The framework of the monetary block's equations in the South African Reserve Bank econometric model

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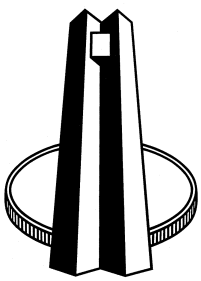

South African Reserve Bank

Contents

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Page

List of graphs

List of tables

Diagram

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1. Introduction

Valuable assistance in the preparation of this paper was provided by the staff of the Econometric Analysis Division and colleagues of the Economics Department, in particular Mr B.L. de Jager, Dr J.P. van den Heever, Mr C.J. Pretorius, Dr M.M. Smal and Mr M. Kleu. However, the views expressed in this document are those of the author and do not necessarily reflect those of the South African Reserve Bank.

The South African Reserve Bank has been set the task of formulating and conducting monetary policy. To this end, it is necessary for the Bank to take cognisance of the dynamic structural inter-relationships of the economy. A systematic quantitative framework of the monetary sector can therefore be of invaluable assistance when the implementation of a certain policy measure is contemplated. The aim of this study is to construct a fairly detailed model of the inter-relationships of the monetary sector, and to incorporate such a substructure into the South African Reserve Bank's quarterly econometric model. The inclusion of a set of monetary equations not only augments the forecasting power of the model, but also provides a reasonable framework in which the impact of alternative monetary policies can be evaluated.

The study firstly outlines the fundamental theory behind the demand for and supply of money. Certain features of the monetary sector's balance sheet and monetary policy in general are then reviewed. This is followed by pertinent aspects with regard to data selection and the technique that has been applied to estimate the behavioural relationships. Then the different estimated equations are discussed in a fair amount of detail, followed by a short summary of the linkages between the monetary model and the main model. Alternative simulations are used to demonstrate the macroeconomic impact of selected monetary policy changes and shocks. Finally, some concluding remarks concerning the relevance of the study are made.

2. The demand for money

Economic theory suggests that the demand for money can be divided into three separate types of demand or "motives". The first involves the individual's requirement for cash balances in order to make day-to-day routine transactions; the second, the individual's need to hold money balances for meeting extraordinary or unforeseen contingencies; and the third, the fact that for various reasons, economic agents wish to hold money balances as an asset in preference to other forms of wealth. These three motives will be discussed in more detail.

2.1 The transactions demand for money

Income and expenditure are seldom perfectly synchronised over time, prompting individuals to hold funds or money balances for the purpose of meeting their transaction needs.

Obviously the size of the transactions demand for money depends on the magnitude of the individual's income, personal expenditure patterns and the frequency at

which the individual wishes to repay outstanding debt. For example, the expenditure patterns of the individual could impact on the transactions demand through a personal preference for making payments on a monthly basis instead of providing for a lump sum payment on completion of a specific task or project.

It can reasonably be assumed that individuals are by nature utility-maximisers and that they will tend to select a suitable amount of cash balances with which they feel comfortable. Traditional theory of demand assumes therefore that the transactions demand is positively related to the level of income and is a decreasing function of the interest rate. This implies that as the rate of interest increases, the incentive to substitute money balances for interest-earning assets will gradually grow stronger. This, of course, assumes that money balances themselves do not bear interest.

2.2 The precautionary demand for money

A suitable example of precautionary demand is seen where prudent individuals tend to hold onto physical money balances as a precautionary store of wealth. Their desire to keep these money balances is closely linked to the degree of risk and rate of return associated with the assets that are currently available for portfolio investment. The primary motivation for maintaining precautionary money balances can therefore be seen as the individual's need to be prepared for bargains or alternatively for sudden unforeseen expenses.

The precautionary demand for money is therefore similar to the transactions demand for money in that it is closely related to the level of income and interest rates. Should interest rates become higher, individuals might feel compelled to sacrifice precautionary balances in return for the added interest earnings on other assets. Consequently the optimal amount of precautionary balances the individual wishes to hold depends on the balancing of interest costs against the advantages of not being caught illiquid.

2.3 The speculative demand for money

Individuals will usually include money balances as one of the assets in their portfolios, indicating the existence of some speculative demand for money.

When the rate of interest is low, prices of interest-bearing assets tend to be high; this inevitably means that a small yield is earned at the expense of a relatively large portfolio outlay. This seems to make investment in fixed interest-bearing assets unattractive and, given this scenario, an increased preference for liquidity can be expected. This implies that speculative demand is intensified in circumstances where individuals prefer to hold onto cash balances rather than alternatively investing in interest-earning assets, which is normally the case when individuals believe the rate of interest will rise in the near future.

Traditionally cash balances did not bear interest, although they did have the added feature of being the most liquid of all assets. In effect, this means that they can quite easily be converted into any other form of asset, which inevitably places the individual in a better position to take advantage of any unexpected arbitrage opportunities that may arise.

The cost of maintaining cash balances could become excessive when interest rates

begin to rise and individuals can be expected to adjust their position by reducing the relative size of their cash balances. This would conversely imply that the individual preference for liquidity will tend to increase with a decline in the interest rate.

2.4 Quantity theory and the demand for money

The fact that money is used for all transactions purposes in the economy allows the quantity of money to be summarised and formulated by means of the following equation: $MV^1=T$

This equation asserts that the value of money changing hands during a given period in time is equal to the value of goods and services exchanged, where T denotes the value of transactions, M the quantity of money utilised for the transactions and V^1 the transactions velocity or turnover of money.

The equation can be reformulated in terms of final output instead of the total value of transactions. When the value of total transactions, T, is considered to be proportional to the value of final nominal output, the equation can be rewritten as follows:

$$T = \propto PQ$$

This equation indicates the value of transactions as proportional to the product of the general price level (P) and the quantity of output (Q). The factor of proportionality is given by $\propto$. After substitution, the above equation yields:

$$MV^1 = \propto PQ$$

By substituting V for $V^1/\propto$, the basic and possibly the most familiar expression in monetary economic theory is derived:

$$MV = PQ$$

This equation is generally known as the quantity equation. It is a definition based on the assumption that all transactions use money as a medium of exchange. The variable V now denotes the income velocity, i.e. the rate of turnover of the money stock in producing the output. Should this velocity term be fixed, it would be possible to infer that the quantity of money, by definition, affects the nominal income level (PQ). Classical quantity theory considers that the level of real output is determined independently of the stock of money and that velocity remains constant over the long term; this necessarily implies that the size of the stock of money ultimately determines the price level.

To change the quantity equation from an accounting identity into an equation describing rational economic behaviour, the equation can be reformulated as follows:

$$M/P = 1/V * Q$$

This price-deflated relationship can be adapted to express the demand for real money balances as a function of income and "the" interest rate:

$$(M/P)^D = L(Y,R)$$

With reference to this demand for money equation, the letter L denotes the functional relationship, R the rate of interest and Y real income.

The demand for money can hence be portrayed in terms of the interest income that has been foregone because of money holdings, i.e. the income from interest forfeited due to the individual's preference for holding cash balances instead of alternatively investing in interest-earning financial assets. As the rate of interest rises, so too will the opportunity costs associated with the holding of money balances. This in effect means that during periods of rising interest rates, the average money balances held by individuals and businesses can be expected to decline. Consequently the demand for cash balances is inversely related to the rate of interest.

The demand for money is therefore defined as a behavioural relationship which gives the demand for real money balances $(M/P)^D$ as an increasing function of output Y and a decreasing function of the interest rate R.

3. The supply of money and the balance sheet of the monetary sector

Attempts by the monetary authorities to contain growth in the money supply are often frustrated by completely rational demand responses to changes in the level and term-structure of interest rates. The offered deposit interest rates on money balances are determined independently by the banks and other financial institutions, in competition with one another for increased market share. As the greater part of money supply consists of interest-bearing deposits, a rise in interest rates will tend to increase the overall holdings of money balances. For a broad definition of money, such as the M3, it is not only the actual level of the interest rate that influences the demand for money, but also the differential between rates available on non-money assets and those paid by banks.

Competition among banks prevents an unlimited rise in the margin between deposit and lending rates. Furthermore, banks' lending rates are usually very similar to those offered outside the banking sector. The absolute differential between deposit and lending rates is consequently unaffected by, or relatively inelastic to, the general level of interest rates. In fact, as the level of interest rates begin to rise, the *absolute* size of the margin between deposit and lending rates remains essentially unchanged and may even decline somewhat. A perverse reaction or increase in the M3 money supply may well be noticed, primarily as a result of a narrowing of the *relative* differential between the bank's deposit and lending rates as domestic interest rates rise. The narrowing of the differential provides an incentive for reintermediation, in which an increase in bank lending relative to credit extended by non-bank sources is recorded.

The South African Reserve Bank's methods of control over the growth in M3 are seen as operating primarily on the demand for credit from the banking sector. Because bank credit extension to the private sector is one of the main sources of money creation, efforts to keep the growth in the money supply in check must therefore also be directed towards controlling the rate of increase in total bank lending. Policy operations therefore also need to focus on the "asset" side of the banks' balance sheet, rather than only on the demand for bank "liabilities", i.e. deposits. Consequently, monetary control requires consideration of both sides of the banks' balance sheet.

Table 1 The consolidated balance sheet of the monetary sector

Liabilities	Assets
Money supply:	Claims on the private sector
- Notes and coin in circulation outside the monetary sector	Claims on the government sector
- Deposits of the domestic private sector	Foreign assets:
	- Gold and foreign exchange
Government deposits	- Other
Foreign liabilities	Other assets
Capital and reserves	
Other liabilities	
Total liabilities	Total assets

The balance sheet shown in Table 1 indicates that the sum of the liabilities is equal to the sum of the assets. Consequently, any liability item identified must be equal to all the asset items less the remaining liability items. This, in essence, means that changes in the total M3 money supply (i.e. notes and coin in circulation plus deposits of the domestic private sector with banks) can also be alternatively derived by means of the following identity:

$$\begin{aligned} \Delta M3 &= \Delta \text{ lending to the domestic private sector} \\ &+ \Delta \text{ lending to the government} - \Delta \text{ government deposits} \\ &+ \Delta \text{ foreign assets} - \Delta \text{ foreign liabilities} \\ &+ \Delta \text{ other assets} - \Delta \text{ capital, reserves and other liabilities} \end{aligned}$$

where : Δ indicates the change in the mentioned variable

Net lending by the banks to the government[1], consisting of the change in the lending to the government less the change in government deposits, can hence be substituted into this identity. Through substitution and by combining the first three terms of the right-hand side, the equation is adjusted to yield the following :

$$\begin{aligned} \Delta M3 &= \Delta \text{ domestic credit extension (private and government sector)} \\ &+ \Delta \text{ net external flows} \\ &+ \Delta \text{ net other assets} \end{aligned}$$

It is within this framework that monetary control can readily be reviewed in South Africa. The South African Reserve Bank influences growth in the money supply in an indirect way, working through domestic credit expansion on the asset or lending side of the banks' balance sheet, and not directly by operating on the demand for money. Moreover, since net lending by the banks to the government relates to fiscal policy and external flows to exchange rate policy, the framework also illustrates the interrelationship of these various arms of economic policy.

1) Net lending by domestic banks to the government is also equal to the government's total borrowing requirement less the sales of public-sector debt to the domestic private non-bank sector and non-residents.

4. Data selection and the estimation technique

Time series data extracted from the *Quarterly Bulletin* of the South African Reserve Bank were used as the basis for the dependent as well as the explanatory variables that appear in the monetary sub-model of the quarterly macroeconometric model. Except for a limited number of non-seasonally adjusted time series, all the functions in the model were specified and estimated using seasonally adjusted time series data as from the first quarter of 1985 up to and including the first quarter of 1996.

Ordinary least squares (OLS) is probably the most commonly used of all the econometric estimation techniques for determining relationships between different economic variables. This technique was also used as the basis for all the parameter estimates and analyses of this study.

The statistical problem pertaining to the estimation of the equations was therefore focused on selecting the values for the independent parameters, i.e. parameter values that suit the data best and which allow a behavioural relationship to be quantified. Economists usually endeavour to specify an equation on the basis of *a priori* economic reasoning and then carefully assess the estimated equation by employing a variety of statistical tests.

The main parameter estimates obtained from the regression analysis were critically evaluated in terms of certain objective statistical criteria, such as

- the R^2 "goodness of fit" multiple coefficient of determination;
- the Durbin-Watson autocorrelation test statistic "D.W.";
- the Student t-value for statistical significance of individual parameters; and
- the first-order serial correlation coefficient "RHO".

5. The estimated equations of the monetary model

The equations of the monetary sub-model can be divided into four subsets of equations and identities. These are the respective monetary aggregates or deposit categories, the accounting counterparts of the M3 money supply other than the net external flows, the net and gross gold and foreign exchange reserves and finally the interest rates. Each component and its respective sub-components will be dealt with in more detail below.

