS - e(a,r^{d'})\log r^{d'} - e(a,r^{t'})\log r^{t'} - e(a,i_{br})\log i_{br}\} + e(a,x)\log x + e(a,r^{d'})\log r^{d'} + e(a,r^{t'})\log r^{t'} + e(a,i_{br})\log i_{br} + e(a,YDIS)\log YDIS + \log B^a \qquad \text{(A.11.1-4)}$$

where the credit market equilibrium condition is

$$E = EA^{b} = EA^{P} \qquad \text{(A.11.1-5)}$$

Defining $N = \dfrac{e(a,i_e)}{e(a,i_e) - e(h,i_e)}$ and collecting terms,

$$\begin{aligned}\log E = {} & (1 - N)\log B^{a} + \{N[e(h,x) - e(a,x)] + e(a,x)\}\log x + \\ & Ne(h,F^{o})\log F^{o} + [- Ne(a,YDIS) + e(a,YDIS)]\log YDIS + \\ & [- Ne(a,r^{d'}) + e(a,r^{d'})]\log r^{d'} + [- Ne(a,r^{t'}) + e(a,r^{t'})]\log r^{t'} \\ & + [- Ne(a,I_{br}) + e(a,i_{br})]\log i_{br}\end{aligned} \qquad \text{(a.11.1-6)}$$

Appendix A.11.2

The Elasticities of the Stock of Earning Assets with respect to the Exogenous Variables

Differentiating the solution function for the stock of earning assets (equation A.11.1-6) yields the elasticities listed below;

$$e(E,B^{a}) = 1 - N \qquad \text{(A.11.2-1)}$$

$$e(E,r^{d'}) = - Ne(a,r^{d'}) + e(a,r^{d'}) \qquad \text{(A.11.2-2)}$$

$$e(E,r^{t'}) = - Ne(a,r^{t'}) + e(a,r^{t'}) \qquad \text{(A.11.2-3)}$$

$$e(E,i_{br}) = - Ne(a,i_{br}) + e(a,i_{br}) \qquad \text{(A.11.2-4)}$$

$$e(E,x) = N[e(h,x) - e(a,x)] + e(a,x) \qquad \text{(A.11.2-5)}$$

$$x = i_o,\ W/P_w,\ P$$

$$e(E,YDIS) = - Ne(a,YDIS) + e(a,YDIS) \qquad \text{(A.11.2-6)}$$

$$e(E,F^{o}) = Ne(h,F^{o}) \qquad \text{(A.11.2-7)}$$

where $N = \dfrac{e(a,i_e)}{e(a,i_e) - e(h,i_e)}$.

Substituting for N in equations A.11.2-1 to A.11.2-8 and substituting expressions A.9.2-1 to A.9.2-7 (Appendix A.9.2) into these same equations yields earning asset elasticities in terms of the credit market multiplier (a) and the credit market rate elasticities, with respect to the exogenous variables.

$$e(E,B^a) = 1 + e(a,i_e)e(i_e,B^a) \tag{A.11.2-8}$$

$$e(E,r^{d'}) = e(a,i_e)e(i_e,r^{d'}) + e(a,r^{d'}) \tag{A.11.2-9}$$

$$e(E,r^{t'}) = e(a,i_e)e(i_e,r^{t'}) + e(a,r^{t'}) \tag{A.11.2-10}$$

$$e(E,i_{br}) = e(a,i_e)e(i_e,i_{br}) + e(a,i_{br}) \tag{A.11.2-11}$$

$$e(E,x) = e(a,i_e)e(i_e,x) + e(a,x) \tag{A.11.2-12}$$

$$x = i_o,\ W/P_w,\ P$$

$$e(E,YDIS) = e(a,i_e)e(i_e,YDIS) + e(a,YDIS) \tag{A.11.2-13}$$

$$e(E,F^o) = e(a,i_e)e(i_e,F^o) \tag{A.11.2-14}$$

Sign Patterns

From Appendix A.9.2 equation A.9.2-16 $e(a,i_e) > 0$ if $P_1 > P_8$ and $r^{d'} > r^{t'}$. From the summaries to Appendices A.10.2 and A.7.1, the signs and inequality conditions for the credit market rate (i_e) and credit market multiplier (a) elasticities are obtained, respectively. Using the information above, equations A.11.2-8 to A.11.2-14 take the signs listed in the summary below, subject to the stated inequalities.

Summary

$$e(E,B^a) > 0$$

$$e(E,r^{d'}) < 0$$

$$e(E,r^{t'}) < 0$$

$$e(E,i_{br}) < 0$$

$$e(E,i_o) > 0$$

$$e(E, W/P_w) > 0$$

$$e(E, P) > 0$$

$$e(E, YDIS) < 0$$

$$e(E, F^o) > 0$$

The signs on all the above expressions require that $P_1 > P_8$, $r^{d'} > r^{t'}$. In addition equations A.11.2-9 to A.11.2-11 and A.11.2-13, require that $|e(a,i_e)e(i_e,x)| < |e(a,x)|$ for $x = r^{d'}, r^{t'}, i_{br}$, YDIS, and equation A.11.2-12 requires that $e(h,x) - e(a,x) > 0$ for $x = i_o$, W/P, P . Equation A.11.2-13 also requires that $|e(a,P_1)e(P_1,YDIS)| > |e(a,P_2)e(P_2,YDIS) + e(a,b_1)e(b_1,\gamma)e(\gamma,YDIS)|$ so that $e(a,YDIS) < 0$ and hence, $e(i_e,YDIS) > 0$.

Appendix A.12

Derivation of a Constraint for the Interest Rate Mechanism

The interest rate effect on the money supply elasticities is represented by variable K, defined as

$$K = \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)} \qquad (A.12\text{-}1)$$

(See Chapter 3, section 4, equation 3-23 and Appendix A.10.2).

To prove that $0 < K < 1$.

$$e(m,i_e) = e(m,P_2)e(P_2,i_e) + e(m,P_8)e(P_8,i_e) + e(m,b_1)e(b_1,\gamma)e(\gamma,i_e) > 0 \qquad (A.12\text{-}2)$$

$$e(a,i_e) = e(a,P_2)e(P_2,i_e) + e(a,P_8)e(P_8,i_e) + e(a,b_1)e(b_1,\gamma)e(\gamma,i_e) > 0 \qquad (A.12\text{-}3)$$

Since all terms in equations A.12-2 and A.12-3 are identical except for the first component of the first multiplicative term, and since

$$e(m,i_e) > 0 \quad \text{(Appendix A.10.2)}$$

$$e(a,i_e) > 0 \quad \text{(Appendix A.9.2)}$$

therefore

$$e(m,i_e) < e(a,i_e) \;\text{ if }\; e(m,P_2) < e(a,P_2) \;. \qquad (A.12\text{-}4)$$

From Appendix A.7.1 equation A.7.1-2

$$e(a,P_2) = \frac{(P_1 - P_8)P_2}{\Delta_2(1 + P_2)} > 0 \;\text{ if }\; \Delta_2 > 0 \qquad (A.12\text{-}5)$$

and from Appendix A.8.1 equation A.8.1-2

$$e(m,P_2) = P_2\left(\frac{1}{1 + P_1 + P_2} - \frac{b_1}{\Delta_2}\right) > 0 \;\text{ if }\; \Delta_2 > 0 \qquad (A.12\text{-}6)$$

where $\Delta_2 = P_1 + b_1(1 + P_2) - P_8 > 0$ if $P_1 > P_8$ ..

Rewrite equation A.12-6 as

$$e(m,P_2) = P_2\left[\frac{P_1+b_1(1+P_2)-P_8] - (1+P_1+P_2)b_1}{(1+P_1+P_2)[P_1+b_1(1+P_2)-P_8]}\right]$$

$$= P_2\left[\frac{P_1+b_1(1+P_2)-P_8-(1+P_2)b_1-P_1b_1}{(1+P_1+P_2)[P_1+b_1(1+P_2)-P_8]}\right]$$

$$= \frac{(P_1-P_8)P_2}{(1+P_1+P_2)[P_1+b_1(1+P_2)-P_8]} - \frac{P_1P_2b_1}{(1+P_1+P_2)[P_1+b_1(1+P_2)-P_8]}$$

(A.12-7)

Comparing equations A.12-7 and A.12-5,

$$0 < \left[\frac{(P_1 - P_8)P_2}{(1 + P_1 + P_2)\Delta_2} - \frac{P_1P_2b_1}{(1 + P_1 + P_2)\Delta_2}\right] < \frac{(P_1 - P_8)P_2}{(1 + P_2)\Delta_2} \qquad \text{(A.12-8)}$$

from which it follows that

$$0 < e(m,P_2) < e(a,P_2)$$

and hence,

$$0 < e(m,i_e) < e(a,i_e) .$$

Since, $e(h,i_e) < 0$ a priori (Chapter 2 equation 2-31),

$$0 < e(m,i_e) < [e(a,i_e) - e(h,i_e)]$$

if the empirical conditions that $P_1 > P_8$ and $r^{d'} > r^{t'}$ are satisfied.

Therefore,

$$0 < \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)} < 1$$

and hence,

$$0 < K < 1 .$$

(Q.E.D)

Appendix A.13

Derivation of the Elasticities of the Money Supply and the Adjusted Monetary Base with respect to Changes in the Credit Market Ceiling Rate

Equations A.13-1 and A.13-2 below are, respectively, the semi-reduced form for the money supply and the equilibrium condition for the credit market (Chapter 2 equations 2-51, 2-54 to 2-56).

$$M_2 = m(i_e, \cdots)B^a \qquad \text{(A.13-1)}$$

$$h(i_e \cdots F^o) = a(i_e \cdots)B^a \qquad \text{(A.13-2)}$$

Rewriting equations A.13-1 and A.13-2 in logarithmic form with the appropriate elasticity coefficients,

$$\log M_2 = \log m(i_e \cdots) + \log B^a$$

$$= e(m,i_e)\log i_e + \cdots + \log B^a \qquad \text{(A.13-3)}$$

$$\log h(i_e \cdots F^o) = \log a(i_e \cdots) + \log B^a$$

$$e(h,i_e)\log i_e + \cdots + e(h,F^o)\log F^o = e(a,i_e)\log i_e + \cdots + \log B^a \qquad \text{(A.13-4)}$$

Solving for $\log i_e$ from A.13-4,

$$\log i_e = \frac{1}{e(a,i_e) - e(h,i_e)}\left[-\log B^a + e(h,F^o)\log F^o\right] \qquad \text{(A.13-5)}$$

Substituting A.13-5 into A.13-3

$$\log M_2 = \left[1 - \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)}\right]\log B^a + \frac{e(m,i_e)e(h,F^o)}{e(a,i_e) - e(h,i_e)}\log F^o \qquad \text{(A.13-6)}$$

The Elasticity of B^a with respect to F^o for a given Ceiling Rate (I_e)

Totally differentiate A.13-5 and set $d \log i_e = 0$.

$$\frac{e(h,F^o)}{e(a,i_e) - e(h,i_e)} \frac{d \log F^o}{dt} - \frac{1}{e(a,i_e) - e(h,i_e)} \frac{d \log B^a}{dt} = 0 \qquad \text{(A.13-7)}$$

Therefore,

$$\frac{d \log B^a}{d \log F^o} = e(B^a,F^o) = e(h,F^o) > 0 \qquad \text{A.13-8)}$$

To maintain interest rate ceiling $(\bar{i}_e)$, B^a must vary positively with F^o.