5.1 Monetary aggregates

The South African Reserve Bank compiles the following monetary aggregates:

- M1A: notes and coin in circulation plus the cheque and transmission deposits of the domestic private sector with monetary institutions;

- M1: M1A plus other demand deposits with monetary institutions held by the domestic private sector;

- M2: M1 plus other short-term and medium-term deposits with monetary institutions held by the domestic private sector; and

- M3: M2 plus long-term deposits with monetary institutions held by the domestic private sector.

It is assumed that, apart from the M3 money supply, the main monetary aggregates will be determined as identities, whereas most of their constituent components are determined by means of stochastic behavioural equations. In addition, it has been decided that the "other demand deposits" category (i.e. the difference between the M1A and M1) should be seen as a balancing item, which implies that this component captures all the resulting estimation errors of the monetary sub-structure.

5.1.1 The M1A monetary aggregate

Two stochastic behavioural equations are identified in the monetary sub-model which together constitute the M1A monetary aggregate. These two components, to be discussed in detail in the following two sections, comprise the coin and banknotes in circulation and the cheque and transmission deposits.

- *Coin and banknotes in circulation*

This category consists of coin and banknotes circulating outside the monetary sector[2] (M_{cn}). On average, coin and banknotes in circulation comprise approximately five per cent of the total M3 money supply. To ensure that the estimated equation complies with the standard theoretical properties of a demand function, the nominal amount of coin and banknotes in circulation was deflated by the consumer price index (P_{cpi}). This manipulation ensures that the estimated demand equation satisfies the homogeneity postulate of demand theory.

2) The monetary sector is defined as all institutions within the monetary sector, i.e. the now-extinct National Finance Corporation, Corporation for Public Deposits and the so-called "pooled" funds of the former Public Debt Commissioners, the Land Bank, Post Office Savings Bank, private banking institutions (including the former banks, discount houses and equity building societies) and mutual building societies.

The demand for notes and coin in circulation was found to be fairly insensitive to interest rate movements. The estimated function is accordingly defined to be dependent on a solitary real income explanatory variable.

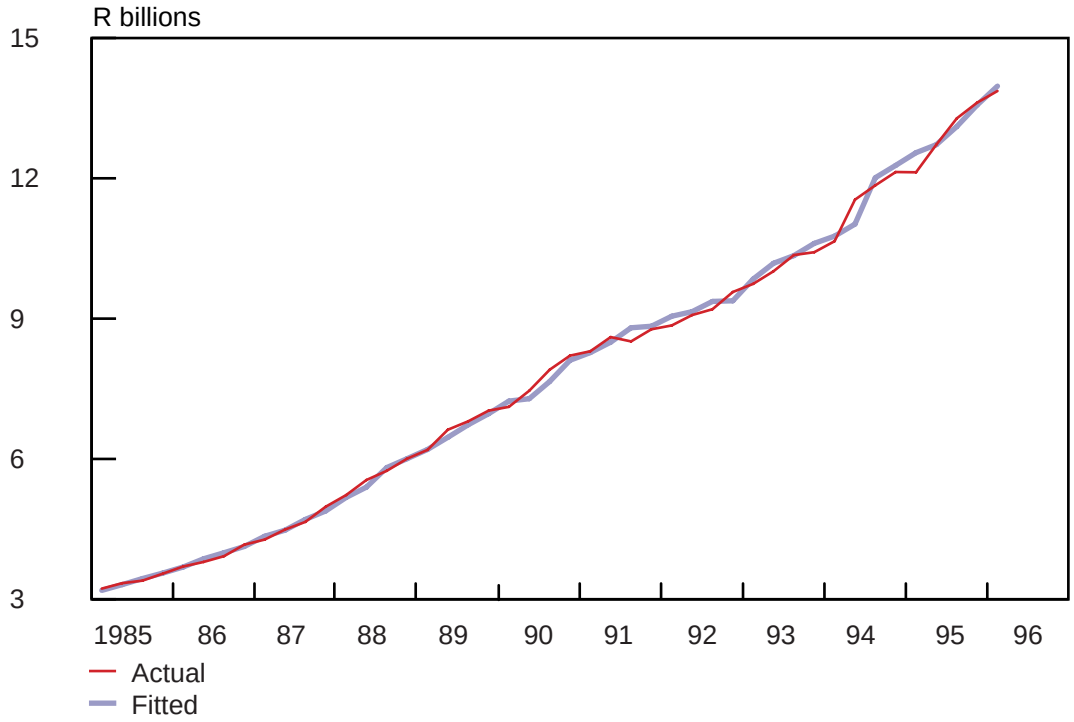
The income variable defined as the best in terms of goodness-of-fit properties for describing the changes in the real value of notes and coin in circulation, is the total real gross domestic product at factor cost (Y_{fk}). The following equation has subsequently been estimated:

$$\ln(M_{cn}/P_{cpi}) = \underset{(1,25)}{-3,04507} + \underset{(4,91)}{1,08344}*\ln(Y_{fk})$$

$\bar{R}^2$ = 0,99
D-W = 1,76
RH0 = 0,74
Estimation period: 1985q1 - 1996q1

A well-known feature of the logarithmic estimate of the demand equation is that the coefficients of the independent variables indicate the elasticity of demand with respect to the relevant variable. This implies that a one per cent increase in real gross domestic product is likely to increase the real value of notes and coin in circulation by 1,08 per cent. The goodness-of-fit of the estimated equation is illustrated in Graph 1.

Graph 1: Notes and coin in circulation



- *Cheque and transmission deposits*

Cheque and transmission deposits (DEP_{ct}) are a subset of demand deposits which, together with the notes and coin in circulation outside the banking sector, constitute the total M1A monetary aggregate. This aggregate, in addition to being highly liquid and convenient, also offers substantial benefits to depositors who feel the need to be able to transfer funds virtually immediately to obtain possible arbitrage gains, e.g. by transfering idle funds into interest-earning assets if interest rates are expected to decline in the near future. This aggregate has increased relative to the total M3 money supply from an average of 11 per cent during the 1980-1985 period to 14,5 per cent during 1991-1996.

The value of cheque and transmission deposits, adjusted by the private consumption expenditure deflator (P_{pc}) to obtain a "real" quantity, was expressed as a function of the real gross domestic expenditure (Y_{exp}), the inflation rate ($\dot{P}$) and a representative interest rate.

The equation describing the demand for cheque and transmission deposits contains a single interest rate variable. Cheque and transmission deposits are by nature very low interest-earning deposits. This necessarily implies that the own interest rate on these deposits plays a fairly inconsequential role in the demand function and has hence been excluded as an explanatory variable. In contrast, a substitute interest rate consisting of a combination of the real long-term ($R_{klr}/\dot{P}$) and real medium-term ($R_{kmr}/\dot{P}$) interest rates has been used to capture investors' preference for interest-bearing assets. This long-term interest rate is the rate on twelve-month deposits, while the medium-term interest rate is the rate on six-month deposits. Both of these two interest rates are expressed relative to the inflation rate ($\dot{P}$), derived as the percentage change over four quarters in the private consumption expenditure deflator (P_{pc}).

An inflation variable ($\dot{P}$) has been included in the demand function to make allowance for the impact of rising domestic prices. As prices begin to rise and start to erode the purchasing power of these low-interest earning cheque and transmission deposits, individuals will tend rather to make some alternative use of these funds, i.e. to either spend them now or invest them in some other form of real-interest earning asset.

A time trend (TT) has also been incorporated in the regression. This variable makes provision for some of the other external factors that have led to a systematic increase in cheque and transmission deposits over time, such as the increase in population and the possible rise in the preference for more liquid deposits. The following equation has been estimated:

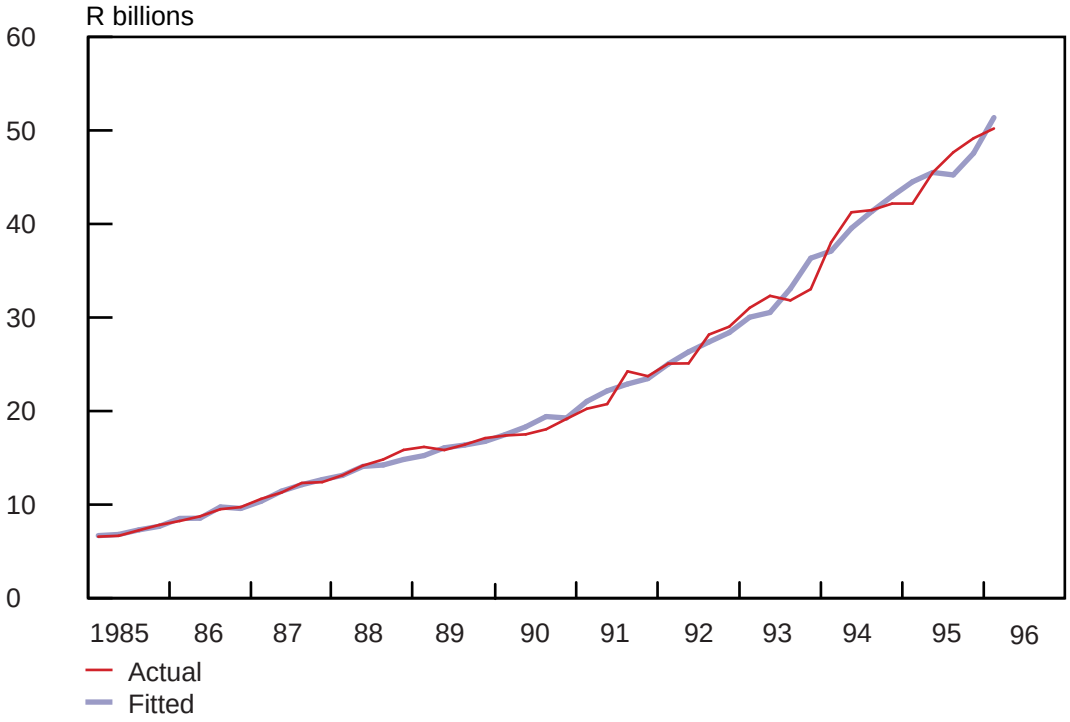
$$\ln(DEP_{ct}/P_{pc}) = \underset{(1,81)}{-3,69405} + \underset{(6,37)}{1,20140}*\ln(Y_{exp}) - \underset{(5,46)}{0,17339}*\ln(((R_{kmr}/\dot{P})+(R_{klr}/\dot{P}))/2) - \underset{(2,56)}{0,23535}*\ln((\dot{P}+\dot{P}_{(-1)})/2)+\underset{(5,56)}{0,00721}*TT$$

$\bar{R}^2$ = 0,95
D-W = 1,63
Estimation period: 1985q1 - 1996q1

where: $\dot{P} = ((P_{pc}/P_{pc(-4)})-1)*100$

The elasticities of the demand for cheque and transmission deposits seem to indicate that a one per cent increase in real gross domestic expenditure would induce an increase of approximately 1,2 per cent in inflation-adjusted cheque and transmission money balances. The elasticity of the substitute interest-bearing asset is fairly small and would seem to indicate that the demand for cheque and transmission deposits is fairly insensitive to the movement in interest rates. This illustrates the investors' overriding desire for the convenience and ease with which they can move in and out of these cheque and transmission deposits compared with the alternative of investing these funds in longer-term deposits. The sensitivity of cheque and transmission deposits to the impact of inflation is also fairly small and indicates that inflation is not a strong motivator to move out of this convenient type of deposit group. The goodness-of-fit of the estimated equation is illustrated in Graph 2.

Graph 2: Cheque and transmission deposits



5.1.2 The M1 monetary aggregate

As indicated earlier, the "other demand deposits" of the private sector with the monetary sector are determined as the balancing item on the consolidated balance sheet of the banking sector. This means that the M1 monetary aggregate can be generated by adding these "other demand deposits" to the M1A monetary aggregate.

- *Other demand deposits*

This monetary component consists of all other demand deposits of the domestic private sector with the monetary sector (DEP_{odd}), excluding cheque and transmission deposits, and constitutes the deposit category that, when added to the M1A monetary aggregate, gives the M1 monetary aggregate.

As from the early 1980s other demand deposits as a percentage of the M3 money supply increased substantially from five and a half per cent to exceed 22 per cent in the second quarter of 1985. Subsequent changes in the regulatory environment[3] resulted in this ratio declining by a quarter, i.e. to 15 per cent within the ensuing two quarters. After this, the ratio, on average, remained roughly in close proximity of this 15 per cent range.

On account of the volatility of the share of other demand deposits in the M3 money supply, it was decided that this item on the liability side of the consolidated balance sheet of the monetary institutions should be derived from the balance sheet identity as the balancing item. This would then yield the following identity:

3) The decline was primarily due to regulations which curtailed the banks' "averaging" procedure in their calculation of liabilities for cash reserve and liquid asset requirement purposes. Further more, as from 31 July 1985 banks' vault cash could qualify as part of their required cash reserves. This in effect meant that the cash reserves could be held in the form of any combination of vault cash and deposits in an interest-free reserve account with the South African Reserve Bank. The increase in private sector liquidity preference also contributed to the shift from longer-term deposits to demand and other short-term deposits.

DEP_{odd} = M3 - DEP_{lt} - DEP_{sm} - DEP_{ct} - M_{cn}

where:

M3 = M3 money supply;
DEP_{lt} = long-term deposits of the private sector with monetary institutions;
DEP_{sm} = short-term and medium-term deposits of the private sector with monetary institutions;
DEP_{ct} = cheque and transmission deposits of the private sector with monetary institutions; and
M_{cn} = notes and coin in circulation outside the monetary sector.

5.1.3 The M2 monetary aggregate

M1 plus the other short-term and medium-term deposits of the private sector with the monetary sector constitute the M2 monetary aggregate. The other short-term and medium-term deposit component has been identified as a stochastic behavioural equation which is described in the following section.

- *Other short-term and medium-term deposits*

The deposits in this instance exclude demand deposits, and include all savings deposits of the domestic private sector with the monetary institutions, including savings deposits with and savings bank certificates issued by the Postbank (previously known as the Post Office Savings Bank).

This category of deposits (DEP_{sm}) also constitutes approximately half of the total M3 money supply over the last five years. From the early 1980s onwards, other short-term and medium-term deposits have shown consistent growth in relation to M3 money supply. This growth signalled a growing preference among individuals for deposits that can easily be converted, with a relatively short delay, into cash.

The function describing the behavioural pattern of holders of these other short-term and medium-term deposits includes a real income variable (Y_{exp}), defined as real gross domestic expenditure, an inflation-adjusted own interest rate ($R_{kmr}/\dot{P}$) and the inflation-adjusted yield on a substitute asset, represented by Eskom stock ($R_{esk}/\dot{P}$). The inflation rate has also been used in an attempt to illustrate the eroding impact of rising prices, but this variable proved to be statistically insignificant and has subsequently been removed from the demand equation. A time trend (TT) has also been incorporated in order to capture the impact of all other variables contributing to the growth in the demand for other short-term and medium-term deposits. The estimated demand equation is specified as follows:

$$\ln(DEP_{sm}/P_{pc}) = \underset{(31,54)}{0,91296}*\ln(Y_{exp}) + \underset{(2,09)}{0,18425}*\ln(\sum_{i=0}^{2}((R_{kmr}/\dot{P})_{(-i)})/3)$$

$$- \underset{(2,51)}{0,35168}*\ln(\sum_{i=0}^{2}((R_{esk}/\dot{P})_{(-i)})/3) + \underset{(3,08)}{0,00825}*TT$$

$\bar{R}^2$ = 0,99
D-W = 1,69
RHO = 0,87
Estimation period: 1985q1 - 1996q1

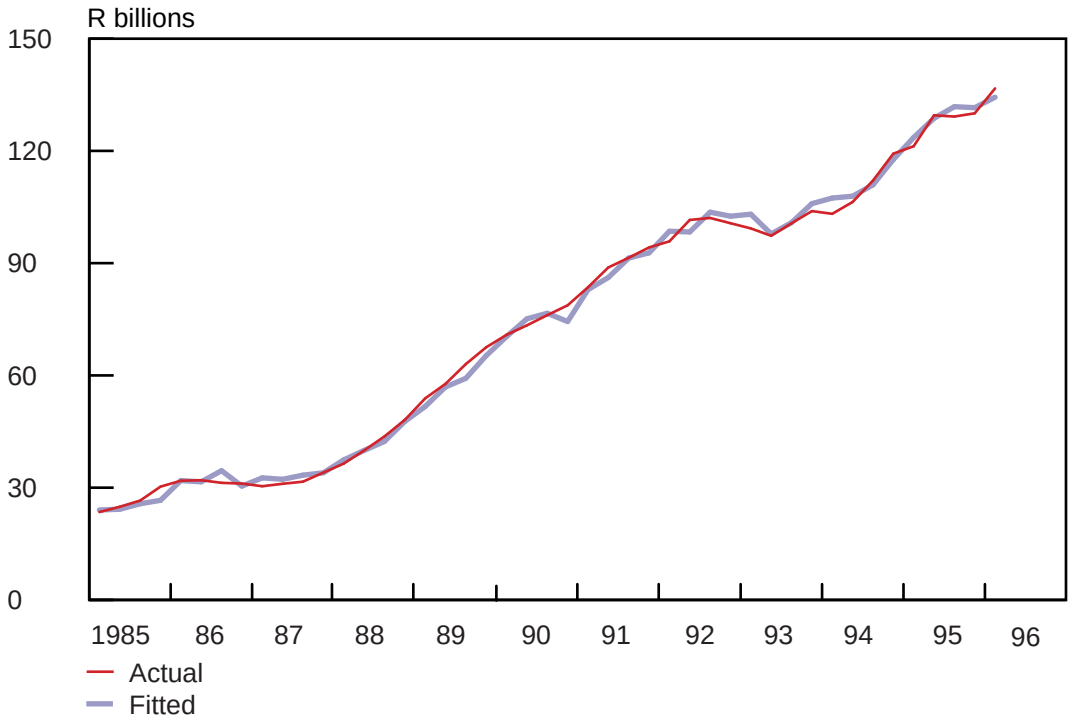
where: $\dot{P} = ((P_{pc}/P_{pc(-4)})-1)*100$

The yield on the substitute asset represented by the rate on Eskom stock is usually in excess of the rate on the medium-term deposits; however, this was not the case during protracted periods of time in which money market rates tended to be high. The high level of money market rates tended to raise the level of deposit rates while simultaneously lowering the future expectations for inflation and hence the yield on Eskom stock. These periods include 1982, the latter half of 1983 up to the first half of 1985 and during the last quarter of 1988 up to the end of 1991.

It would appear as if the demand for other short-term and medium-term deposits is less sensitive to changes in the interest rate on medium-term deposits than to changes in the yield on fixed-interest bearing assets. Yet real income remains the overriding factor that seems to affect the demand for other short-term and medium-term deposits, since a one per cent increase in real income leads to a nine-tenths of one per cent increase in real short-term and medium-term deposits.

The actual and estimated nominal values of other short-term and medium-term deposits are indicated in Graph 3.

Graph 3: Other short-term and medium-term deposits



5.1.4 The M3 monetary aggregate

The structure of the monetary sub-model makes allowance for the demand for both the M3 monetary aggregate and the long-term deposits of the private sector with the monetary institutions. This implies that, with the exception of the other demand deposits, all the deposit categories will be generated as behavioural equations.

- *Long-term deposits*

The long-term deposits of the domestic private sector with monetary institutions include national savings certificates issued by the Postbank, and together with the M2 monetary aggregate they comprise the total M3 money supply. The increased liquidity preference of individuals has come to play a major role in the declining trend of the share of long-term deposits in the total M3 money supply. This was illustrated during the early 1980s when both the long-term and medium-term deposits comprised approximately 37 per cent of the total M3 monetary aggregate, but as time progressed the shift from long-term deposits to medium-term and even to shorter-term deposits began to gain momentum. In fact, the liquidity preference impact was so strong that at the end of 1995 the contribution of long-term deposits to the total M3 money supply had declined to 12½ per cent, or roughly one-third of the percentage that had been registered in the early 1980s. A factor contributing to this development was the initial very high cash-reserve and liquid-asset requirements against short-term deposits that applied to short-term and medium-term deposits with the monetary institutions over the first half of the 1980s[4]. Subsequently, the reserve requirements against short-term and medium-term deposits were relaxed and hence the growing preference for shorter-term deposits.

4) Over the years, liquid asset requirements were gradually lowered to 5 per cent of banks' total liabilities in April 1993. This has been drastically reduced from the approximate 50 per cent of short-term liabilities, and 30 per cent of medium-term liabilities that prevailed in the early 1980s. Money and banking statistics of South Africa, 1973-1993: Supplement to the South African Reserve Bank *Quarterly Bulletin* September 1993; Liquid asset requirements: Table 17 pp B94-96.

The equation describing the demand for long-term money deposits by the private sector with monetary institutions (DEP_{lt}) is specified as a logarithmic function, and the real gross domestic expenditure (Y_{exp}) is used as the major explanatory variable in the behavioural equation.

Provision is made for the inclusion of two real interest rate variables as explanatory variables. The first indicates a class of assets that can be seen as a substitute for long-term deposits with monetary institutions. This class of assets is represented by Eskom stock with a long maturity and the relevant inflation-adjusted interest rate is indicated by ($R_{esk}/\dot{P}$). The second interest-rate variable represents the return on long-term deposits and is indicated by ($R_{lklr}/\dot{P}$).

An inflation variable ($\dot{P}$) has been included in the demand function to make allowance for the impact of rising domestic prices. The long-term nature of this type of deposit forces the individual to be cautious when investing in this type of deposit. If depositors anticipate a rising inflation rate while long-term interest rates remain stable, they may well feel obliged to invest their money balances in an alternative inflation-hedging asset such as shares. The opposite is also true in that if inflation is perceived to be at its pinnacle, the next movement will be expected to trend downwards. This decline is usually associated with a synchronised lowering of domestic interest rates and hence the depositors' desire to invest at the prevailing high interest rate before the anticipated downward movement in interest rates.

The growing preference for liquidity inevitably made long-term deposits less attractive over time relative to the more convenient shorter-term and medium-term depository investments. To capture this steady decline in the relative importance of long-term deposits, a time trend (TT) has been incorporated in the equation describing the demand for this type of depository investment.

The estimated demand equation for long-term deposits of the private sector with the monetary institutions is as follows:

$$\ln(DEP_{lt}/P_{pc}) = \underset{(39,73)}{1,39193}*\ln(Y_{exp}) + \underset{(4,61)}{0,35168}*\ln\left(\sum_{i=0}^{1}((R_{klr}/\dot{P})_{(-i)})/2\right)$$

$$- \underset{(2,49)}{0,27244}*\ln((R_{esk}/\dot{P})_{(-1)}) - \underset{(3,08)}{0,26988}*\ln(\dot{P})$$

$$- \underset{(19,97)}{0,03632}*(TT)$$

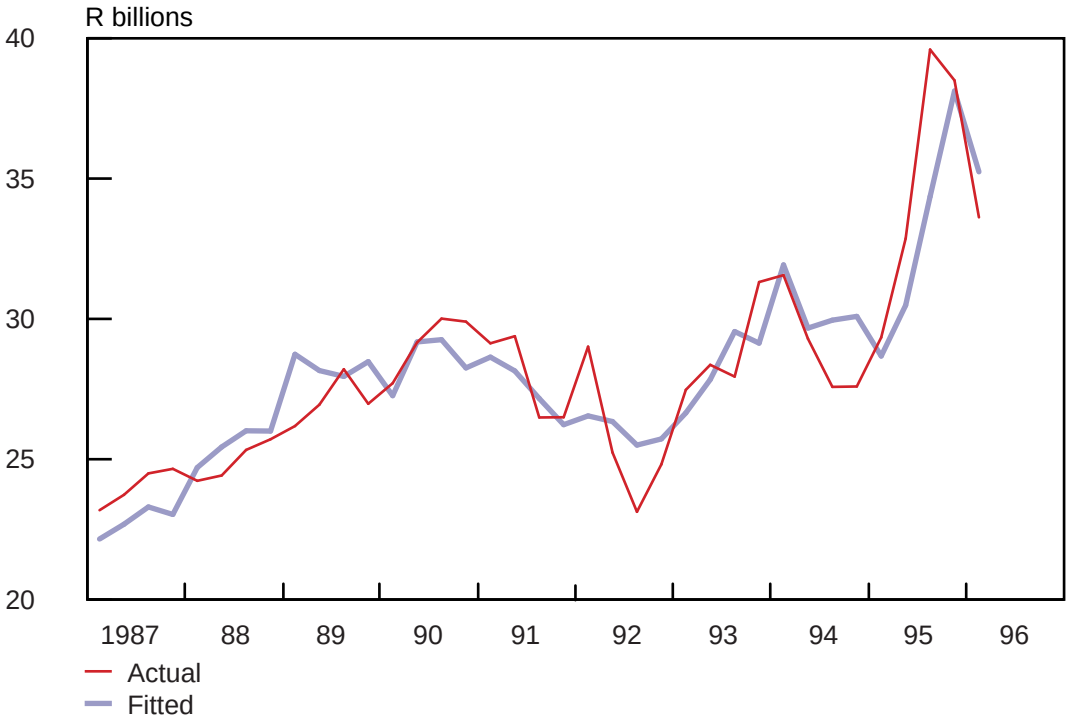
$\bar{R}^2 = 0,95$
D-W = 1,43
Estimation period: 1987q1 - 1996q1

where: $\dot{P} = ((P_{pc}/P_{pc(-4)})-1)*100$

The estimated equation indicates that the demand for long-term deposits with monetary institutions is highly sensitive to changes in real gross domestic expenditure; the estimated elasticity is 1,39. The estimated elasticities of demand with respect to changes in interest rates and inflation are considerably smaller and suggest a significant lower degree of sensitivity to that of the change in real gross domestic expenditure. The negative sign of the time-trend variable indicates the declining share of long-term deposits in the aggregate M3 money supply.