The Response of the Money Supply with respect
to Changes in the Ceiling Rate

By definition,

$$e(M_2,\bar{i}_e) = e(M_2,B^a)e(B^a,\bar{i}_e) \qquad \text{(A.13-9)}$$

and from the credit market rate solution function (equation A.13-5),

$$e(B^a,\bar{i}_e) = - [e(a,\bar{i}_e) - e(h,\bar{i}_e)] < 0 \qquad \text{(A.13-10)}$$

(the negative sign is proved in Appendix A.9.2; see equation A.9.2-17)

Solving for $e(M_2,B^a)$ from equation A.13-6

$$e(M_2,B^a) = 1 - \frac{e(m,i_e)}{e(a,i_e) - e(h,i_e)} \qquad \text{(A.13-11)}$$

Substituting equations A.13-10 and A.13-11 into A.13-9 yields the response of the money supply with respect to changes in the ceiling rate.

$$e(M_2,\bar{i}_e) = e(m,\bar{i}_e) - [e(a,\bar{i}_e) - e(h,\bar{i}_e)] < 0 \qquad \text{(A.13-12)}$$

That $0 < e(m,i_e) < [e(a,i_e) - e(h,i_e)]$ is proved in Appendix A.12. A change in the interest rate ceiling requires a fall in the money supply.

Appendix A.14

The Interest Rate Effects of Open Market Operations, and Government Deficit Finance

The general form for the credit market rate solution function (equation 2-52 of the text) is:

$$i_e = i_e(B^a \cdots F^o) \qquad \text{(A.14-1)}$$

Totally differentiating equation A.14-1,

$$di_e = \frac{\partial i_e}{\partial B^a} dB^a + \frac{\partial i_e}{\partial F^o} dF^o \qquad \text{(A.14-2)}$$

Converting equation A.14-2 to percentage changes,[1]

$$\frac{di_e}{i_e} = e(i_e,B^a) \frac{dB^a}{B^a} + e(i_e,F^o) \frac{dF^o}{F^o} \qquad \text{(A.14-3)}$$

An open market purchase of government securities or a shift in government deficit finance from the banking and private sectors to the Reserve Bank (for a given deficit) is written as,

$$\Delta B^a = - \Delta F^o \qquad \text{(A.14-3a)}$$

Writing A.14-3 in discrete form, and substituting A.14-3a:[2]

$$\frac{\Delta i_e}{i_e} = e(i_e,B^a) \frac{\Delta B^a}{B^a} - e(i_e,F^o) \frac{\Delta B^a}{F^o} \qquad \text{(A.14-4)}$$

$$= \left[e(i_e,B^a) - e(i_e,F^o) \frac{B^a}{F^o} \right] \frac{\Delta B^a}{B^a} \qquad \text{(A.14-5)}$$

[1] With respect to equation A.14-2; multiply both sides by $1/i_e$, multiply the first term on the right-hand side by B^a/B^a and the second term by F^o/F^o, and regroup terms.

[2] Multiplying the right-hand side of A.14-4 by B^a/B^a yields equation A.14-5.

From Appendix A.9.2 equation A.9.2-14:

$$e(i_e,F^o) = - e(i_e,B^a)e(h,F^o) \ . \qquad \text{(A.14-6)}$$

Substituting A.14-6 into A.14-5 yields the interest rate response for policy decisions embodied in the condition $\Delta B^a = - \Delta F^o$.

$$\frac{\Delta i_e}{i_e} = \left[e(i_e,B^a) + e(i_e,B^a)e(h,F^o)\ \frac{B^a}{F^o}\right] \frac{\Delta B^a}{B^a}$$

$$= e(i_e,B^a)\left[1 + e(h,F^o)\ \frac{B^a}{F^o}\right] \frac{\Delta B^a}{B^a} \quad < \quad 0 \qquad \text{(A.14-7)}$$

The interest response of an open market operation or a shift in government deficit finance is negative, where $e(i_e,B^a) < 0$ (Appendix 9.2) and $e(h,F^o) > 0$ a priori.

Appendix A.15

Empirical Estimation of the Banking Sector Reserves Equations

The banking sector's statutory reserves equation (derived in Appendix A.2) is given by:

$$R_s = r^{d'} D + r^{t'} T \qquad (A.15\text{-}1)$$

where:

$$r^{t'} = \frac{r^{s'} S_d + r^{f'} F}{T} \qquad (A.15\text{-}2)$$

$$r^{f'} = \frac{r^{fst'} F_{st} + r^{fm\ell t'} F_{m\ell t}}{F} \qquad (A.15\text{-}3)$$

(see Appendix A.2, equations A.2-1, A.2-4 and A.2-5).

R_s = statutory reserves, S_d = savings deposits, F = fixed deposits, F_{st} = short-term fixed deposits, $F_{m\ell t}$ = medium plus long-term fixed deposits, $r^{d'}$ = statutory reserves on demand deposits, $r^{t'}$ = statutory reserves on time deposits, $r^{f'}$ = statutory reserves on total fixed deposits, $r^{fst'}$ = statutory reserves on short-term fixed deposits, and $r^{fm\ell t'}$ = statutory reserves on medium plus long-term fixed deposits.

Total banking sector deposits in South Africa consist of the following maturity categories: demand deposits (D), saving deposits (S_d), and fixed deposits (F); the latter are divided into short-term (F_{st}), medium-term (F_{mt}) and long-term ($F_{\ell t}$) fixed deposits. Thus, total deposits (D + T), time deposits (T) and fixed deposits (F) are defined as:

$$D + T = D + S_d + F \qquad (A.15\text{-}4)$$

$$T = S_d + F \qquad (A.15\text{-}5)$$

$$F = F_{st} + F_{m\ell t} \qquad (A.15\text{-}6)$$

$$F_{m\ell t} = F_{mt} + F_{\ell t} \qquad (A.15\text{-}7)$$

Demand deposits are distinguished from other deposit categories since they alone are transferable by cheque.

In order to calculate $r^{t'}$ we examine the provisions of South African banking legislation. The promulgation of the Banking Act No. 38 of 1942, established the first comprehensive controls over the banking system, and apart from minor amendments, remained in force until 1965. Under the

Act, the commerical banks were required to maintain reserve balances with the Reserve Bank equal to not less than 10 per cent and 3 per cent of their demand and time liabilities, respectively; demand liabilities being defined as demand plus savings deposits.[1] In 1965, the old legislation was amended by the Banks Act No. 23 of 1965 (promulgated in January 1965, becoming fully effective from January 1966). Under the new Act, the major revision for our purpose is the removal of the cash reserve requirement on savings deposits and the imposition of an 8 per cent requirement on short-term liabilities to the public; defined as demand plus short-term fixed deposits.[2]

The statutory reserve requirements are summarised in Table A.15.I. Inserting this data into equation A.15-2 we calculate $r^{t'}$ for the period 1944-1971 using equations A.15-8 and A.15-9 below, for the periods 1944-1964, 1965-1971, respectively.

$$r^{t'} = 0.07 \frac{S}{T} + 0.03 \qquad \text{(A.15-8)}$$

$$r^{t'} = 0.08 \frac{FST}{T} \qquad \text{(A.15-9)}$$

where: $F/T = 1 - S/T$, and $r^{f'} = r^{fst'} FST/F$ for the period 1965-1971. Hence, statutory reserves may be calculated from equation A.15-1.

Total banking sector reserves (R) are defined as vault cash (R_c) plus banking sector deposits at the Reserve Bank (R_{CB}):

$$R = R_c + R_{CB} \qquad \text{(A.15-10)}$$

Since statutory reserves are required by law to be held as deposits at the Reserve Bank (vault cash is not counted as part of statutory reserves), we define excess reserves for empirical purposes (R_e^{CB}) as:

$$R_e^{CB} = R_{CB} - R_s \qquad \text{(A.15-11)}$$

In the period 1956-1964, the Reserve Bank imposed supplementary reserve requirements on the banking sector and to this extent our estimate of R_s is biased downwards, giving an overestimate of R_e^{CB} for certain years. The bias is not serious, however, since supplementary reserves may be held as a combination of Reserve Bank deposits and specified liquid assets.

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[1] E.H.D. Arndt [5], p. 239.

[2] de Kock [30], p. 295 and n.2.

Annual year-end data for R, R_{CB}, R_c and calculated valves for R_s and R_e^{CB} are given in Table A.15.II.

Dividing equations A.15-10 and A.15-11 by $D + T$, we obtain the aggregate reserve ratio (b_1), the statutory reserve ratio (b_{11}), the excess reserve ratio (e_{CB}), and the vault cash ratio (v). Annual year-end data on banking sector deposits are provided in Table A.15.III and calculated valves for $r^{t'}$ are given in Table A.15.IV.

TABLE A.15.I

STATUTORY RESERVE REQUIREMENTS

	Deposits	$r^{d'}$	$r^{s'}$	$r^{f'}$	$r^{fst'}$
1944-1964	D,S,F	0.1	0.1	0.03	...
1965-1971	D,F_{st}	0.08	...	...	0.08

SOURCE: The Banking Act No. 38 of 1942 and the Banks Act No. 23 of 1965.

TABLE A.15.II

ANNUAL BANKING SECTOR RESERVES:1944-1971
(Millions of Rand)

Year	R	R_{CB}	R_C	R_S	R_e^{CB}
1944	323.5	308.2	15.3	49.1	259.1
1945	386.9	368.6	18.3	58.2	310.4
1946	315.3	269.0	19.3	62.7	233.3
1947	672.4	337.2	19.9	73.0	264.2
1948	214.7	193.4	21.3	71.9	121.5
1949	131.9	107.8	24.1	63.4	44.4
1950	162.6	134.3	28.3	72.4	61.9
1951	117.7	84.4	33.3	73.8	10.6
1952	129.6	94.5	35.1	74.6	19.9
1953	122.3	86.2	36.1	78.5	7.7
1954	131.5	91.0	40.5	82.4	8.6
1955	133.1	88.6	44.5	82.3	6.3
1956	144.2	92.8	51.4	87.7	5.1
1957	143.8	92.7	51.1	89.5	3.2
1958	143.6	93.6	50.0	87.2	6.3
1959	145.5	97.5	48.0	93.6	3.9
1960	153.8	99.6	54.2	94.4	5.2
1961	156.9	101.3	55.6	95.1	6.2
1962	183.9	121.7	62.2	113.6	8.2
1963	198.3	133.6	64.7	126.9	6.7
1964	219.3	152.8	66.5	142.9	9.9
1965	166.5	90.2	76.3	90.5	0.1
1966	192.1	99.4	92.7	94.9	4.5
1967	195.5	101.9	93.6	100.6	1.3
1968	240.9	139.4	101.5	120.9	18.5
1969	251.8	148.6	103.2	133.8	14.9
1970	270.9	170.9	100.0	138.0	32.9
1971	253.4	151.0	102.4	144.9	6.1

SOURCE: South African Reserve Bank Quarterly Bulletin. All data are year-end.