Graph 4 illustrates the goodness-of-fit of the estimated equation.

Graph 4: Long-term deposits



- *Total M3 money supply*

Ever since 1989 the main objective of monetary policy has been to secure a stable financial environment in which optimal economic growth and development can be sustained in the long run. To this end, the Reserve Bank has generally adopted a fairly orthodox monetary policy stance, which in essence meant that the monetary authorities' decisions were primarily guided by prevailing circumstances, such as

- changes in inflation and inflation expectations;

- changes in the balance of payments situation;

- changes in the exchange rate and expectations of further changes in the exchange rate in the light of current movements on the balance of payments;

- changes in the public debt and the budget deficit as ratios of the gross domestic product;

- changes in the growth of credit extension to the private and government sectors;

- the levels of and current trends in foreign reserves; and

- recent trends in short-term market-determined interest rates.

Guidelines for the growth of the M3 money supply are announced at the beginning of every calendar year by the South African Reserve Bank, but these guidelines should not be seen as rigid and uncompromising targets for monetary growth. On the contrary, monetary policy decisions are always subject to discretionary assessments of the prevailing market conditions. Needless to say, if the money supply guidelines were uncompromising and rigidly adhered to, M3 could quite easily be seen as exogenous in the model.

Money demand theory postulates that changes in income, together with changes in a representative interest rate variable, are the primary forces that influence the variation in the total M3 monetary aggregate. For the purposes of this study, the estimated equation describing the demand for M3 money balances does not deviate from this hypothesis.

This best-fitting function for the aggregate demand for real M3 balances has been estimated in logarithms and incorporates the following explanatory variables:

- a variable depicting real aggregate domestic final demand (Y_{dem}), defined as the sum of the three principal real expenditure components, i.e. private consumption expenditure, gross domestic fixed investment and government consumption expenditure;

- the inflation-adjusted yield on a substitute investment instrument that offers the individual an alternative to holding M3 balances;

- a combined weighted inflation-adjusted interest rate on deposits ($R_{trn}/\dot{P}$), which is defined as the combination of the own interest rates that are applicable to all M3 type deposits;

- a variable indicating the incentive for holders of M3 money balances to make funds available directly to economic agents that are currently experiencing a financing deficit (to be elaborated on later); and

- an inflation variable ($\dot{P}$) to make allowance for the eroding impact of rising domestic prices.

The yield on Eskom stock (R_{esk}) has been included in the demand function as an indicator of the yield on substitute assets. When capital market rates are high in relation to deposit rates, the market price of fixed-interest securities is low and this tends to encourage investors to prefer keeping their funds invested in the long-term securities market. Of course, this yield will also have to be corrected for the yield-raising impact of higher inflation expectations. The yield on long-term bonds is expected to affect the demand for M3 balances inversely, as higher bond yields relative to deposit rates would cause substitution of deposits for bonds. The relevant real yield variable is indicated by ($R_{esk}/\dot{P}$).

The own interest rate on M3 balances is defined as the weighted average of the interest rates applicable to the various classes of M3 deposits, i.e. other demand deposits[5] (DEP_{odd}), short-term and medium-term (DEP_{sm}) and long-term deposits (DEP_{lt}). As this combination of the various interest rates constitutes the own interest rate on M3 type deposits, it should necessarily be positively correlated with the M3 monetary aggregate. The identity for determining the own interest rate on deposits is defined as follows:

$$R_{trn} = [DEP_{odd}/DEP_{trn}] * R_{kkr} + [DEP_{sm}/DEP_{trn}] * R_{kmr} + [DEP_{lt}/DEP_{trn}] * R_{klr}$$

where:

$DEP_{trn} = DEP_{odd} + DEP_{sm} + DEP_{lt}$

and:

R_{kkr} = short-term deposit interest rate (31 days)
R_{kmr} = medium-term deposit interest rate (6 months)
R_{klr} = long-term deposit interest rate (12 months)

5) The interest rate on cheque and transmission deposits is far lower than the rates of the other interest-bearing deposits and has subsequently been removed from the identity. In addition, the other demand deposit category has its own rate known as the "call rate". However, the trend in this rate is fairly similar to that of the short-term deposit rate.

Disintermediation takes place when "direct financing", by "primary lenders" of "ultimate borrowers" is substituted for lending that previously was, or normally would have been, extended by a bank or other monetary institution.[6] It is usually fostered by an increase in the relative size of the disparity between the banks' average lending rates and their average deposit rates. Of course, lending and borrowing activities by banks will increase relative to those of the non-bank sector when the margin between banks' lending and deposit rates narrows. The effect of these changes on the demand for M3 balances is captured by including the ratio of the prime overdraft rate to the combined yield on interest-bearing deposits (R_{por}/R_{trn}) as an explanatory variable in the demand equation.

6) The South African Reserve Bank Annual Economic Report: 1988; Monetary and financial developments p.33.

The wealth-eroding impact of rising prices and inflation justifies the inclusion of this explanatory variable in its own right. As inflation starts to rise, investors begin to hedge against inflation by looking at alternative investments, i.e. by possibly transferring potential low real-yielding deposit balances into some alternative and hopefully higher real-yielding type of asset such as shares or real estate.

The logarithmic demand function that most adequately estimates the behavioural relationship between these explanatory variables and the real money supply is specified as follows:

$$\ln(M3/P_{pc}) = \underset{(113,64)}{1,10304}*\ln\left(\sum_{i=0}^{1}(Y_{dem(-i)})/2\right)$$

$$- \underset{(3,98)}{0,21955}*\ln\left(\sum_{i=0}^{1}\left((R_{esk}/\dot{P})_{(-i)}\right)/2\right)$$

$$+ \underset{(2,13)}{0,04818}*\ln\left((R_{trn}/\dot{P})_{(-1)}\right)$$

$$- \underset{(2,33)}{0,17054}*\ln\left(\sum_{i=0}^{1}\left((R_{por}/R_{trn})_{(-i)}\right)/2\right)$$

$$- \underset{(2,98)}{0,10614}*\ln(\dot{P})$$

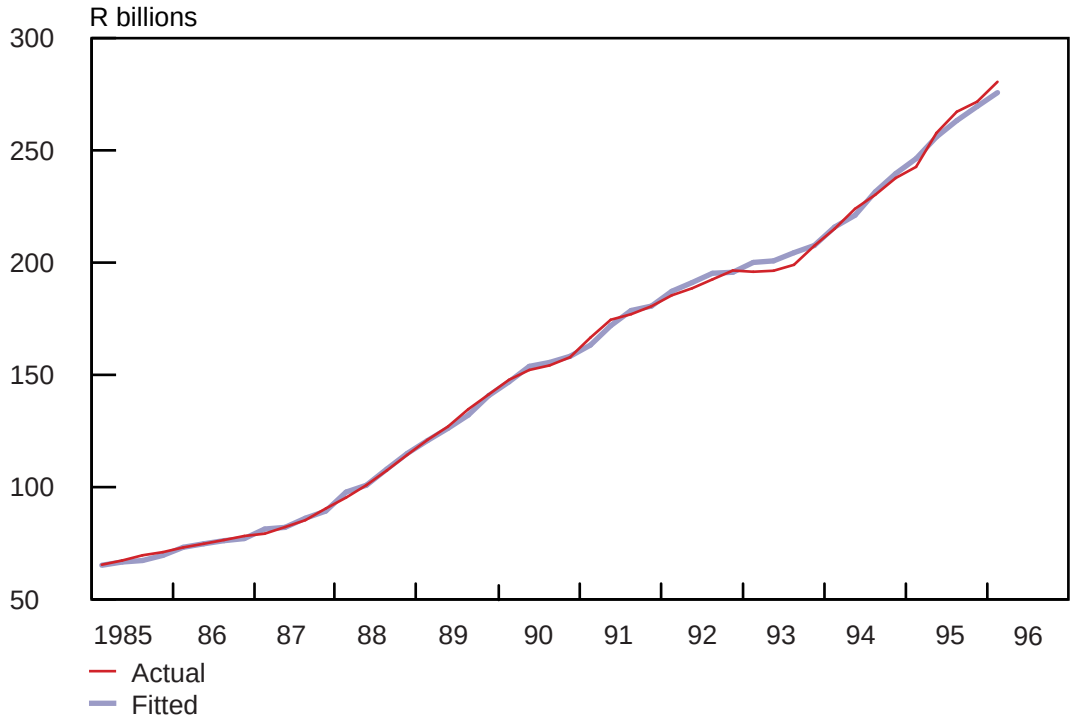
$\bar{R}^2$ = 0,99
D-W = 1,60
RHO = 0,82
Estimation period: 1985q1- 1996q1

where: $\dot{P} = ((P_{pc}/P_{pc(-4)})-1)*100$

The money demand function illustrates near-unity elasticity in that a one per cent increase in real aggregate final demand will induce a 1,1 per cent increase in the real M3 monetary aggregate. The elasticities with respect to changes in interest rates and the change in inflation are considerably smaller than the elasticity with respect to aggregate final demand. The "own" interest rate elasticity is estimated at 0,05 and the elasticity of the yield on possible substitute assets is estimated at -0,22. The function therefore indicates that individuals are more sensitive to the potential yields from an interest change in the substitute asset, than they are to the potential yield of the own interest rate on interest-bearing deposits.

The estimated value of the M3 monetary aggregate is compared with the actually recorded M3 values in Graph 5.

Graph 5: Total M3 money supply



5.2 Accounting counterparts of the M3 money supply

7) Money and banking statistics of South Africa, 1973-1993: *Supplement to the South African Reserve Bank Quarterly Bulletin* September 1993; p.1.

The institutional composition of the monetary sector – the sector whose deposit, coin and note liabilities to the domestic private sector constitute the money supply – has changed considerably over the last two decades. Factors contributing to this change include the scrapping of rigid distinctions between different types of deposit-taking institutions, and the acquisition of the functions of the dissolved National Finance Corporation by the Corporation for Public Deposits[7].

The separate balance sheets of the monetary institutions form the basis for the compilation of the consolidated balance sheet of the monetary sector which can be used to explain changes in the broadly defined money supply (M3).

The accounting counterparts of M3 distinguished in this analysis consist of the following components:

- the change in the monetary sector's net claims on the government sector, i.e. gross claims less government deposits with the monetary sector, which is seen as an exogenously determined variable (MC_{govt});

- the monetary sector's claims on the private sector, or credit extended to the private sector, which is determined by a behavioural stochastic function (MC_{priv}) in the model;

- the change in the net gold and other foreign assets of the monetary sector, i.e. gold, foreign exchange and other foreign assets less short-term foreign liabilities ($NGFOR_{sa}$); and

- the change in net other assets of the monetary sector, i.e. other assets less capital and reserves and other liabilities ($LARBO_{sa}$).

5.2.1 The net claims on the government sector

The net claims of the monetary sector on the government sector (MC_{govt}) are characteristically highly variable from quarter to quarter. This variability can partly be attributed to changes in government stock held by monetary institutions and changes in the level of government deposits with monetary institutions in an attempt to influence monetary conditions in the economy, or as part of government's debt management strategy. However, monetary institutions are not the major holders of short-term and long-term marketable government debt. The major holders of government stock are the so-called institutional investors, such as insurance companies and pension funds.

The lack of systematic change in the net claims of the monetary sector on the government sector and the policy-related nature of these changes led to the exogenous treatment of this variable in the model, i.e. the net changes in this variable cannot easily be explained in terms of the interrelationships contained in the model. In addition, the long-term contribution of the change in the net claims of the monetary sector on the government sector is relatively small in comparison to the change in the M3 money supply.

5.2.2 The net foreign assets

The holdings of foreign assets by the monetary sector ($NGFOR_{sa}$) reflect the accumulated total of previous surpluses or deficits on the current account of the balance of payments plus the accumulated net inflow of capital from the rest of the world. It is through this variable that South Africa's interaction with the rest of the world makes itself felt on the domestic monetary conditions. For model purposes, the surplus or deficit on current account ($CABOP_{sa}$) of the balance of payments will be determined by the interaction of the structural relationships of the main model, i.e. where the balance on current account is largely determined by forces endogenous to the model.

On balance, the net capital movements ($CAPM_{sa}$) are seen to be determined essentially outside the identified structure of the model. The change in the level of net gold and foreign exchange reserves equals the sum of the surplus or deficit on the current account of the balance of payments and the net outflow or inflow of capital to or from the rest of the world.

Compared to the change in the M3 monetary aggregate, the change in the net gold and other foreign reserves is relatively small. However, this should not detract from the important role of the net gold and other foreign reserves in shaping decisions on monetary policy. The quarterly model offers no distinction between the long-term and short-term external capital movements.

The equation summarising the changes in the M3 monetary aggregate is as follows:

$$\Delta M3 = \Delta MC_{govt} + \Delta MC_{priv} + \Delta LARBO_{sa} + \Delta NGFOR_{sa}$$

and where :

$$\Delta NGFOR_{sa} = CAPM_{sa} + CABOP_{sa}$$

The role and composition of the net gold and other foreign assets in the model warrants further explanation; these will be elaborated on in section 5.3.

5.2.3 The net other assets of the monetary sector

The change in the net other assets of the monetary sector constitutes the change in net other assets held by the South African Reserve Bank and the rest of the monetary sector ($LARBO_{sa}$), and is determined as the residual item once the changes in the claims by the monetary sector on the government sector (MC_{govt}), the net gold and other foreign reserves ($NGFOR_{sa}$) and the claims of the monetary sector on the private sector (MC_{priv}) have been deducted from the changes in the M3 money supply.

The change in the net other assets of the monetary institutions is also highly variable. In the long run, it is relatively small in relation to the overall change in M3 and can be seen as being determined outside the endogenous interrelationships of the model.

The change in net other assets of the monetary sector is derived in the model as a balancing item in the following way (for *ex post* simulation purposes) :

$$\Delta LARBO_{sa} = \Delta M3 - \Delta MC_{govt} - \Delta MC_{priv} - CAPM_{sa} - CABOP_{sa}$$

5.2.4 Claims of the monetary sector on the private sector

The claims of the monetary institutions on the private sector constitute mortgage advances, instalment sale credit, overdrafts, leasing finance, credit card and other loans and advances extended to both the households and businesses. Holdings of private-sector debt paper by the monetary institutions are also included. These holdings consist of bills discounted and investments in the form of promissory notes, bankers' acceptances and debentures.

Of all the credit facilities available to private-sector households, mortgage advances consistently remain the most important type of credit, as more and more individuals continually revert to this form of credit for not only the exclusive financing of residences, but also for the purchase of durable consumer goods and other consumer articles. Although business enterprises make use of mortgage facilities, the other loans and advances, instalment sale credit and overdrafts are apparently the most popular credit instruments that the business community employs.

The magnitude of the credit extended to the private sector suggests that it is by far the most important of all the accounting counterparts of M3. Since 1985 it has remained very close to the absolute size of M3, and in some instances, especially over the last few years, actually surpassed the M3 monetary aggregate.

The theory postulated in the demand for credit function defines the real demand for credit from the monetary sector by the domestic private sector as being explained by a real income variable, an inflation-adjusted interest rate, the long-term level of the nominal prime rate and an interest-rate variable to capture the effect of dis- and re-intermediation. The stochastic behavioural relationship accordingly consists of the following variables:

- a variable representing real aggregate private-sector demand (Y_{pdm}) which is defined as the sum of the real private consumption expenditure and real gross domestic fixed investment expenditure in the private business enterprises and the public corporations;

- the change in the inflation-adjusted prime overdraft rate ($R_{por}/\dot{P}$) which captures the direct costs involved when making use of any of the available credit facilities;

- the banks' prime overdraft interest rate (R_{por}); and

- a disintermediation or reintermediation variable in the form of the ratio of the prime overdraft rate to the combined yield on interest-bearing deposits (R_{por}/R_{trn}).

A priori reasoning leads to the assumption that the algebraic sign of the estimated coefficient of the level of the prime overdraft rate should be negative, i.e. the actions of individuals in making use of credit facilities is to a large degree dependent on the prevailing level and longer-term trend of the banks' prime overdraft rate (R_{por}).

However, a perverse effect can be expected in the immediate short term, in which the first-period impact of a change in the inflation-adjusted interest rate $\Delta(R_{por}/\dot{P})$ may well be in the same direction as the change in the interest rate itself. This offers a possible explanation for the behaviour of individuals and business enterprises whose first response to an interest rate rise may be to increase their use of credit facilities rather than to sacrifice their standard of living and current expenditure patterns.

The non-linear behavioural relationship that best defines the demand for bank credit in the private sector is as follows[8]:

$$\ln(MC_{priv}/P_{pc}) = \underset{(2,77)}{-2,11343} + \underset{(17,57)}{1,31849}*\ln\left(\sum_{i=1}^{3}(Y_{pdm(-i)})/3\right)$$

$$+ \underset{(1,34)}{0,01703}*[\ln(R_{por}/\dot{P})-\ln((R_{por}/\dot{P})_{(-1)})]$$

$$- \underset{(2,15)}{0,06402}*\ln\left(\sum_{i=1}^{3}(R_{por(-i)})/3\right)$$

$$- 0,1*\ln((R_{por}/R_{trn})_{(-1)})$$

$\bar{R}^2 = 0,99$
D-W = 1,68
RHO = 0,60
Estimation period: 1985q3 - 1996q1

where: $\dot{P} = ((P_{pc}/P_{pc(-4)})-1)*100$

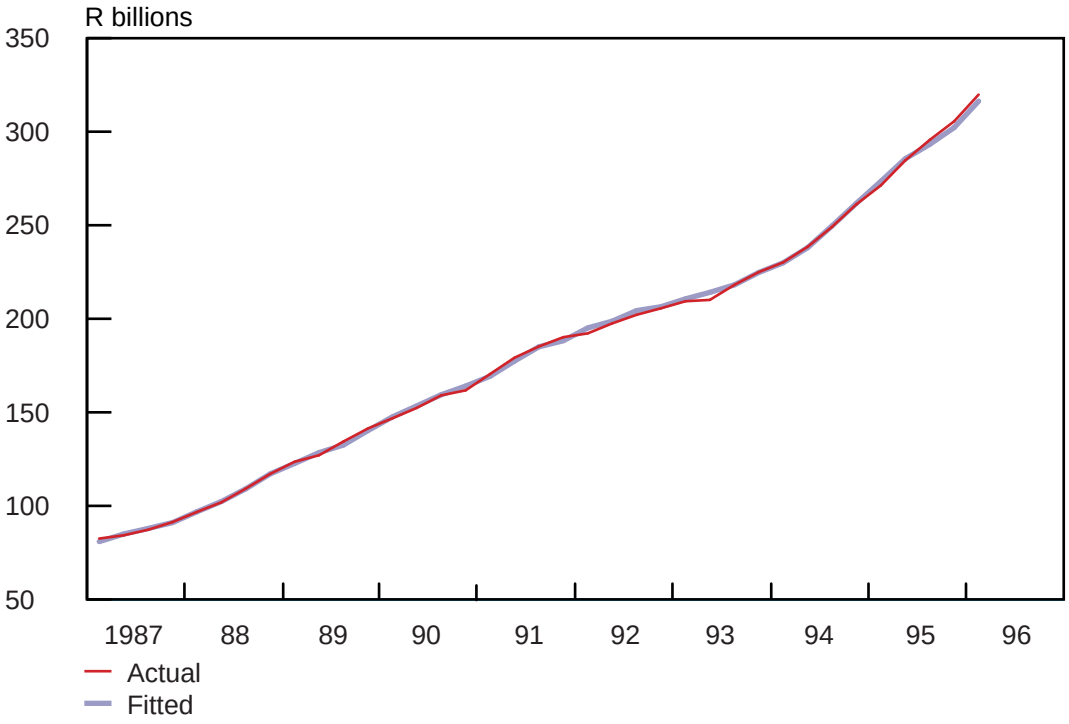
The estimated equation indicates that the demand for bank credit in the private sector has an elasticity regarding private-sector aggregate spending in excess of unity (at 1,3), indicating that a one per cent increase in private-sector aggregate

8) Disintermedition and reintermediation ultimately affect both the asset and liability structure of the monetary sector to the same extent. This necessarily implies that the elasticity of the (R_{por}/R_{trn}) variable on the asset side should be fairly similar to that shown on the deposit or liability side. In other words, at least equal to the elasticity of approximately 0,1 as defined in the M3 money supply on page 27. Regression analysis estimates this coefficient at 0,067, and hence by only slightly constraining this coefficient to 0,1 (as in the aforementioned equation), the elasticity of each explanatory variable remains essentially unchanged from its original unconstrained estimate.

demand will bring about a more than proportional change in the demand for bank credit in the private sector. The elasticities for changes in the various interest rates are low; this illustrates that the main impact of an increase in interest rates is shown more through the diminished aggregate spending channel than through the less sensitive direct interest rate channel. The relative size of the coefficients of the various interest rate variables further indicates that the first-period response to a change in the inflation-adjusted prime overdraft rate is perverse in the sense that the demand for credit will change in the same direction as the change in the interest rate. Only after a delay of one quarter will the demand for bank credit of the private sector react in the way that standard demand theory predicts.

The correlation between the actual and estimated values of the demand for bank credit by the private sector is shown in Graph 6.

Graph 6: Claims of the monetary banks on the private sector



5.3 The net and gross gold and other foreign reserves

The change in the net gold and foreign reserves is determined as the sum of the exports of goods and services (including gold) minus the imports of goods and services, plus the net long-term and short-term capital inflows which are not related to reserves.

The change in the net gold and other foreign reserves owing to the balance of payments transactions can therefore be determined by adding the current account of the balance of payments to the total capital movements:

$$\Delta NGFOR_{nsa} = CABOP_{nsa} + CAPM_{nsa}$$

where:

$NGFOR_{nsa}$ = change in the net gold and foreign reserves owing to balance of payments transactions, not seasonally adjusted;

$CABOP_{nsa}$ = current account of the balance of payments, not seasonally adjusted; and

$CAPM_{nsa}$ = total long-term and short-term capital movements, not seasonally adjusted.

Once the change in the net gold and foreign reserves ($NGFOR_{nsa}$) has been determined, the change in the gross gold and foreign reserves can be calculated by adding the change in the liabilities related to reserves (LRR_{nsa}), and the allocation of Special Drawing Rights (SDR) and valuation adjustments ($VASDR_{nsa}$) to the change in the net gold and other foreign reserves.

The identity for determining the change in the gross gold and other reserves can hence be written as follows:

$$\Delta GGFOR_{nsa} = \Delta NGFOR_{nsa} + \Delta LRR_{nsa} + \Delta VASDR_{nsa}$$

5.4 Interest rates

The interest rate structure of the quarterly econometric model provides for the determination of short-term and long-term interest rates. Variations in short-term money market interest rates primarily reflect changes in Bank rate, and money market conditions, whereas capital market rates are primarily determined by the supply of and demand for loanable funds.

5.4.1 Short-term or money market interest rates

- *Bank rate*

The South African Reserve Bank originally opted for what is called the classical cash reserve system in which the Bank was willing to refinance the money market shortage fully and automatically on certain predetermined terms, conditions and costs. This system of accommodation is characterised by Bank rate which refers to the operational variable at which the Reserve Bank provides overnight loans against the collateral of certain financial assets at the discount window. Eligible assets consist of Treasury bills, Land Bank bills, Government stock, and Reserve Bank bills with an outstanding maturity of less than 92 days.

Subsequent revisions to monetary policy operational procedures on 9 March 1998 have seen the introduction of a repurchase rate (Repo rate) as a substitute to Bank rate. The Repo rate refers to the rate at which banks regularly tender for central bank funds through repurchase transactions, i.e. by temporarily selling securities to the Reserve Bank. Repos have accordingly become known as the primary apparatus, or refinancing instrument, in the management of the banking sector's liquidity positions and requirements. It can also be seen as a highly responsive tool which is capable of reflecting any easing or tightening of conditions in the money market. The system of repurchase transactions has the added advantage that it can be used by the central bank to send signals of its intentions to the market in a flexible and transparent way. In addition, counterparties or participants in the new system can now send more reliable signals to the Reserve Bank concerning underlying market conditions.

Consequently, the minimum rate for Reserve Bank accommodation – Bank rate up to 8 March 1998 and after that, the Repo rate – constitutes the most important operational variable in the execution and implementation of monetary policy in the monetary model. It should however be noted that throughout the remainder of this study, the term "Bank rate" will henceforth be used to represent the "minimum rate charged for accommodation" by the South African Reserve Bank.

9) Some alternative simulations to be performed later will nevertheless allow for changes in Bank rate to respond to changes in some of the endogenous variables.

Ideally the model should include a policy-reaction function for the determination of Bank rate. Such a policy-reaction would summarise in a single behavioural equation the decision rules adhered to when changes to Bank rate are considered. For the purposes of this study, Bank rate is seen as an exogenously determined policy variable[9].

- *The Treasury bill tender rate*

The Treasury bills considered in this instance are short-term government securities with an initial maturity of 91 days. The discount rate at which the bills are issued is called the Treasury bill rate, and is determined by means of a weekly tendering system.

10) The repurchases agreement or Repo rate has subsequently replaced Bank rate as the official rate of accommodation from the central bank. However, the relationship between the Treasury bill rate and the Repo rate remains broadly similar to that of the Treasury bill and Bank rate.