NOTES: R = aggregate reserves, R_{CB} = reserves at the Reserve Bank, R_C = notes, coin, gold coin and bullion, R_S = estimated statutory reserves from equation A.15-1, R_e^{CB} = estimated excess reserves at the Reserve Bank from equation A.15-10

TABLE A.15.III

ANNUAL BANKING SECTOR DEPOSITS:1944-1971
(Millions of Rand)

Year	D	S_d	F_{st}	F	T	DL	D+T
1944	445.6	38.0	...	56.8	94.8	473.6	530.4
1945	528.6	33.0	...	67.4	100.4	561.6	629.0
1946	583.3	32.0	...	65.4	97.4	615.3	680.7
1947	674.9	31.7	...	77.7	109.4	706.6	784.3
1948	672.1	31.6	...	50.9	82.5	703.7	754.6
1949	592.6	30.4	...	35.9	66.3	623.0	658.9
1950	676.0	33.7	...	48.7	82.4	709.7	758.4
1951	684.5	38.3	...	51.9	90.2	722.8	774.7
1952	670.3	49.4	...	87.3	136.7	719.7	807.0
1953	694.3	68.2	...	74.1	142.3	762.5	836.6
1954	706.5	83.1	...	116.0	199.1	789.6	905.6
1955	667.2	97.6	...	193.8	291.4	764.8	958.6
1956	684.0	114.9	...	259.6	374.5	798.9	1058.5
1957	671.6	131.7	...	304.8	436.5	803.3	1108.1
1958	643.2	141.3	...	291.7	433.0	784.5	1076.2
1959	685.3	156.8	...	313.5	470.3	842.1	1155.6
1960	685.0	168.0	...	303.8	471.8	853.0	1156.8
1961	666.5	175.1	...	364.7	539.8	841.6	1206.3
1962	799.6	204.2	...	439.0	643.2	1003.8	1442.8
1963	921.2	229.0	...	396.6	625.6	1150.2	1546.8
1964	1012.4	252.9	...	547.1	800.0	1265.3	1812.4
1965	983.6	287.3	147.0	726.9	1014.2	1130.6	1997.8
1966	1091.6	346.4	94.8	764.2	1110.6	1186.4	2202.2
1967	1139.2	374.9	118.3	846.6	1221.5	1257.5	2360.7
1968	1416.3	414.5	95.1	941.3	1355.8	1511.4	2772.1
1969	1582.4	461.0	88.4	1110.3	1571.3	1670.8	3153.7
1970	1599.9	540.4	125.2	1081.6	1622.0	1725.1	3221.9
1971	1704.3	591.3	107.0	1076.2	1667.5	1811.3	3371.8

SOURCE: South African Reserve Bank Quarterly Bulletin. All data are year-end.

NOTES: D = demand deposits, S_d = savings deposits, F_{st} = fixed short-term deposits, F = total fixed deposits, T = time deposits, DL = demand liabilities, D+T = total deposits. T = D+F. DL = D+S_d(1944-1964); D+F_{st}(1965-1971).

TABLE A.15.IV

ESTIMATED ANNUAL STATUTORY RESERVE REQUIREMENT ON TIME DEPOSITS: 1950-1971

Year	$r^{t'}$	Year	$r^{t'}$
1950	0.0586	1961	0.0527
1951	0.0597	1962	0.0522
1952	0.0553	1963	0.0556
1953	0.0635	1964	0.0521
1954	0.0592	1965	0.0116
1955	0.0534	1966	0.0068
1956	0.0515	1967	0.0077
1957	0.0511	1968	0.0056
1958	0.0528	1969	0.0045
1959	0.0533	1970	0.0062
1960	0.0549	1971	0.0051

NOTES: This table is calculated by inserting annual year-end data into equations A.15-7 and A.15-8.

Appendix A.16

Calculation of the Contributions of the Source Components of the Monetary Base to Percentage Changes in the Base

The source identity of the monetary base (B) for empirical purposes is given by:

$$B = C + IR + GLOAN + AFI + S + AO + O - (RG + RFI + F^{*}) \qquad (A.16\text{-}1)$$

(see Appendix A.1).

Let X_i = the i^{th} source component. Then the contribution of X_i to percentage changes in B is approximated by $\Delta X_i/B$, thus:

$$\frac{\Delta B_t}{B_{t-1}} = \sum \frac{\Delta X_{it}}{B_{t-1}} \qquad (A.16\text{-}2)$$

Table A.16.I is calculated by inserting quarterly data for the terms in equation A.16-1 into equation A.16-2, where Δ = the first difference between corresponding quarters in adjacent years. The notes to Table A.16.I contains definitions of the terms in equation A.16-1 and the equivalent items in the balance sheet of the South African Reserve Bank, used as empirical measures.

The adjusted monetary base (B^a) is defined as:

$$B^a = B - AFI \qquad (A.16\text{-}3)$$

Thus, the contributions of B and AFI to percentage changes in B^a is given by:

$$\frac{\Delta B^a_t}{B^a_{t-1}} = \frac{\Delta B_t}{B^a_{t-1}} - \frac{\Delta AFI_t}{B^a_{t-1}} \qquad (A.16\text{-}4)$$

Table A.16.II is calculated from equation A.16-4 using quarterly data, where Δ is defined as above.

TABLE A.16.1

CONTRIBUTIONS OF BASE SOURCES TO CHANGES IN THE MONETARY BASE: 1954-1971 (%)

Year and Quarter		ΔB/B	ΔIR/B	ΔAFI/B	ΔAO/B	ΔS/B	ΔCLOAN/B	ΔRG/B	ΔRFI/B	ΔO/B	ΔF*/B	ΔC/B	Δ(GLOAN+RG)/B
1954	1	2.74	-13.06	20.52	...	19.84	0.00	- 4.62	-0.14	0.239	-20.31	0.07	- 4.62
	2	3.11	2.00	- 5.18	...	- 6.91	- 1.17	0.48	-0.41	0.207	12.43	- 0.48	- 0.69
	3	3.58	13.72	- 7.43	...	-16.22	- 8.85	0.03	-0.34	0.270	22.64	- 1.82	- 8.82
	4	4.73	18.54	- 4.73	...	-10.37	- 7.45	-12.80	0.06	0.162	20.29	1.23	-20.25
1955	1	4.06	23.37	- 6.99	...	- 6.66	0.00	-17.08	0.00	0.200	9.05	- 0.40	-17.08
	2	4.89	6.10	15.61	...	18.08	0.00	-14.87	0.40	0.201	-21.03	0.20	-14.87
	3	6.85	- 0.39	13.50	...	8.48	- 2.35	- 4.83	-0.20	0.326	-10.63	2.09	- 7.18
	4	3.16	- 2.60	6.56	...	9.90	0.00	4.49	0.00	0.248	-16.03	- 0.25	4.49
1956	1	4.29	-13.31	15.80	...	15.36	0.00	- 0.74	-0.06	0.448	-13.50	0.45	- 0.74
	2	3.64	- 4.47	-10.03	...	- 8.30	0.00	13.67	0.26	0.415	10.66	0.51	13.67
	3	2.20	0.12	- 9.52	...	3.05	5.49	3.24	0.12	0.244	- 1.59	- 0.12	8.73
	4	5.10	1.20	- 0.96	...	- 2.40	0.00	- 1.26	-0.06	0.120	7.50	- 0.06	- 1.26
1957	1	2.70	10.31	-10.37	...	- 8.59	0.00	8.04	0.00	0.184	- 0.31	- 0.31	8.04
	2	4.99	7.39	0.80	...	1.23	2.03	0.96	-0.18	0.123	- 8.19	- 0.49	2.99
	3	4.48	- 4.42	- 0.36	...	13.74	9.44	1.76	0.12	0.090	-15.83	- 0.24	11.20
	4	1.66	-16.55	12.10	...	18.84	0.00	8.25	-0.40	0.143	-17.29	- 0.11	8.25
1958	1	1.97	-28.08	27.84	...	23.30	0.00	1.79	-0.06	0.119	-11.95	0.24	1.79
	2	1.47	-29.05	30.16	...	30.52	- 1.94	- 5.13	0.06	0.117	-14.50	0.00	- 7.07
	3	0.11	-10.52	14.87	...	8.58	- 1.40	- 0.23	0.11	-0.057	- 2.86	- 2.12	- 1.72
	4	0.79	5.73	- 6.96	...	-11.79	0.00	- 1.74	0.34	0.056	- 13.19	0.22	- 1.74
1959	1	1.73	16.70	-26.98	...	-11.13	0.00	3.98	0.12	1.611	10.57	- 0.00	3.98
	2	0.17	24.47	-33.92	...	-27.18	4.45	5.52	0.29	1.619	10.66	- 0.09	9.98
	3	2.66	20.47	-12.54	...	-21.13	-12.68	- 7.08	-0.09	1.713	22.16	2.03	-19.76
	4	2.37	22.12	- 6.69	...	- 3.34	0.00	-14.15	0.08	1.588	3.57	- 0.28	-14.15
1960	1	2.39	16.15	1.76	...	-24.13	0.00	- 9.85	-0.03	0.115	20.56	- 0.17	- 9.85
	2	4.04	- 4.79	16.89	...	- 6.64	- 4.45	-12.53	-0.17	0.144	20.15	0.14	-16.97
	3	4.26	-21.28	15.16	...	- 5.06	0.00	2.03	-0.06	0.187	21.97	0.03	2.03
	4	1.14	-36.11	17.52	...	- 1.71	0.00	8.14	0.16	0.136	25.31	- 3.46	8.14
1961	1	- 9.22	-29.50	6.72	...	9.39	0.00	6.33	0.08	0.394	14.99	- 8.13	6.33
	2	- 4.30	-18.53	3.25	...	14.40	0.00	8.55	-0.28	0.388	0.22	- 7.66	8.55
	3	- 0.72	1.17	- 3.87	...	2.21	2.93	3.12	-0.08	0.293	- 1.07	- 7.58	6.06
	4	4.01	28.38	-10.73	...	0.03	0.00	- 6.08	-0.30	0.289	- 8.93	- 4.39	- 6.08
1962	1	15.33	47.46	-22.06	...	- 7.34	0.00	- 4.06	-0.06	0.124	-16.79	8.24	- 4.06
	2	11.51	73.67	-21.89	...	-26.38	0.00	-12.21	0.03	0.087	-18.21	7.31	-12.21
	3	8.63	64.53	- 6.58	...	-17.47	- 2.96	-20.08	0.05	0.188	-21.45	6.56	-23.03
	4	10.84	39.89	6.85	...	-17.98	0.00	-14.28	-0.08	0.207	-12.39	6.62	-14.28
1963	1	10.77	35.67	6.90	...	-11.68	0.00	-20.84	0.11	0.242	- 0.67	- 0.51	-20.84
	2	9.41	20.54	7.54	...	- 3.17	0.00	-24.18	0.05	0.312	6.60	- 0.26	-24.18
	3	10.00	20.26	4.26	...	0.37	0.00	-25.61	-0.07	0.346	8.78	0.07	-25.61
	4	9.29	19.58	- 6.91	...	0.58	0.00	-13.07	0.12	0.420	6.18	- 1.03	-13.07