The monetary sub-model makes provision for Bank rate to be the operational rate at which accommodation is provided by the South African Reserve Bank against collateral of Treasury bills[10]. This means that the Treasury bill rate tends to gravitate towards Bank rate.

In the context of the model, the Treasury bill tender rate reacts to the full extent of changes in Bank rate. This yields the following relationship:

$$R_{ttr} = R_{rbd} + res_{ttr}$$

where:

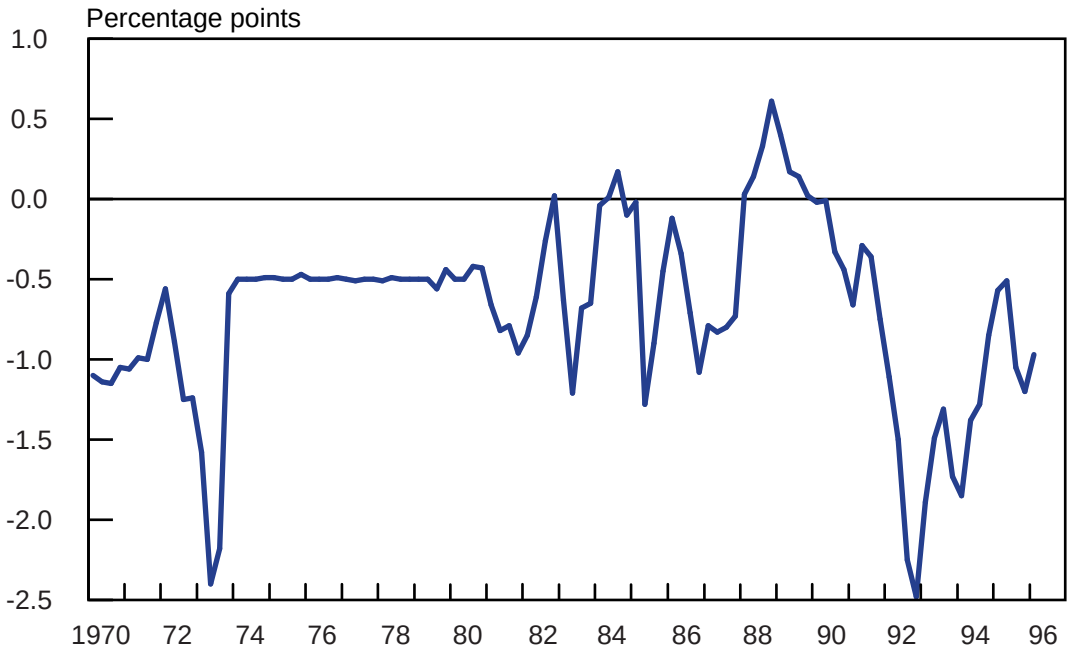
R_{ttr} = Treasury bill tender rate;

R_{rbd} = Bank rate; and

res_{ttr} = $R_{ttr} - R_{rbd}$ for *ex post* simulation purposes.

Under normal market conditions the Treasury bill tender rate tends to be lower than Bank rate, *inter alia* because the tender rate is a discount rate. The discount rate called the Treasury bill tender rate is higher when translated to a yield basis, while Bank rate is already a yield rate, and has been a yield rate ever since 1993. A positive margin can however be tolerated for a short time as long as the gap between the Treasury bill tender rate and Bank rate remains relatively small. If this positive gap begins to increase excessively, banks would be able to borrow at Bank rate from the Reserve Bank and invest at a higher rate in the money market, i.e. the so-called "round tripping" phenomenon.

Graph 7: The gap between the Treasury bill tender rate and Bank rate (res_{ttr})



- *The three-month bankers' acceptance rate*

The bankers' acceptance (BA) rate is the rate at which domestic banks are willing to discount three-month bankers' acceptances (91 days). The discount rate varies continually and reflects conditions in the money market. Usually a declining bankers' acceptance rate indicates an actual or expected easing of money market conditions. Conversely, tight money-market conditions are normally reflected in higher levels of the bankers' acceptance rate. Over the longer term, the discount rate on bankers' acceptances of three months shows a relatively close correlation with Bank rate.

Bank rate has been incorporated as the sole explanatory variable that influences a change in the three month bankers' acceptance rate. This yields the following identity:

$R_{bar} = R_{rbd} + res_{bar}$

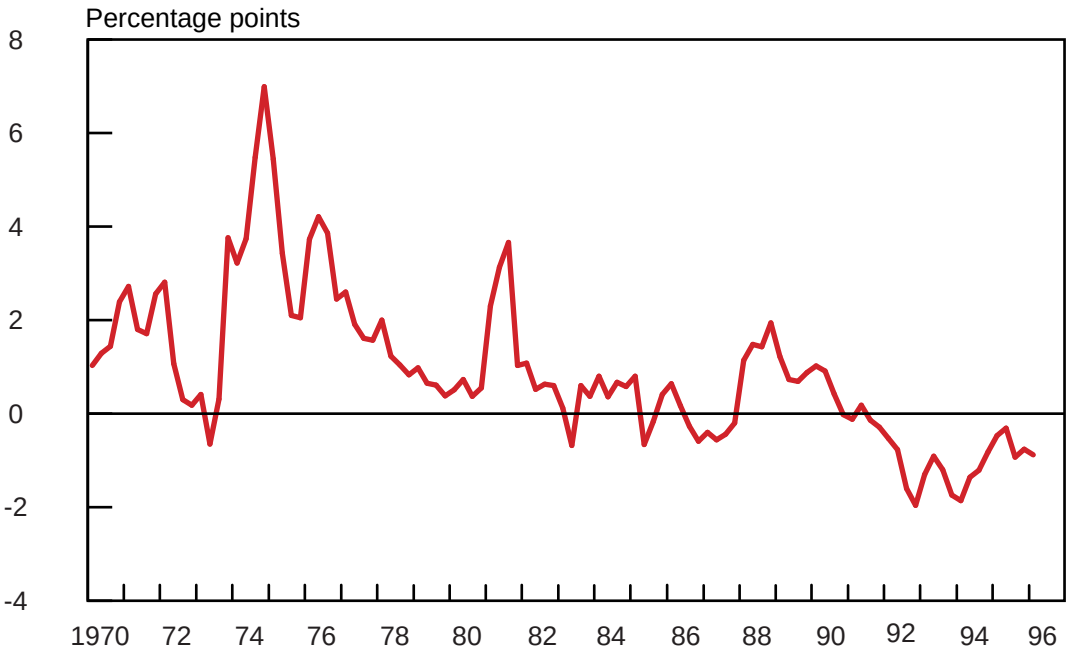
where:
R_{bar} = interest rate on three-month bankers' acceptance;
R_{rbd} = Bank rate; and
res_{bar} = $R_{bar} - R_{rbd}$ for ex post simulation purposes.

The average gap between Bank rate and the bankers' acceptance rate (res_{bar}) has changed markedly over time, having been quite high during the 1970s and the early 1980s. The gap then tapered off towards the end of the 1980s to yield a bankers' acceptance rate that was lower than Bank rate during the first half of the 1990s. The larger gap observed during the 1970s and early 1980s can partly be attributed to accommodation procedures of the Reserve Bank, which at that time differed somewhat from the current procedures[11].

11) Up to 30 April 1993 Bank rate was seen as the rediscount rate on Treasury bills. Thereafter, Bank rate referred to the accommodation rate for overnight loans against collateral of Treasury bills, short-term government stock, Land Bank bills or Reserve Bank bills with an outstanding maturity of less than 92 days: South African Reserve Bank *Quarterly Bulletin*; March 1996 p. S-26.

The gap between the three-months bankers' acceptance rate and Bank rate therefore reflects the following three characteristics: firstly, the intrinsic risks associated with the issue of an acceptance to an applicant; secondly, the current expectations of the next movement in Bank rate; and thirdly, the technical changes associated with the extension of accommodation at Bank rate and the acceptability of bankers' acceptances as collateral for accommodation purposes and liquid asset requirements. Recently the gap between Bank rate and the discount rate on bankers' acceptances has narrowed and is expected on average to tend towards zero, i.e. after converting the bankers' acceptance rate to a yield basis.

Graph 8: The gap between the bankers' acceptance rate and Bank rate (res_{bar})



- *The banks' prime overdraft rate*

The prime overdraft rate is probably the most significant interest rate in the money market and is identified as the lowest rate at which a bank will lend money to an individual or business enterprise in the form of an overdraft facility. Ever since February 1982 commercial banks have been allowed a greater degree of freedom in determining their overdraft rates independently of Bank rate. Nevertheless, the prime overdraft rate of the major banks is still broadly tracking the movements of Bank rate.

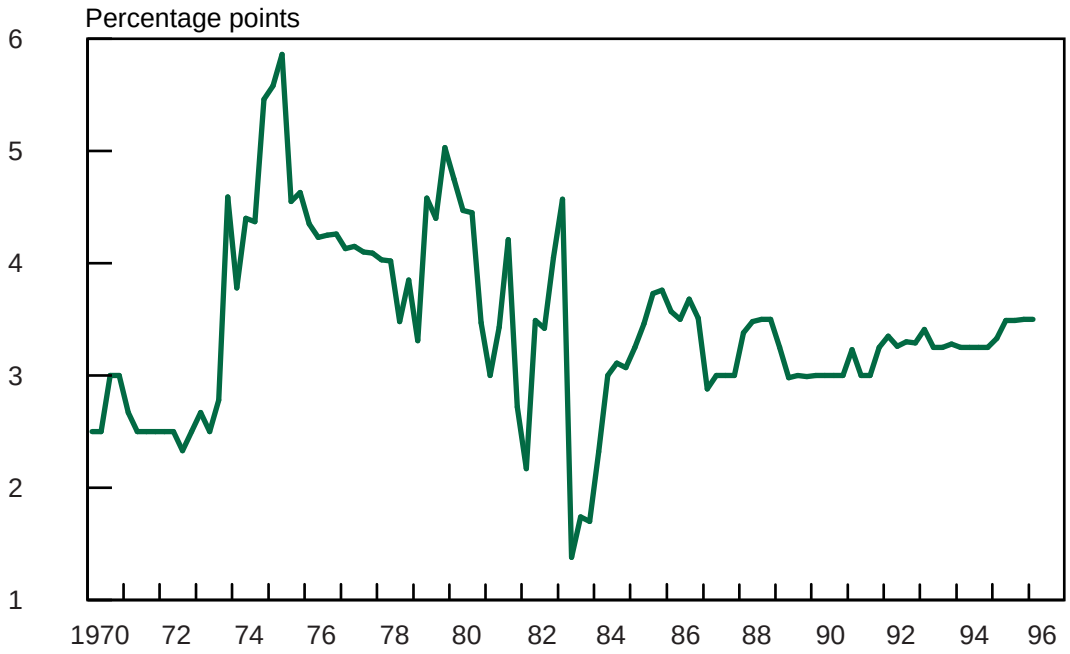
The relationship between Bank rate and the prime overdraft rate is summarised in the model as follows :

$R_{por} = R_{rbd} + res_{por}$

where:
R_{por} = interest rate on prime overdraft facilities;
R_{rbd} = Bank rate; and
res_{por} = $R_{por} - R_{rbd}$ for *ex post* simulation purposes.

The gap between Bank rate and the prime overdraft rate fluctuated fairly widely in the range between a high of 6,0 and a low of 1,5 percentage points until 1986. The pattern of this gap can also partly be attributed to the changing definition of Bank rate. As from 1986 onwards, the gap has remained fairly stable in the 3,0 to 3,5 percentage point range.

Graph 9: The gap between the prime overdraft rate and Bank rate (res_{por})



The model thus allows for the prime overdraft rate to always change in tandem with Bank rate. Indirectly, through its relationship with the prime overdraft rate of the private banks, Bank rate plays a pivotal role in the demand for credit, money growth and ultimately in the determination of the overall price level.

5.4.2 Short-term, medium-term and long-term deposit rates

As private banks are typical profit-maximising economic agents, there is good reason to expect that changes in the banks' lending rates will also be reflected in changes in the interest rates that banks are prepared to offer on their deposit liabilities. For this reason the prime overdraft rate has been incorporated as the single most important explanatory variable in determining the level of the banks' deposit rates.

The longer the maturity of any financial instrument, the higher the risk associate with investing in such an instrument. This necessarily means that longer-term deposits should be compensated to a larger extent than their shorter term counterparts. These differences in risk profiles should be reflected in the interest rate structure of deposits with different maturities. Furthermore, because deposit interest rates usually respond to changes in the prime overdraft rate, it seems obvious to link the level of the banks' deposit rates to the level of their lending rates.

The following set of equations summarises the process of determining the levels of the interest rates that apply to various kinds of deposits:

$R_{kkr} = R_{por} + res_{kkr}$

where:
R_{kkr} = interest rate on short-term demand deposits (31 days);
R_{por} = interest rate on prime overdraft facilities; and
$res_{kkr} = R_{kkr} - R_{por}$.