TABLE A.16.I - <u>Continued</u>

Year and Quarter		ΔB/B	ΔIR/B	ΔAFI/B	ΔAO/B	ΔS/B	ΔGLOAN/B	ΔRG/B	ΔRFI/B	ΔO/B	ΔF*/B	ΔC/B	Δ(GLOAN+RG)/B
1964	1	13.07	8.05	0.73	0.46	0.46	2.74	5.14	-1.84	0.339	- 2.57	- 0.73	7.88
	2	11.83	2.90	2.64	0.45	6.08	2.92	1.40	0.07	0.356	- 6.32	- 0.36	4.33
	3	10.14	- 6.79	4.18	0.43	5.94	3.15	9.78	-0.07	0.247	- 8.43	- 0.07	12.93
	4	11.77	- 9.37	5.45	0.41	9.29	3.40	16.29	-1.32	0.256	-10.06	0.79	19.69
1965	1	0.75	-17.03	10.29	0.00	9.09	8.36	- 7.74	-0.94	0.343	- 0.90	0.36	0.62
	2	- 3.31	-36.36	14.87	0.47	11.90	1.38	11.26	-3.40	0.850	0.42	- 0.08	12.64
	3	- 3.14	-34.51	1.86	0.45	10.84	5.00	22.48	-2.72	1.654	0.51	- 0.08	27.49
	4	- 4.99	-16.72	- 1.55	0.00	5.31	4.43	4.62	-1.99	3.477	2.81	- 1.15	9.06
1966	1	7.02	5.41	- 9.86	0.00	7.26	- 4.34	6.39	-1.75	3.959	7.66	- 0.62	2.04
	2	11.54	39.21	-13.49	-0.42	- 3.52	2.95	-15.96	-0.79	3.516	8.33	- 0.13	-13.01
	3	11.95	46.93	9.76	0.53	- 5.04	- 0.19	-46.19	-1.56	2.635	7.80	- 0.06	-46.38
	4	11.24	27.75	9.99	0.95	- 1.11	- 0.86	-23.06	-1.49	0.442	0.32	1.17	-23.93
1967	1	7.10	3.66	9.67	0.93	- 4.00	- 2.49	0.64	-1.07	0.298	0.26	- 1.59	- 1.85
	2	5.83	-18.76	5.04	0.83	4.20	- 4.75	13.66	-0.69	0.690	2.66	0.26	8.91
	3	6.87	-23.16	18.79	1.85	7.06	- 5.73	9.55	-0.73	0.640	- 4.05	- 0.36	3.82
	4	5.44	- 6.49	- 1.07	-0.04	3.58	- 3.27	8.15	-0.33	0.669	1.59	- 0.54	4.88
1968	1	4.07	27.26	-15.65	-0.04	4.68	- 3.23	- 7.76	-0.84	0.706	29.72	- 7.00	-10.99
	2	6.18	66.64	- 7.17	0.00	1.28	- 1.51	-49.95	-2.74	0.317	19.68	- 7.91	-51.46
	3	5.66	84.97	-15.12	-1.76	- 3.22	- 1.20	-53.09	-1.18	0.335	26.94	- 7.79	-54.29
	4	11.71	85.65	- 0.14	0.02	- 1.78	0.26	-63.19	-3.07	0.377	7.20	- 5.98	-62.94
1969	1	18.59	91.61	15.81	0.02	- 3.07	0.00	-78.21	-4.64	0.375	-15.47	2.96	-78.21
	2	18.38	58.62	14.36	0.19	- 5.14	0.30	-42.61	-2.17	0.403	- 2.67	- 7.03	-42.31
	3	12.61	2.27	- 4.70	0.18	8.39	0.10	- 9.16	-1.55	0.417	1.47	2.65	- 9.06
	4	9.61	-15.95	- 4.27	0.17	0.69	0.32	11.72	0.34	0.552	8.73	5.16	12.05
1970	1	9.90	-40.93	12.85	-0.36	4.26	0.54	27.76	2.45	0.557	2.26	4.00	28.30
	2	7.24	-29.82	2.33	-0.56	6.41	1.97	38.35	1.41	0.578	-11.15	0.62	40.32
	3	10.35	-16.10	35.55	-0.52	- 2.70	2.78	21.13	-2.12	0.622	- 1.07	- 9.89	23.92
	4	10.36	-27.99	28.26	-0.50	5.08	4.80	28.65	0.99	0.518	- 9.68	-12.46	33.45
1971	1	6.72	-30.13	4.70	-0.03	2.51	19.96	28.19	-0.10	0.493	0.68	-12.51	48.15
	2	6.01	-45.86	9.14	0.03	4.74	15.86	19.45	0.76	0.483	5.61	- 2.71	35.30
	3	9.22	-44.29	- 1.17	0.00	5.14	16.91	24.80	2.55	0.456	-15.04	- 0.01	41.71
	4	5.30	-27.57	7.68	0.00	4.38	11.52	9.15	0.25	0.584	13.03	9.62	20.67

SOURCE: South African Reserve Bank Quarterly Bulletin: balance sheet items of the South African Reserve Bank. *** NOTES: Definitions of variables: IR = international reserves; AFI = loans to the banking and private sectors; AO = other loans (1964-1971 only); S = government securities; GLOAN = loans to the Government; RG = total Government deposits; RFI = non bank financial intermediary deposits; O = other assets; F* = other deposits; C = total minted coin plus gold coin and bullion in the banking sector; B = the monetary base.

Balance sheet items of the South African Reserve Bank corresponding to the above variables are as follows: IR = Gold Coin, Bullion and Foreign Assets (bills, investments and other); AFI = Domestic Bills Discounted (commercial and Treasury) for 1950-1955, and Bills from and Advances to Monetary Banking Institutions for 1956-1971; AO = Other Discounts, Advances and Investments (1961-1971), (1956-1960 = estimated); S = Government Securities; GLOAN = Bills fom and Advances to the Government; RG = Deposits of the Central and Provincial Governments (the Exchequer and Pay-Master General account and Other Government accounts); RFI = non bank financial intermediary deposits; O = other assets (estimated for 1950- 1964); F* = Other Deposits; C = Total Minted Coin plus Gold Coin and Bullion with the Commercial Banks; B = Notes and Coin with the Non Banking Public, Notes, Coin and Gold Coin and Bullion with the Commercial Banks, plus Bankers Balances.

Since RG (say) is a negative source component, - RG/B appears in the table as positive, and similarly for other negative components. The table is calculated for quarterly changes at an annual rate , where

Δ = the first difference between corresponding quarters in adjacent years.

TABLE A.16.11

CONTRIBUTIONS OF THE MONETARY BASE AND RESERVE BANK LENDING TO CHANGES IN THE ADJUSTED MONETARY BASE: 1954-1971 (%)

Year and Quarter		$\Delta B^a/B^a$	=	$\Delta B/B^a$	-	$\Delta AFI/B^a$
1954	1	-18.03		2.77		20.80
	2	8.80		3.30		- 5.50
	3	11.90		3.87		- 8.03
	4	9.98		4.99		- 4.99
1955	1	14.04		5.16		- 8.88
	2	-10.79		4.92		15.71
	3	- 6.65		6.85		13.50
	4	- 3.42		3.17		6.59
1956	1	-13.35		4.97		18.32
	2	16.18		4.31		-11.87
	3	13.42		2.52		-10.90
	4	6.50		5.47		- 1.03
1957	1	18.24		3.77		-14.47
	2	4.42		5.27		0.85
	3	4.99		4.62		- 0.37
	4	-11.06		1.75		12.81
1958	1	-31.35		2.39		33.74
	2	-30.47		1.56		32.02
	3	-15.14		0.12		15.26
	4	9.38		0.95		- 8.42
1959	1	51.69		3.11		-48.58
	2	52.82		0.27		-52.55
	3	18.40		3.22		-15.18
	4	10.09		2.64		- 7.45
1960	1	0.76		2.89		2.12
	2	-13.05		4.10		17.15
	3	-11.45		4.47		15.92
	4	-16.98		1.18		18.17
1961	1	-19.57		-11.32		8.25
	2	- 9.17		- 5.23		3.94
	3	3.89		- 0.89		- 4.78
	4	18.62		5.06		-13.56
1962	1	51.78		21.24		-30.54
	2	42.76		14.74		-28.03
	3	17.97		10.19		- 7.78
	4	4.41		12.00		7.59
1963	1	4.07		11.33		7.26
	2	1.87		9.41		7.54
	3	6.24		10.87		4.63
	4	19.04		10.92		- 8.12

TABLE A.16.II - Continued

Year and Quarter		$\Delta B^a/B^a$ =	$\Delta B/B^a$ -	$\Delta AFI/B^a$
1964	1	13.82	14.64	0.81
	2	9.88	12.71	2.83
	3	6.71	11.42	4.71
	4	6.82	12.70	5.88
1965	1	-10.62	0.84	11.45
	2	-19.88	- 3.62	16.26
	3	- 5.82	- 3.66	2.16
	4	- 3.88	- 5.63	- 1.75
1966	1	21.17	8.81	-12.36
	2	33.02	15.22	-17.80
	3	2.62	14.29	11.67
	4	1.39	12.55	11.16
1967	1	- 2.84	7.87	10.71
	2	0.87	6.45	5.58
	3	-15.55	8.96	24.51
	4	7.97	6.66	- 1.31
1968	1	24.08	4.97	-19.12
	2	15.49	7.17	- 8.32
	3	34.28	9.33	-24.95
	4	14.17	14.00	- 0.16
1969	1	2.85	19.04	16.19
	2	4.28	19.61	15.32
	3	22.48	16.37	- 6.11
	4	16.24	11.24	- 4.99
1970	1	- 3.48	11.69	15.17
	2	5.96	8.77	2.82
	3	-30.07	12.36	42.43
	4	-19.75	11.43	31.18
1971	1	2.72	9.04	6.31
	2	- 3.84	7.37	11.21
	3	19.57	17.37	- 2.20
	4	- 3.60	8.05	11.65

NOTES: The table is calculated from equation A.16.I, where Δ = the first difference between corresponding quarters in adjacent years.

Appendix A.17

Tables of Frequency Distributions

TABLE A.17.I

FREQUENCY DISTRIBUTIONS OF RELATIVE PERCENTAGE CHANGES IN THE MONEY MULTIPLIER AND THE ADJUSTED MONETARY BASE: 1954-1971

	No. of Changes Per Period		
	12 Months	3 Months	12 Half-Cycles
$\Delta m/m > \Delta B^a/B^a$			
Signs Different (Complete Attenuation)	25	20	6
Signs the Same (Accentuation)	10	5	...
Total	35	25	6
$\Delta m/m < \Delta B^a/B^a$			
Signs Different (Incomplete Attenuation)	29	45	5
Signs the Same (Accentuation)	8	2	1
Total	37	47	6
Total Changes	72	72	12

NOTES : The frequency distributions are derived from Tables 4.XII,4.XIII and 4.XVI in Chapter 4 of the text.

TABLE A.17.II

FREQUENCY DISTRIBUTIONS OF H COEFFICIENTS: 1954-1971

Intervals	No. of H Coefficients: 12 Months	3 Months	12 Half-Cycles
0.0-0.09	...	2	1
0.1-0.19	4	5	1
0.2-0.29	5	9	1
0.3-0.39	5	5	1
0.4-0.49	11	14	2
0.5-0.59	29	14	1
0.6-0.69	8	11	1
0.7-0.79	4	6	...
0.8-0.89	2	5	3
0.9-0.99	4	1	1
Total	72	72	12

NOTES : The frequency distributions are derived from Tables 4.XII, 4.XIII and 4.XVI in Chapter 4 of the text.

Appendix A.18

Estimated Determinants of the Money Multiplier and the Money Supply

The money multiplier is defined in terms of the ratio parameters as:

$$m = \frac{1 + P_1 + P_2}{P_1 + b_1(1 + P_2) - P_1} \qquad \text{(A.18-1)}$$

Let $\alpha = 1 + P_1 + P_2$ and $\beta = P_1 + b_1(1 + P_2) - P_8$. We expand equation 4-16 in the text as follows:

$$\frac{dM_2}{dt} = \left(\frac{1}{\alpha}\frac{\partial\alpha}{\partial P_1} - \frac{1}{\beta}\frac{\partial\beta}{\partial P_1}\right)\frac{dP_1}{dt} + \left(\frac{1}{\alpha}\frac{\partial\alpha}{\partial P_2} - \frac{1}{\beta}\frac{\partial\beta}{\partial P_2}\right)\frac{dP_2}{dt}$$

$$+ \left(\frac{1}{\alpha}\frac{\partial\alpha}{\partial P_8} - \frac{1}{\beta}\frac{\partial\beta}{\partial P_8}\right)\frac{dP_8}{dt} + \left(\frac{1}{\alpha}\frac{\partial\alpha}{\partial b_1} - \frac{1}{\beta}\frac{\partial\beta}{\partial b_1}\right)\frac{db_1}{dt}$$

$$+ \frac{1}{B^a}\frac{dB^a}{dt} \qquad \text{(A.18-2)}$$

Evaluating the partial derivatives and approximating for discrete time, we obtain:

$$\frac{M_{2t+j} - M_{2t}}{M_{2t}} = \left(\frac{1}{\alpha} - \frac{1}{\beta}\right)P_{1t+j} - P_{1t} + \left(\frac{1}{\alpha} - \frac{b_1}{\beta}\right)P_{2t+j} - P_{2t}$$

$$+ \left(\frac{1}{\beta}\right)P_{8t+j} - P_{8t} - \left(\frac{1 + P_1}{\beta}\right)b_{1t+j} - b_{1t}$$

$$+ \frac{B^a_{t+j} - P_{8t}}{B^a_t} \qquad \text{(A.18-3)}$$

We evaluate equation A.18-3 by inserting quarterly data and setting $j = 4$ for $t = 1 \cdots T$. Basic quarterly data is given in Tables A.19.VII, VIII In Table A.18.I we provide the contributions of the ratio parameters to percentage changes in the money multiplier, and the contributions of the money multiplier and the adjusted monetary base to percentage changes in the predicted value of the money supply ($\hat{M}_2$) . Notice $\hat{M}_2$ closely approximates actual percentage changes in M_2.[1]

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[1] Approximating the total differential (equation A.18-2) for discrete time (equation A.18-3) involves an interaction error since the total differential assumes that the partial derivatives are constant with respect to the differentials; whereas, for discrete time, the partial derivatives vary. In general the error is not serious. This method of evaluating the determinants of the money multiplier and the money supply is generally used in money supply analysis (Friedman - Schwartz [43], Appendix B and pp. 794-996 in particular; Ahrensdorf and Kanesathasan [1], p. 134; Kelly [67], p. 42,54 and nn.; Crouch [27], p 148). For our purposes this formulation provides useful data for business cycle analys

TABLE A.18.1

DETERMINANTS OF CHANGES IN THE MONEY MULTIPLIER AND THE MONEY SUPPLY: 1954-1971 (%)

Year and Quarter		$\Delta M_2/M_2$	$\Delta \hat{M}_2/\hat{M}_2$	$\Delta m/m$	Contributions of Ratio Parameters to Changes in m				$\Delta B^a/B^a$
					P_1	P_2	P_g	b_1	
1954	1	2.376	2.478	20.509	- 3.161	0.809	20.958	1.902	-18.930
	2	1.161	0.952	- 7.853	- 4.074	1.024	- 5.484	0.681	8.804
	3	5.783	5.743	- 6.155	- 2.599	1.622	- 8.029	2.851	11.898
	4	7.297	7.272	- 2.708	- 1.241	2.484	- 4.997	1.046	9.979
1955	1	6.639	6.484	- 7.560	- 3.176	2.080	- 8.006	2.442	14.044
	2	6.803	7.090	17.879	- 4.048	4.126	16.128	1.673	-10.789
	3	6.911	7.465	14.118	- 6.910	5.266	14.236	1.526	- 6.654
	4	5.299	5.643	9.061	- 4.508	4.979	7.017	1.573	- 3.418
1956	1	6.362	7.487	20.840	- 9.137	5.345	21.182	3.470	-13.353
	2	7.857	7.143	- 9.032	- 5.284	4.743	-11.617	3.126	16.175
	3	7.816	7.485	- 5.932	- 1.857	4.028	-10.869	2.765	13.417
	4	8.912	8.784	2.285	- 0.493	2.998	- 1.375	0.956	6.499
1957	1	9.486	9.633	- 8.603	1.403	1.937	-15.549	3.606	18.236
	2	9.535	9.199	4.775	0.062	2.389	0.544	1.779	4.424
	3	9.070	8.834	3.843	0.582	2.608	- 0.486	1.139	4.991
	4	7.264	6.710	17.767	- 0.583	2.442	12.458	3.451	-11.057
1958	1	2.732	3.111	34.465	- 1.019	1.625	34.323	- 0.465	-31.354
	2	2.290	2.805	33.272	- 1.315	1.869	32.630	0.097	-30.467
	3	- 1.506	- 0.712	14.429	- 2.586	1.675	16.256	- 0.917	-15.141
	4	- 1.562	- 1.959	-11.334	- 3.011	0.543	- 7.952	- 0.914	9.375
1959	1	1.843	2.162	-49.526	- 2.990	0.115	-48.787	2.136	51.688
	2	4.461	6.052	-46.771	1.926	0.428	-52.635	3.510	52.822
	3	6.709	7.378	-11.018	1.740	0.409	-15.531	2.365	18.396
	4	5.808	6.035	- 4.058	1.350	0.191	- 7.677	2.078	10.093
1960	1	10.123	9.045	8.280	8.059	-0.082	- 0.519	0.823	0.765
	2	6.383	4.764	17.810	3.821	-0.610	15.604	- 1.005	-13.046
	3	4.396	3.915	15.363	- 0.425	0.583	15.281	- 0.076	-11.449
	4	2.468	2.041	19.023	2.643	0.533	17.063	- 1.816	-16.982
1961	1	1.665	1.560	21.125	- 3.036	0.908	8.624	14.630	-19.565
	2	- 2.107	- 1.836	7.335	- 7.239	1.994	6.131	6.459	- 9.171
	3	1.635	1.484	- 2.408	- 1.722	2.158	- 4.127	1.282	3.892
	4	4.434	3.980	-14.640	- 4.804	2.263	-13.221	1 121	18.629
1962	1	4.657	4.062	-47.718	- 5.871	4.378	-30.181	-15.844	51.789
	2	15.207	18.091	-24.671	4.352	2.547	-28.025	- 3.545	42.762
	3	15.638	15.781	- 2.187	2.482	1.877	- 8.894	2.348	17.962
	4	17.492	15.337	10.925	5.559	-0.970	4.568	0.869	4.411

TABLE A.18.I - Continued

Year and Quarter		$\Delta M_2/M_2$	$\Delta\hat{M}_2/\hat{M}_2$	$\Delta m/m$	P_1	P_2	P_s	b_1	$\Delta B^a/B^a$
1963	1	14.751	13.093	9.022	4.220	-0.950	5.314	0.439	4.070
	2	11.122	9.890	8.018	3.002	-1.514	6.536	- 0.005	1.872
	3	7.900	7.505	1.262	3.954	-2.948	2.806	- 2.550	6.243
	4	7.597	9.055	- 0.984	2.091	-2.382	- 9.343	- 0.350	19.040
1964	1	10.388	10.795	- 3.029	3.805	-3.445	- 1.340	- 2.049	13.824
	2	11.314	10.926	1.049	5.258	-3.577	1.020	- 1.653	9.878
	3	11.797	11.249	4.537	1.471	0.087	2.846	0.133	6.712
	4	16.345	15.335	8.513	- 1.254	2.620	4.651	2.495	6.822
1965	1	14.348	13.311	23.029	- 5.550	7.812	12.174	9.493	-10.618
	2	14.281	12.653	32.537	- 6.190	7.740	16.969	14.018	-19.884
	3	11.051	9.484	15.299	- 7.863	6.037	2.838	14.287	- 5.815
	4	7.716	6.457	10.340	- 8.031	5.500	- 1.049	13.911	- 3.883
1966	1	6.323	6.988	-14.181	- 4.766	0.201	-12.959	3.342	21.169
	2	9.647	11.756	-21.268	- 2.075	-0.317	-19.076	0.200	33.024
	3	12.073	11.168	8.547	- 4.544	0.433	8.796	3.862	2.621
	4	10.079	9.208	7.816	0.985	-0.327	8.092	- 1.744	1.392
1967	1	13.200	11.485	14.327	- 0.048	1.037	8.568	4.791	- 2.842
	2	8.851	8.310	7.438	- 3.676	1.558	4.776	4.781	0.872
	3	4.404	4.366	19.911	- 3.924	1.746	24.397	- 2.107	-15.545
	4	7.225	7.198	- 0.772	- 1.914	1.170	- 2.191	2.153	7.970
1968	1	6.920	7.537	-16.545	- 0.831	1.432	-19.234	2.087	24.982
	2	10.057	10.362	- 5.131	1.152	2.996	- 8.707	- 0.571	15.493
	3	15.385	18.399	-15.884	14.407	-0.333	-31.315	1.357	34.293
	4	15.801	15.372	1.204	9.690	-2.541	- 3.967	- 1.978	14.160
1969	1	16.271	13.154	10.303	9.082	-2.984	12.498	- 8.283	2.851
	2	14.231	10.980	6.695	11.725	-5.723	10.347	- 9.653	4.284
	3	10.044	11.815	-10.662	7.337	-3.885	-10.320	- 3.985	22.477
	4	13.614	13.825	- 2.411	- 0.460	0.800	- 6.256	3.514	16.236
1970	1	13.407	11.566	15.040	- 1.042	0.570	11.652	3.860	- 3.483
	2	10.795	10.239	4.283	- 6.448	2.773	2.008	5.950	5.956
	3	12.452	11.247	41.321	- 6.821	4.594	41.040	2.508	-30.074
	4	3.404	3.173	22.919	- 6.247	0.505	30.726	- 2.065	-19.747
1971	1	4.425	4.372	1.648	- 4.912	0.413	5.280	0.867	2.725
	2	7.369	6.574	10.418	- 2.027	-0.647	8.625	4.467	- 3.844
	3	5.063	6.175	-13.395	- 7.791	-0.933	- 8.090	3.419	19.570
	4	5.595	5.129	8.729	- 3.975	-0.598	7.764	5.538	- 3.600

NOTES: The table is calculated from quarterly data using equation A.18-15, where changes are the first differences between corresponding quarters in adjacent years. M_2 = actual percentage changes in the money supply; $\hat{M}_2$ = predicted changes in the money supply, equal to the sum of the percentage changes in m and B^a; and percentage changes in m are given by the sum of the contributions of the ratio parameters to changes in m.