$R_{kmr} = R_{por} + res_{kmr}$

where:
R_{kmr} = interest rate on medium-term deposits (6 months); and
$res_{kmr} = R_{kmr} - R_{por}$.

$R_{klr} = R_{por} + res_{klr}$

where:
R_{klr} = interest rate on long-term deposits (12 months); and
$res_{klr} = R_{klr} - R_{por}$.

The margins between the respective interest rates on different kinds of deposits and the prime overdraft rate, i.e. res_{kkr}, res_{kmr} and res_{klr}, tend to remain fairly constant over time. Occasionally the constancy of these margins may be disturbed temporarily when the private banks have strong views on imminent changes in Bank rate and adjust their funding strategies in view of these expectations. It is conceivable that tighter or easier money market conditions may influence the margins to a significant degree, but money market sentiment is difficult to capture in the structure of the model and these margins are hence assumed to remain constant for *ex ante* simulation purposes.

5.4.3 Long-term or capital market interest rates

The capital market can be seen as the market for lending and borrowing long-term funds. The major issuers of securities in the capital market can be identified as the central government of South Africa, public corporations, public enterprises, local authorities and private companies. The main buyers of these securities include the Public Investment Commissioners, insurance companies and pension funds.

The financial instruments traded in the capital market generally fall into four main categories, namely fixed-interest securities, variable-interest securities, shares and long-term negotiable certificates of deposit. The monetary sub-model incorporates the price formation process of one category of fixed-interest securities, namely the yield on Eskom stock.

Mortgage loans remain essentially long term. Therefore the mortgage lending rate will be considered as a capital market rate in the South African Reserve Bank monetary sub-model, despite its strong link to money market rates in the form of the banks' prime overdraft rate.

- *The yield on Eskom stock*

In a market economy, the level of interest rates is ultimately determined by the demand for and supply of investible funds. Subsequent pressures exerted on the balance between this "demand for loanable funds" and the "supply of domestic

savings" can either be alleviated or aggravated by cross-border capital flows. A net inflow of foreign capital, for example, will supplement domestic savings and alleviate the potential upward pressure on interest rates. Conversely, a net outflow of such capital will, in turn, erode the country's pool of savings and add to upward pressures on interest rates.

For virtually a decade, a combination of compulsory foreign debt repayments and politically motivated capital-flight resulted in a chronic net outflow of capital from South Africa. This net outflow seriously impeded capital formation in the economy. The domestic savings shortfall and the persistent outflow of capital put upward pressure on capital market rates, particularly since the latter half of 1985, and capital market rates moved well in excess of the contemporaneous rate of inflation.

For estimating the price-formation process in the capital market, the supply-demand imbalance is approximated by the ratio of domestic saving to investment. Domestic saving is defined as the sum of the personal, corporate and government saving whereas domestic investment is defined as the level of nominal gross domestic fixed investment.

Eskom was at times considered to be its own market-maker in that the yield on Eskom stock was often influenced by the investment of internal funds in Eskom stock. This, in addition to disruptive occurrences such as domestic violence and political instability, significantly restricts the estimation of a consistent relationship between the yield on the long-term Eskom stock and other pertinent explanatory variables. This led to the incorporation of a dummy variable to expressly allow for the impact of such occurrences. The dummy variable explicitly provides for three distinct incidents which have been identified as having had a profound influence on the yield on Eskom stock. These are

- the fourth quarter of 1985 which allows for the negative market sentiment arising from the debt standstill and the high occurrence of domestic violence;

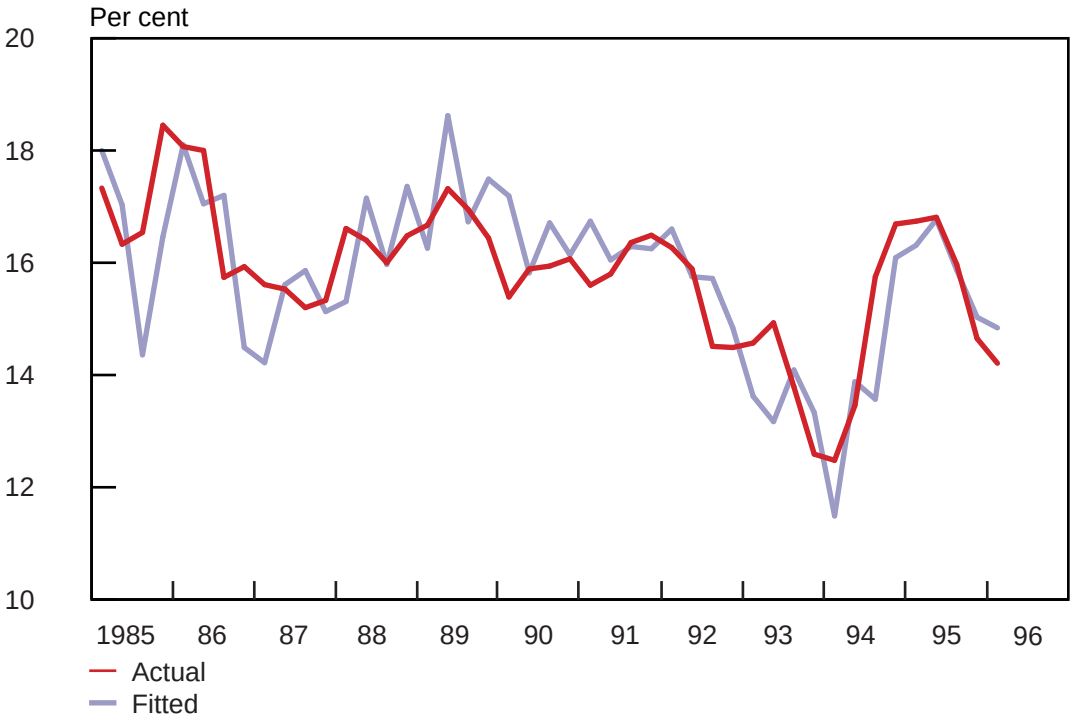
- the second quarter of 1989 which allows for the abolition of certain prescribed investment requirements that had been imposed on institutional investors; and

- to make provision for the market expectation of the removal of the financial rand mechanism as from the second quarter of 1994 to the first quarter of 1995.

The abolition of certain prescribed investment requirements for institutional investors warrants further explanation in that as from early May 1989, new regulations became effective which stipulated that pension funds and long-term and short-term insurers would henceforth no longer be required to hold a minimum percentage of their assets invested in public-sector securities. The general impact of these measures was to grant most of the institutions concerned opportunities to reduce their portfolios of public-sector securities and to strengthen their holdings of fixed property and company shares. The termination of the captive market arrangements, and uncertainties about what the new restrictions would involve, contributed to an increase in public-sector stock trading activity in March, and higher long-term stock yields during March and April of 1989 (South African Reserve Bank, 1989. *Annual Economic Report*: 43).

Inflation expectations and expectations of prospective changes in the policy stance of the monetary authorities also play a part in the determination of capital-market yields. Effectively this means that at least over the longer term Bank rate also has an influence on the yield on Eskom stock. Furthermore, specific provision is also made for the direct impact of inflation expectations on the level of the long-term Eskom stock yield.

Graph 10: The yield on long-term Eskom stock



The functional relationship that best describes the changes in the yield on long-term Eskom stock is as follows :

$$((1+(R_{esk}/100))/(1+(\dot{P}_{exp}/100))) = \underset{(5,10)}{0,47207} - \underset{(2,12)}{0,10480}*(\sum_{i=0}^{3}((SAV/INV)_{(-i)})/4)$$

$$+ \underset{(6,47)}{0,56862}*[(1+(R_{rbd}/100))/(1+(\dot{P}_{exp}/100))]$$

$$+ \underset{(2,44)}{0,00940}*(DUMEVK)$$

$\bar{R}^2$ = 0,97
D-W = 1,86
RHO = 0,89
Estimation period: 1985q1 - 1996q1

where: R_{esk} = yield on long-term Eskom stock;
$\dot{P}_{exp}$ = variable for inflationary expectations, defined as the percentage change over 4 quarters in the private consumption expenditure deflator (P_{pc});
R_{rbd} = Bank rate;
SAV = domestic savings, defined as the sum of the personal, corporate and government savings;

INV = nominal gross domestic fixed investment; and
DUMEVK = dummy variable for the disruptive occurrences.

The goodness-of-fit of the estimated equation is illustrated in Graph 10.

- *The mortgage lending rate*

The virtual absence of fixed-rate mortgages in South Africa and competition among monetary institutions ensure that the finance and other charges for various types of credit move in harmony. For this reason the prime overdraft rate (R_{por}) has been used as the sole determining factor that causes a change in the mortgage lending rate (R_{mlr}). The identity illustrating this functional relationship is as follows:

$R_{mlr} = R_{por} + res_{mlr}$

Where
R_{mlr} = interest rate on mortgage loans;
R_{por} = interest rate on prime overdraft facilities; and
res_{mlr} = $R_{mlr} - R_{por}$ for *ex post* simulation purposes.

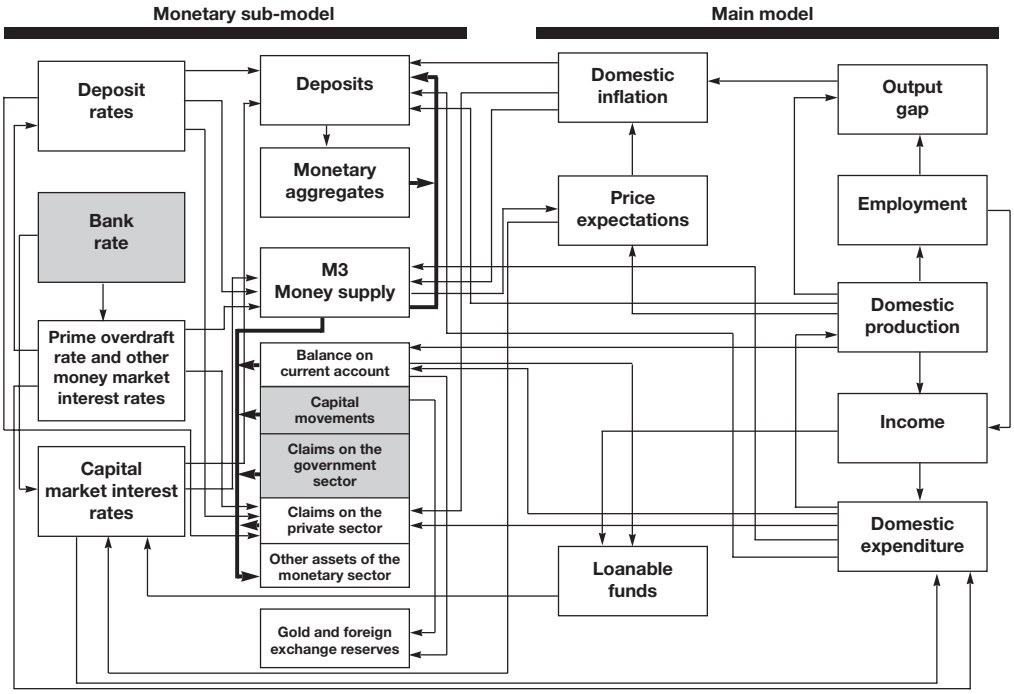
The difference between the prime overdraft rate and the mortgage lending rate (res_{mlr}) is seldom higher than a quarter of a percentage point throughout the entire sample period.

6. Linkages of the monetary sector sub-model to the quarterly econometric model

Macroeconomic policy measures are aimed at fostering economic growth, creating employment opportunities and improving the living standards of all the people of

Diagram

FLOW CHART OF THE MAJOR LINKAGES OF THE MONETARY SUB-MODEL TO THE MAIN MODEL



Shaded areas indicate those variables that are not determined by the structural interrelationships of the model

the country. Monetary policy and its objectives of creating and maintaining a stable financial environment, play an integral role in achieving the overall goals of macro-economic policy. The single most important instrument that the monetary authorities have at their disposal for influencing monetary conditions in the interest of overall financial stability is the Repo or Bank rate.

The diagram illustrates the central role of Bank rate and the main channels through which monetary impulses influence the creation of income and spending in the economy. Any change in the real income of economic agents would inevitably lead to changes in the level and composition of aggregate domestic spending.

Furthermore, the flow chart illustrates the relationship between the growth in the money supply and inflation. The macro-model allows for inflation expectations to be influenced by the growth in the total M3 money supply aggregate in relation to a change in the domestic output volume.

Changes in the domestic aggregate price level are primarily influenced by price expectations, changes in the prices of imported goods and services and productivity developments. Wage rate fluctuations and the change in the gap between potential and actual output, also play an important role in the process of determining prices (Pretorius and Smal: 25-36).