Appendix A.19

Data Appendix and Glossary

This appendix contains the major time series used in the study. All the data are taken from the South African Reserve Bank Quarterly Bulletin. Annual data are year-end, as published, and quarterly data are obtained, in most cases, by using monthly figures for March, June, September and December, as published.

Glossary of Variables

AFI = Reserve Bank lending to the banking and private sectors

B = monetary base

B^a = adjusted monetary base

b_1 = ratio of commercial bank reserves to total deposits

C_p = notes and coin with the private sector

D = commercial bank demand deposits

DL/DT = ratio of demand liabilities to total deposits at the commercial banks

F^O = outstanding government debt (excluding the Reserve Bank's portfolio)

F_2^O = long-term government debt (excluding the Reserve Bank's portfolio)

F^N = government debt excluding the Reserve Bank the the Public Debt Commissioners

F_2^N = long-term government debt, excluding the Reserve Bank and the Public Debt Commissioners

F^{DC} = government debt with the Public Debt Commissioners

F_2^{DC} = long-term government debt with the Public Debt Commissioners

GLOAN = Reserve Bank loans to the Government

i_{LT} = long-term rate on government debt

i_{OD} = commercial bank minimum overdraft rate

i_{12CB} = 12-month fixed deposit rate at commercial banks

i_o = dividend yield on industrial shares

i_{br} = South African Reserve Bank discount rate

i_{cal} = National Finance Corporation call rate

IR = gold and foreign exchange reserves at the Reserve Bank

LA_2 = commercial bank liquid assets: viz. Land Bank bills; Discounts, Promissory Notes and Acceptances; short-term government securities

LA_3 = LA_2 plus Treasury bills

M_2 = money supply

P_y = national income deflator

P_1 = ratio of currency to demand deposits

P_2 = ratio of time to demand deposits

P_8 = Reserve Bank's lending ratio

R_C = vault cash

R_{CB} = commercial bank reserves at the Reserve Bank

RG = Government's account at the Reserve Bank

S = government debt with the Reserve Bank

T = commercial bank time deposits

WN = nominal wealth

W/P_W = real wealth

YDIS = income distribution

Nominal wealth is calculated by summing property income (interest, dividends, rents, profits of non-corporate business) and corporate savings, net of direct and indirect taxes. The national income deflator is obtained from the ratio of gross domestic product at market prices to real gross domestic product (at 1963 prices); so that real wealth is obtained by dividing nominal wealth by the national income deflator. Income distribution is the ratio of the remuneration of employees to net national income at factor cost. Demand liabilities (DL) are defined as demand plus savings deposits (1950 - 1964) and demand plus short-term fixed deposits (1965 - 1971). Reserve Bank lending (AFI) is calculated as Treasury and commercial bills discounted by the Bank, plus loans to financial institutions on pledge of assets. Annual interest rate data is obtained from quarterly averages and yearly averages (the latter are published for select years).

TABLE A.19.I

ANNUAL INTEREST RATE DATA: 1950-1971 (%)

Year	i_{LT}	i_{OD}	i_{12CB}	i_{O}	i_{br}	i_{cal}
1950	3.63	5.00	2.00	...	3.50	0.875
1951	3.60	5.00	2.00	...	3.50	0.875
1952	4.28	5.38	2.75	...	4.00	1.375
1953	4.50	5.50	3.00	...	4.00	1.592
1954	4.46	5.50	3.00	7.31	4.00	1.800
1955	4.33	5.63	3.83	7.10	4.25	2.411
1956	4.73	6.00	4.50	7.26	4.50	3.078
1957	4.75	6.00	4.50	7.40	4.50	3.120
1958	5.13	6.38	4.50	7.36	4.50	3.425
1959	5.25	6.00	4.00	7.13	4.00	3.143
1960	5.29	6.25	4.00	7.63	4.25	3.363
1961	5.76	6.88	5.00	7.51	4.75	4.002
1962	5.44	6.13	4.00	6.16	4.00	2.458
1963	4.75	5.50	4.00	4.88	3.50	1.738
1964	4.80	5.89	4.50	4.61	3.88	2.700
1965	5.68	7.00	5.50	5.70	5.00	3.809
1966	6.25	7.38	5.50	5.06	5.50	4.020
1967	6.50	7.75	7.00	4.51	6.00	4.733
1968	6.50	7.75	6.75	4.21	5.75	4.758
1969	6.50	7.75	6.75	3.42	5.50	4.473
1970	7.25	7.75	7.25	5.02	5.50	4.233
1971	8.31	8.25	7.60	5.99	6.25	5.188

TABLE A.19.II

ANNUAL DATA FOR THE EXOGENOUS VARIABLES: 1950-1971

Year	R Mill.								
	B^{a}	WN	LA_2	LA_3	IR	W/P_w	P_y	YDIS	DL/DT
1950	302.8	741.9	10.4	86.3	332.0	1001.7	0.7407	0.5881	0.9358
1951	273.3	728.3	16.4	65.2	273.8	951.6	0.7653	0.6072	0.9330
1952	298.9	827.0	22.4	119.7	270.0	1036.2	0.7982	0.6453	0.8918
1953	293.5	902.3	28.5	111.3	209.2	1047.7	0.8612	0.5969	0.9114
1954	327.6	950.3	37.8	113.1	295.5	1093.3	0.8692	0.6074	0.8719
1955	314.7	1029.6	37.1	97.9	258.1	1181.8	0.8712	0.6195	0.7978
1956	331.6	1086.8	43.9	129.2	262.0	1217.6	0.8926	0.6170	0.7547
1957	299.5	1178.9	101.3	175.1	204.0	1305.7	0.9029	0.6194	0.7249
1958	334.1	1138.4	83.5	169.6	224.3	1253.9	0.9079	0.6406	0.7290
1959	355.3	1243.0	78.3	168.9	303.8	1336.6	0.9300	0.6318	0.7286
1960	272.1	1243.7	81.0	131.9	171.1	1309.0	0.9501	0.6207	0.7374
1961	354.7	1385.7	94.3	159.6	276.6	1432.9	0.9670	0.6324	0.6977
1962	361.8	1480.2	82.9	125.3	430.8	1515.7	0.9765	0.6249	0.6957
1963	408.9	1508.1	113.5	165.6	514.7	1506.2	1.0012	0.6180	0.7436
1964	463.6	1632.5	136.4	151.3	470.8	1582.0	1.0319	0.6225	0.6981
1965	445.6	1750.9	326.7	409.5	383.3	1721.8	1.0169	0.6358	0.5659
1966	451.7	1923.6	401.1	526.4	521.3	1753.6	1.0969	0.6480	0.5387
1967	487.7	2126.8	457.4	541.3	485.4	1881.7	1.1302	0.6335	0.5327
1968	556.8	2060.0	501.4	582.2	985.0	1765.6	1.1668	0.6578	0.5452
1969	647.2	2278.1	486.4	526.3	881.1	1871.7	1.2171	0.6546	0.5298
1970	519.4	2347.3	523.6	527.6	681.2	1848.5	1.2698	0.6762	0.5354
1971	500.7	2532.6	545.6	545.6	463.9	1878.9	1.3479	0.6981	0.5372

TABLE A.19.III

ANNUAL MONEY SUPPLY DATA: 1950-1971

Year	R Mill.			
	M_2	C_p	T	D
1950	902.7	144.3	82.4	676.0
1951	933.7	159.0	90.2	684.5
1952	976.3	169.3	136.7	670.3
1953	1023.8	187.2	142.3	694.3
1954	1103.2	197.6	199.1	706.5
1955	1162.9	204.3	291.4	667.2
1956	1269.4	210.9	374.5	684.0
1957	1325.9	217.8	436.5	671.6
1958	1297.1	220.9	433.0	643.2
1959	1377.8	222.2	470.3	685.3
1960	1374.8	218.0	471.8	685.0
1961	1436.1	229.8	539.8	666.5
1962	1687.3	244.5	643.2	799.6
1963	1816.9	270.1	625.6	921.2
1964	2116.6	304.2	800.0	1012.4
1965	2328.7	330.9	1014.2	983.6
1966	2563.3	361.1	1110.6	1091.6
1967	2748.5	387.8	1221.5	1139.2
1968	3182.8	410.7	1355.8	1416.3
1969	3616.1	462.4	1571.3	1582.4
1970	3739.2	517.2	1622.0	1599.9
1971	3948.4	576.6	1667.5	1704.3

TABLE A.19.IV

ANNUAL DATA FOR THE RATIO PARAMETERS: 1950-1971

Year	P_1	P_2	P_8	b_1
1950	0.2135	0.1219	0.0061	0.2144
1951	0.2323	0.1318	0.0050	0.1519
1952	0.2526	0.2039	0.0010	0.1606
1953	0.2696	0.2050	0.0230	0.1462
1954	0.2797	0.2818	0.0021	0.1452
1955	0.3062	0.4368	0.0340	0.1388
1956	0.3083	0.5475	0.0344	0.1362
1957	0.3243	0.6499	0.0925	0.1298
1958	0.3434	0.6732	0.0473	0.1334
1959	0.3242	0.6863	0.0181	0.1259
1960	0.3182	0.6858	0.1455	0.1330
1961	0.3448	0.8099	0.0480	0.1301
1962	0.3058	0.8044	0.0833	0.1275
1963	0.2932	0.6791	0.0646	0.1282
1964	0.3005	0.7902	0.0592	0.1210
1965	0.3364	1.0311	0.0527	0.0835
1966	0.3308	1.0174	0.0930	0.0872
1967	0.3404	1.0722	0.0839	0.0828
1968	0.2900	0.9573	0.0669	0.0869
1969	0.2922	0.9930	0.0423	0.0798
1970	0.3233	1.0138	0.1680	0.0841
1971	0.3383	0.9784	0.1932	0.0752

TABLE A.19.V

ANNUAL DATA FOR GOVERNMENT SECURITIES: 1950-1971

Year	R Mill.					
	F^O	F_2^O	F^N	F_2^N	F^{DC}	F_2^{DC}
1950	1304.9	962.6	1292.7	962.6	12.2	...
1951	1287.5	1008.4	1271.3	1008.4	16.2	...
1952	1349.1	1020.2	1341.1	1020.2	8.0	...
1953	1381.4	1068.3	1381.3	1068.3	0.1	...
1954	1414.8	1108.7	668.5	387.9	746.3	720.8
1955	1425.9	1154.2	596.4	374.8	829.5	779.4
1956	1515.1	1175.2	662.6	364.6	852.5	810.6
1957	1532.1	1263.2	629.5	398.2	902.6	865.0
1958	1611.7	1222.6	684.0	363.0	927.7	859.6
1959	1757.0	1364.9	761.5	427.0	995.5	937.9
1960	1708.6	1395.8	638.8	382.7	1069.8	1013.1
1961	1806.9	1440.0	698.6	367.5	1108.3	1072.5
1962	2116.8	1667.5	852.4	474.9	1264.4	1192.6
1963	2284.3	1675.7	870.0	398.6	1414.3	1277.1
1964	2419.3	1753.8	797.9	327.8	1621.4	1426.0
1965	2681.8	1909.1	901.5	287.4	1780.3	1621.7
1966	3157.0	2136.8	1272.5	381.2	1884.5	1755.6
1967	3397.0	2355.4	1287.0	386.9	2110.0	1968.5
1968	3909.9	2782.9	1582.3	559.1	2327.6	2223.8
1969	4201.5	3207.7	1648.0	660.4	2553.5	2547.3
1970	4294.0	3352.8	1551.6	630.5	2742.4	2722.3
1971	4612.0	3568.1	1737.5	723.1	2874.5	2845.0

TABLE A.19.VI

QUARTERLY INTEREST RATE DATA: 1953-1971 (%)

Year and Quarter	i_{LT}	i_{OD}	i_{br}	i_{cal}
1953 1	4.50	5.50	4.00	1.37
2	4.50	5.50	4.00	1.75
3	4.50	5.50	4.00	1.75
4	4.50	5.50	4.00	1.75
1954 1	4.50	5.50	4.00	1.75
2	4.50	5.50	4.00	1.75
3	4.50	5.50	4.00	1.87
4	4.25	5.50	4.00	1.87
1955 1	4.25	5.50	4.00	2.37
2	4.25	5.50	4.00	2.37
3	4.27	5.50	4.00	2.37
4	4.62	6.00	4.50	2.87
1956 1	4.75	6.00	4.50	3.12
2	4.75	6.00	4.50	3.12
3	4.75	6.00	4.50	3.12
4	4.75	6.00	4.50	3.12
1957 1	4.75	6.00	4.50	3.12
2	4.75	6.00	4.50	3.12
3	4.75	6.00	4.50	3.12
4	4.75	6.00	4.50	3.12
1958 1	5.00	6.00	4.50	3.37
2	5.25	6.50	4.50	3.50
3	5.25	6.50	4.50	3.50
4	5.75	6.50	4.50	3.50
1959 1	5.25	6.00	4.00	3.37
2	5.25	6.00	4.00	2.25
3	5.25	6.00	4.00	3.17
4	5.25	6.00	4.00	3.07
1960 1	5.25	6.00	4.00	3.22
2	5.25	6.00	4.00	3.35
3	5.38	6.50	4.50	3.30
4	5.38	6.50	4.50	3.65
1961 1	5.63	6.50	4.50	3.95
2	5.88	7.00	5.00	4.45
3	5.88	7.00	5.00	3.95
4	5.88	7.00	4.50	3.80

TABLE A.19.VI - Continued

1962	1	5.88	6.50	4.50	3.45
	2	5.68	6.50	4.00	2.40
	3	5.00	6.00	4.00	1.95
	4	4.75	5.50	3.50	1.60
1963	1	4.75	5.50	3.50	1.80
	2	4.75	5.50	3.50	1.90
	3	4.75	5.50	3.50	1.60
	4	4.75	5.50	3.50	1.70
1964	1	4.75	5.50	3.50	2.40
	2	4.75	5.50	3.50	2.60
	3	4.75	6.00	4.00	2.90
	4	4.94	6.50	4.50	3.35
1965	1	5.22	7.00	5.00	3.85
	2	5.50	7.00	5.00	3.75
	3	6.00	7.00	5.00	4.00
	4	6.00	7.00	5.00	4.00
1966	1	6.00	7.00	5.00	4.10
	2	6.00	7.00	5.00	3.60
	3	6.50	8.00	6.00	4.10
	4	6.50	7.50	6.00	4.41
1967	1	6.50	7.50	6.00	4.85
	2	6.50	7.50	6.00	4.79
	3	6.50	8.00	6.00	4.67
	4	6.50	8.00	6.00	4.86
1968	1	6.50	8.00	6.00	4.93
	2	6.50	8.00	6.00	4.83
	3	6.50	7.50	5.50	4.56
	4	6.50	7.50	5.50	4.61
1969	1	6.50	7.50	5.50	4.53
	2	6.50	7.50	5.50	4.53
	3	6.50	7.50	5.50	4.49
	4	6.50	7.50	5.50	4.19
1970	1	6.50	7.50	5.50	4.25
	2	7.00	7.50	5.50	4.21
	3	7.75	7.50	5.50	4.20
	4	7.75	7.50	5.50	4.33
1971	1	7.75	7.50	5.50	4.79
	2	8.50	8.50	6.50	5.35
	3	8.50	8.50	6.50	5.29
	4	8.50	8.50	6.50	5.70

TABLE A.19.VII

QUARTERLY MONEY SUPPLY DATA: 1953-1971

Year and Quarter	R mill.			
	M_2	C_p	T	D
1953 1	938.7	169.7	130.0	639.0
2	964.8	175.6	135.6	653.6
3	968.4	179.4	129.6	659.4
4	999.1	185.5	132.4	681.2
1954 1	961.0	181.6	144.8	634.6
2	976.0	186.4	152.0	637.6
3	1024.4	191.8	164.6	668.0
4	1072.0	193.6	186.6	691.8
1955 1	1024.8	191.8	197.6	635.4
2	1042.4	198.6	222.0	621.8
3	1095.2	210.6	251.0	633.6
4	1128.8	202.0	274.8	652.0
1956 1	1090.0	208.0	295.2	586.8
2	1124.3	209.3	316.2	598.8
3	1180.8	215.8	337.2	627.8
4	1229.4	209.0	352.8	667.6
1957 1	1193.4	213.0	367.2	613.2
2	1231.5	219.3	384.0	628.2
3	1287.9	222.5	410.2	655.2
4	1318.7	215.7	422.6	680.4
1958 1	1226.0	214.4	404.8	606.8
2	1259.7	221.5	419.8	618.4
3	1268.5	222.1	425.8	620.6
4	1298.1	218.9	423.4	655.8
1959 1	1248.6	222.6	415.1	610.9
2	1315.9	223.9	451.8	640.2
3	1353.6	229.2	464.6	659.8
4	1373.5	225.6	453.7	694.2
1960 1	1375.0	217.6	466.8	690.6
2	1399.9	224.9	477.1	697.9
3	1413.1	238.4	494.2	680.5
4	1407.4	218.0	478.8	710.6
1961 1	1397.9	226.0	489.6	682.3
2	1370.4	232.2	495.5	642.7
3	1436.2	236.8	541.8	657.6
4	1469.8	229.8	547.7	692.3

TABLE A.19.VII - Continued

1962	1	1463.0	231.8	578.8	652.4
	2	1578.8	240.9	626.4	711.5
	3	1660.8	254.2	669.5	737.1
	4	1726.9	244.7	653.2	829.0
1963	1	1678.8	251.3	654.4	773.1
	2	1754.4	260.3	673.3	820.8
	3	1792.0	272.3	666.6	853.1
	4	1858.1	270.0	635.8	952.3
1964	1	1853.2	280.5	643.4	929.3
	2	1952.9	284.1	671.3	997.5
	3	2003.4	296.8	750.6	956.0
	4	2161.8	304.1	812.6	1045.1
1965	1	2119.1	301.0	917.4	900.7
	2	2231.8	309.7	951.5	970.6
	3	2224.8	326.7	976.1	922.0
	4	2328.6	330.8	1014.2	983.6
1966	1	2253.1	338.2	970.9	944.0
	2	2447.1	349.7	1030.6	1066.8
	3	2493.4	384.0	1093.9	1015.5
	4	2563.3	361.1	1110.6	1091.6
1967	1	2550.5	376.3	1124.7	1049.5
	2	2663.7	389.8	1151.4	1122.5
	3	2603.2	405.4	1176.5	1021.3
	4	2748.5	387.8	1221.5	1139.2
1968	1	2727.0	396.4	1237.9	1092.7
	2	2931.6	403.6	1346.2	1181.8
	3	3003.7	414.1	1375.4	1214.2
	4	3182.8	410.7	1355.8	1416.3
1969	1	3170.7	417.3	1389.1	1364.3
	2	3348.8	422.4	1399.6	1526.8
	3	3305.4	450.4	1393.0	1462.0
	4	3616.1	462.4	1571.3	1582.4
1970	1	3595.8	474.7	1595.2	1525.9
	2	3710.3	481.8	1648.3	1589.2
	3	3717.0	508.4	1712.9	1495.7
	4	3739.2	517.3	1622.0	1599.9
1971	1	3754.9	519.3	1670.0	1565.6
	2	3983.7	537.1	1735.6	1711.9
	3	3905.2	582.7	1717.1	1605.4
	4	3948.4	576.6	1667.5	1704.3

TABLE A.19.VIII

QUARTERLY DATA FOR THE RATIO PARAMETERS: 1953-1971

Year and Quarter		P_1	P_2	P_g	b_1
1953	1	0.2656	0.2034	0.0063	0.1596
	2	0.2687	0.2075	0.0260	0.1445
	3	0.2721	0.1965	0.0334	0.1478
	4	0.2723	0.1944	0.0235	0.1513
1954	1	0.2862	0.2282	0.1009	0.1524
	2	0.2923	0.2384	0.0031	0.1421
	3	0.2871	0.2464	0.0	0.1379
	4	0.2798	0.2697	0.0020	0.1475
1955	1	0.3019	0.3110	0.0677	0.1450
	2	0.3194	0.3570	0.0782	0.1358
	3	0.3324	0.3961	0.0653	0.1323
	4	0.3098	0.4215	0.0347	0.1418
1956	1	0.3545	0.5031	0.1575	0.1338
	2	0.3495	0.5281	0.0287	0.1260
	3	0.3437	0.5371	0.0162	0.1233
	4	0.3131	0.5285	0.0291	0.1386
1957	1	0.3474	0.5988	0.0956	0.1242
	2	0.3491	0.6113	0.0315	0.1200
	3	0.3396	0.6261	0.0137	0.1195
	4	0.3170	0.6211	0.0908	0.1274
1958	1	0.3533	0.6671	0.2502	0.1255
	2	0.3582	0.6788	0.1983	0.1197
	3	0.3579	0.6861	0.0983	0.1224
	4	0.3338	0.6456	0.0564	0.1298
1959	1	0.3644	0.6795	0.0977	0.1215
	2	0.3497	0.7057	0.0083	0.1122
	3	0.3474	0.7042	0.0259	0.1159
	4	0.3250	0.6536	0.0187	0.1236
1960	1	0.3151	0.6759	0.0953	0.1192
	2	0.3223	0.6836	0.0914	0.1153
	3	0.3503	0.7262	0.1052	0.1161
	4	0.3068	0.6738	0.1089	0.1292
1961	1	0.3312	0.7176	0.1315	0.0826
	2	0.3613	0.7719	0.1175	0.0990
	3	0.3601	0.8239	0.0868	0.1128
	4	0.3319	0.7911	0.0542	0.1265

TABLE A.19.VIII - Continued

1962	1	0.3553	0.8872	0.0284	0.1141
	2	0.3386	0.8804	0.0	0.1074
	3	0.3449	0.9083	0.0442	0.1066
	4	0.2952	0.7879	0.0772	0.1240
1963	1	0.3251	0.8465	0.0572	0.1129
	2	0.3171	0.8203	0.0353	0.1074
	3	0.3192	0.7814	0.0584	0.1134
	4	0.2835	0.6676	0.0361	0.1249
1964	1	0.3018	0.6923	0.0508	0.1181
	2	0.2848	0.6739	0.0402	0.1118
	3	0.3105	0.7851	0.0715	0.1130
	4	0.2910	0.7775	0.0573	0.1180
1965	1	0.3342	1.0185	0.1057	0.0928
	2	0.3191	0.9803	0.1134	0.0756
	3	0.3543	1.0587	0.0841	0.0778
	4	0.3363	1.0311	0.0527	0.0833
1966	1	0.3583	1.0285	0.0518	0.0860
	2	0.3278	0.9661	0.0457	0.0752
	3	0.3781	1.0772	0.1219	0.0697
	4	0.3308	1.0174	0.0930	0.0872
1967	1	0.3586	1.0717	0.0929	0.0746
	2	0.3473	1.0257	0.0662	0.0648
	3	0.3969	1.1520	0.2189	0.0738
	4	0.3404	1.0722	0.0839	0.0828
1968	1	0.3628	1.1329	0.0121	0.0704
	2	0.3415	1.1391	0.0303	0.0659
	3	0.3410	1.1328	0.1135	0.0716
	4	0.2900	0.9573	0.0669	0.0869
1969	1	0.3059	1.0182	0.0746	0.0898
	2	0.2767	0.9167	0.0771	0.0864
	3	0.3081	0.9528	0.0750	0.0787
	4	0.2922	0.9930	0.0423	0.0798
1970	1	0.3111	1.0454	0.1227	0.0819
	2	0.3049	1.0431	0.0844	0.0750
	3	0.3399	1.1452	0.2337	0.0738
	4	0.3233	1.0138	0.1680	0.0841
1971	1	0.3317	1.0667	0.1415	0.0804
	2	0.3139	1.0144	0.1167	0.0668
	3	0.3630	1.0696	0.2123	0.0696
	4	0.3383	0.9784	0.1932	0.0752

TABLE A.19.IX

QUARTERLY DATA ON THE SOURCES OF GOVERNMENT DEFICIT FINANCE: 1953-1971

Year and Quarter	R mill.			
	F^O	S	GLOAN	RG
1953 1	842.40	44.0	0.0	41.0
2	865.90	64.0	3.4	16.6
3	889.60	96.0	33.4	11.9
4	890.60	80.0	23.0	12.5
1954 1	884.60	102.0	0.0	54.5
2	908.30	44.0	0.0	15.2
3	928.20	48.0	7.2	11.8
4	926.80	48.0	0.0	52.0
1955 1	933.60	82.0	0.0	105.8
2	944.60	98.0	0.0	59.6
3	961.10	74.0	0.0	26.6
4	960.20	80.0	0.0	37.5
1956 1	964.80	130.0	0.0	108.1
2	974.40	72.0	0.0	16.8
3	1005.20	84.0	18.0	16.0
4	1007.20	72.0	0.0	41.7
1957 1	1010.10	102.0	0.0	81.9
2	1041.70	76.0	6.6	13.7
3	1080.80	130.0	49.6	19.1
4	1072.10	138.0	0.0	12.8
1958 1	1078.30	180.0	0.0	75.9
2	1118.90	180.0	0.0	31.2
3	1156.40	160.0	44.4	10.9
4	1158.30	96.0	0.0	19.0
1959 1	1149.40	142.0	0.0	62.3
2	1189.60	86.0	15.4	12.1
3	1231.10	86.0	0.0	35.7
4	1229.30	84.0	0.0	69.8
1960 1	1865.30	58.2	0.0	96.5
2	1890.40	63.0	0.0	55.5
3	1935.50	67.8	0.0	28.4
4	1909.40	77.7	0.0	39.9
1961 1	1855.20	91.6	0.0	74.0
2	1758.50	114.9	0.0	24.7
3	1980.40	76.1	11.0	16.7
4	2000.60	77.8	0.0	62.5

TABLE A.19.IX - Continued

1962 1	2068.40	67.9	0.0	87.1
2	2258.80	23.9	0.0	66.8
3	2365.60	11.1	0.0	91.4
4	2383.00	8.3	0.0	117.7
1963 1	2460.70	24.4	0.0	164.7
2	2555.20	11.7	0.0	159.8
3	2612.40	12.6	0.0	194.9
4	2725.10	10.8	0.0	173.7
1964 1	2779.60	26.3	11.3	143.5
2	2928.00	37.3	12.3	153.9
3	2972.00	39.0	14.0	151.4
4	2974.20	54.3	15.9	97.4
1965 1	3128.30	68.7	50.3	179.6
2	3136.90	93.3	18.8	100.9
3	3138.20	92.1	38.5	41.3
4	3289.30	82.1	39.1	73.2
1966 1	3408.00	102.8	29.9	149.6
2	3672.10	77.3	32.2	173.5
3	3853.60	68.2	37.6	260.4
4	3954.10	76.6	34.8	187.9
1967 1	3912.10	82.7	17.4	146.4
2	4019.10	98.6	8.1	104.2
3	4164.70	105.7	7.2	209.7
4	4296.30	96.4	16.7	142.8
1968 1	4420.30	107.9	0.0	188.2
2	4703.90	105.5	0.0	372.5
3	4877.30	87.4	0.4	511.0
4	4897.60	86.0	18.2	511.4
1969 1	5007.20	90.7	0.0	626.5
2	5193.80	76.2	1.7	615.5
3	5153.40	137.7	1.0	565.9
4	5092.80	90.5	20.3	435.0
1970 1	5094.20	119.0	3.6	442.0
2	5138.20	119.5	15.0	356.6
3	5317.10	119.5	19.8	423.2
4	5226.20	126.8	54.6	230.4
1971 1	4974.60	137.3	149.4	236.1
2	5376.50	153.8	129.8	215.8
3	5478.30	157.8	145.8	238.4
4	5645.40	161.3	145.4	158.3

TABLE A.19.X

QUARTERLY DATA ON THE ADJUSTED MONETARY BASE: 1953-1971

Year and Quarter	R mill.				
	R_{CB}	R_c	AFI	B	B^a
1953 1	95.4	27.3	4.0	292.4	288.4
2	86.0	28.0	17.0	289.6	272.6
3	88.2	28.4	22.0	296.0	274.0
4	89.2	33.9	16.0	308.6	292.6
1954 1	87.4	31.4	64.0	300.4	236.4
2	81.0	31.2	2.0	298.6	296.6
3	83.6	31.2	0.0	306.6	306.6
4	91.4	38.2	1.4	323.2	321.8
1955 1	89.2	31.6	43.0	312.6	269.6
2	83.4	31.2	48.6	313.2	264.6
3	91.8	25.2	41.4	327.6	286.2
4	89.6	41.8	22.6	333.4	310.8
1956 1	90.0	28.0	92.4	326.0	233.6
2	85.8	29.5	17.2	324.6	307.4
3	90.0	29.0	10.2	334.8	324.6
4	93.4	48.0	19.4	350.4	331.0
1957 1	90.8	31.0	58.6	334.8	276.2
2	90.6	30.9	19.8	340.8	321.0
3	94.6	32.7	9.0	349.8	340.8
4	92.6	47.9	61.8	356.2	294.4
1958 1	91.2	35.8	151.8	341.4	189.6
2	90.6	33.7	122.6	345.8	223.2
3	93.6	34.5	61.0	350.2	289.2
4	93.6	46.5	37.0	359.0	322.0
1959 1	87.6	37.1	59.7	347.3	287.6
2	87.4	35.1	5.3	346.4	341.1
3	95.7	34.6	17.1	359.5	342.4
4	97.5	44.4	13.0	367.5	354.5
1960 1	96.9	41.1	65.8	355.6	289.8
2	96.3	39.2	63.8	360.4	296.6
3	105.1	31.3	71.6	374.8	303.2
4	99.6	54.1	77.4	371.7	294.3
1961 1	66.2	30.6	89.7	322.8	233.1
2	79.6	33.1	75.5	344.9	269.4
3	96.2	39.1	57.1	372.1	315.0
4	101.3	55.5	37.5	386.6	349.1

TABLE A.19.X - Continued

1962 1	103.3	37.2	18.5	372.3	353.8
2	106.0	37.7	0.0	384.6	384.6
3	111.9	38.1	32.6	404.2	371.6
4	121.7	62.1	64.0	428.5	364.5
1963 1	118.7	42.4	44.2	412.4	368.2
2	120.8	39.7	29.0	420.8	391.8
3	128.5	43.8	49.8	444.6	394.8
4	133.6	64.7	34.4	468.3	433.9
1964 1	137.7	48.1	47.2	466.3	419.1
2	136.2	50.3	40.1	470.6	430.5
3	142.6	50.3	68.4	489.7	421.3
4	152.8	66.5	59.9	523.4	463.5
1965 1	111.1	57.7	95.2	469.8	374.6
2	87.9	57.4	110.1	455.0	344.9
3	92.9	54.7	77.5	474.3	396.8
4	90.2	76.3	51.8	497.3	445.5
1966 1	100.9	63.7	48.9	502.8	453.9
2	94.9	62.9	48.7	507.5	458.8
3	96.8	50.2	123.8	531.0	407.2
4	99.4	92.7	101.5	553.2	451.7
1967 1	102.9	59.3	97.5	538.5	441.0
2	95.9	51.4	74.3	537.1	462.8
3	101.5	60.6	223.6	567.5	343.9
4	101.9	93.6	95.6	583.3	487.7
1968 1	104.5	59.5	13.2	560.4	547.2
2	108.8	57.9	35.8	570.3	534.5
3	115.6	69.9	137.8	599.6	461.8
4	139.4	101.5	94.8	651.6	556.8
1969 1	170.6	76.7	101.8	664.6	562.8
2	178.3	74.4	117.7	675.1	557.4
3	148.3	76.5	109.6	675.2	565.6
4	148.6	103.2	67.0	714.2	647.2
1970 1	172.7	83.0	187.2	730.4	543.2
2	160.4	81.8	133.4	724.0	590.6
3	153.6	83.1	349.6	745.1	395.5
4	170.9	100.0	268.8	788.2	519.4
1971 1	171.5	88.7	221.5	779.5	558.0
2	144.0	86.4	199.6	767.5	567.9
3	150.1	81.0	340.9	813.8	472.9
4	151.0	102.4	329.3	830.0	500.7

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