7. Simulations with the quarterly econometric model

Four separate simulation exercises were performed with the South African Reserve Bank quarterly econometric model in order to test the macroeconomic consistency and stability properties of the monetary sub-model. These tests usually consist of a series of dynamic simulations in which different time paths are set for one or more of the exogenous variables in the model. For this purpose, a baseline scenario was determined by solving the model over a twenty-quarter period from the first quarter of 1991 up to and including the fourth quarter of 1995. The actual values of the exogenous variables were used, and the least squares residuals of the stochastic equations were added back to each equation to ensure that the model replicates the actual values of the endogenous variables in the baseline scenario. The response of the main endogenous variables to controlled exogenous shocks is discussed in more detail below.

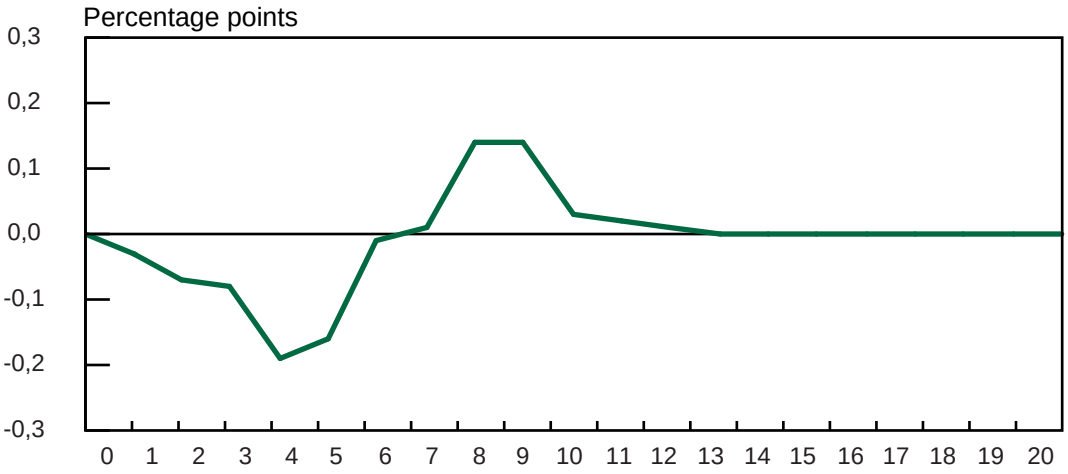
7.1 A test for model stability

An analysis of the time paths of endogenously determined variables in response to shocks to exogenously determined variables offers a means for determining the stability of the model. A model can be considered stable if, given a situation where the exogenous variables are held constant through time, the mean values of the endogenous variables tend to settle down at some constant level, and do not either explode or display a regular oscillatory movement over time (Kmenta: 592-593).

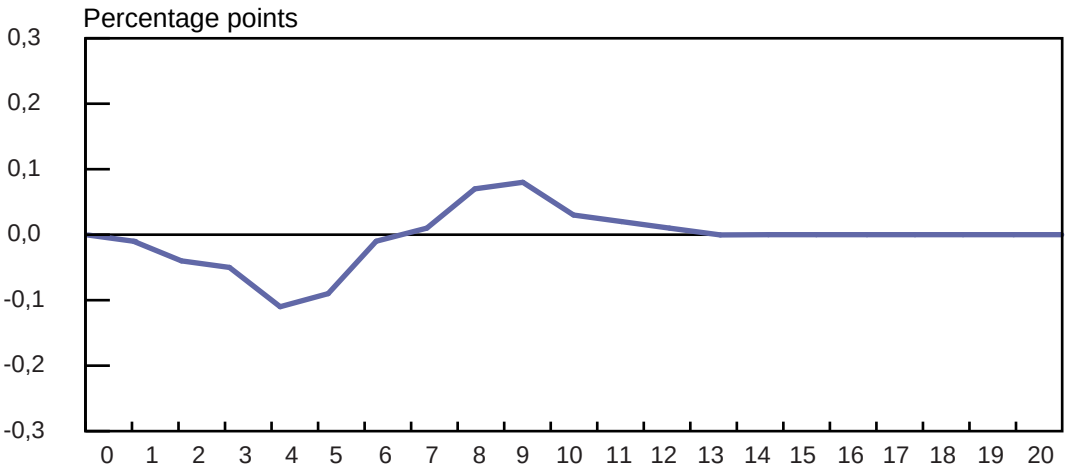
This essentially means that when the equilibrium solution of the model is shocked by a one-off change in an exogenous variable, the values of those variables determined by the model should eventually return back to their equilibrium levels. Graph 11 (a),(b) and (c) illustrates the stability of the model when exposed to a solitary one-off increase or shock of approximately 1½ percentage points in Bank rate during the first quarter of the twenty-quarter simulation period. This is tantamount to a

Graph 11: The time paths of endogenous variables in response to a solitary one-off increase of 1½ percentage points in exogenous Bank rate during the first quarter

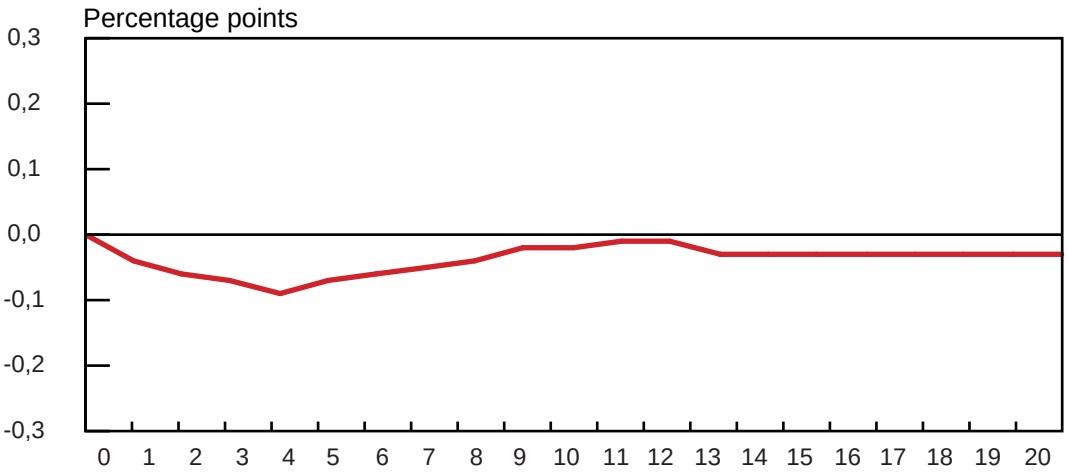
(a): The change in the growth rate of real gross domestic product



(b): The change in the employment rate in the non-agricultural sector



(c): The change in the inflation rate as defined by changes in the consumer price index



first quarter increase of ten per cent in the level of Bank rate. However, Bank rate is returned to the level found in the baseline for the remaining nineteen quarters. The graphical presentations show that all three endogenous variables suitably converge to their baseline or equilibrium level after a period of approximately ten quarters.

7.2 Alternative 1: A sustained increase in Bank rate

An alternative simulation was performed in which the level of Bank rate was increased by ten per cent over the entire twenty-quarter simulation period. This in effect means that Bank rate was raised beyond its baseline value by approximately 1½ percentage points, and maintained at this new higher level throughout the simulation. Changes in the prime overdraft rate are primarily determined by changes in Bank rate. This essentially means that the level of the prime overdraft rate will increase simultaneously and to the same extent as the change in Bank rate. Results of this simulation were then compared with the values of the endogenous variables of the baseline in order to determine the multiplier impact of such a policy-induced shock.

The increase in Bank rate will almost immediately reduce the level of real private consumption expenditure, whereas the level of investment is reduced on account of the increased interest costs of investment only after a fairly long time delay. The decline in these two aggregates reduce the level of aggregate demand and the level of the real gross domestic product by an average of 0,7 per cent per year over the simulation period (see Graph 12(a)).

The levels of both the M3 money supply and the claims of the monetary sector on the private sector came out lower in the alternative simulation compared with the baseline simulation. The results of the alternative simulation suggest that the level of the M3 money supply declined by an average of 2,7 per cent per year, while the level of the claims of the monetary sector on the private sector declined by about 2,0 per cent per year on average over the entire simulation period.

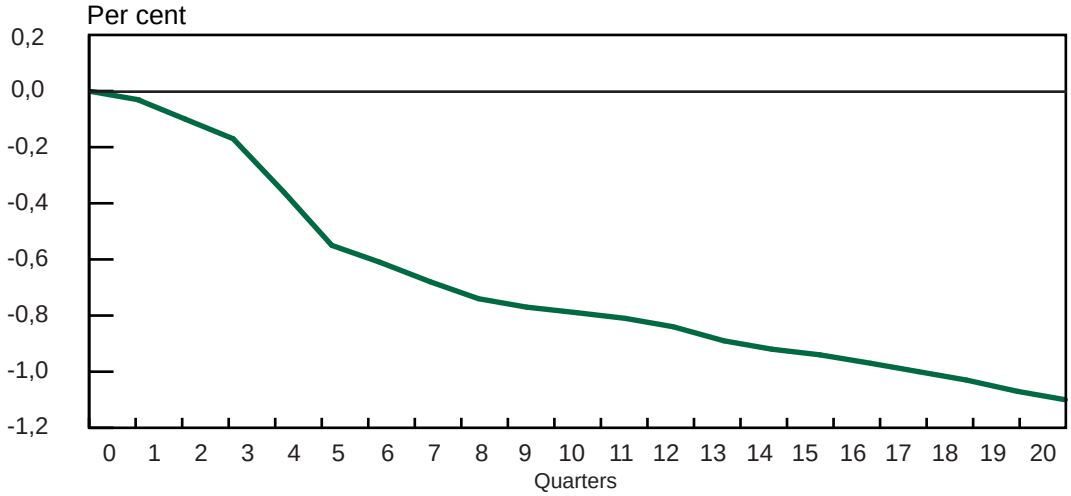
Although the M3 money supply declines immediately and consistently throughout the simulation (see Graph 12(b)), the simulation results regarding the amount of credit extended to the domestic private sector do indicate the expected short-term perverse reaction to the increase in the interest rate, i.e. where credit extension increases slightly in the very first quarter after the increase in Bank rate. As from the second quarter, both the levels of the M3 money supply and the amount of credit extended to the private sector start to recede to levels below those that prevailed at the lower level of Bank rate.

Inflation expectations are determined (according to the structure of the model) by the ratio of the total M3 money supply relative to the volume of domestic production. The slower rate of increase in the growth of the money supply in the alternative simulation reduces inflation expectations, and the growth in labour remuneration and finally the inflation rate as well.

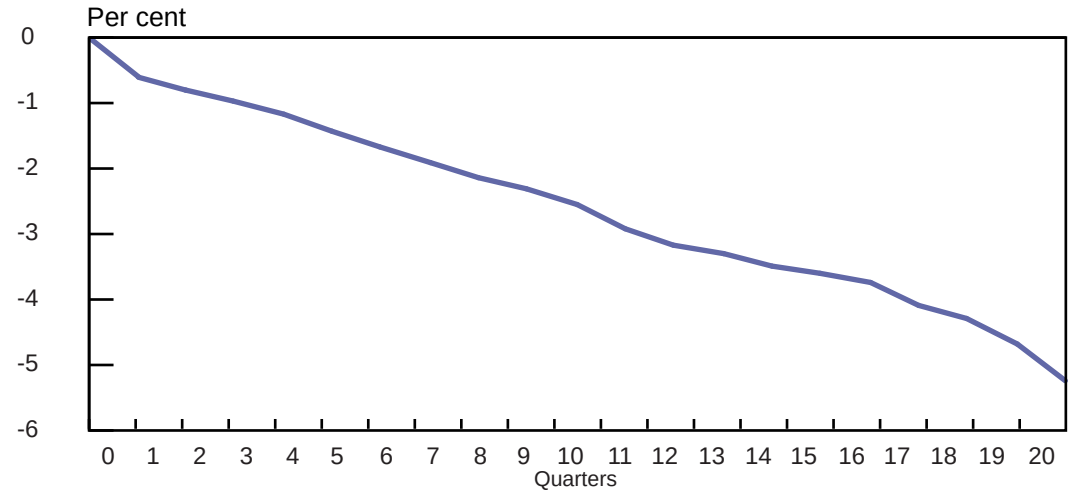
The alternative simulation illustrates that a sustained increase in Bank rate of ten per cent (approximately 1½ percentage points) throughout the full five years, will lower the level of domestic price inflation by approximately 0,40 percentage points on average over each year of the simulation period. The accompanying graph (see Graph 12(c)) illustrates the response of inflation to the increase in Bank rate. By the end of the five-year simulation period, annual inflation can be reduced by 0,71 percentage points, or by an approximate half of the initial change in Bank rate.

Graph 12: The impact of a sustained ten per cent increase in exogenous Bank rate (approximately 1½ percentage points over the twenty-quarter simulation period)

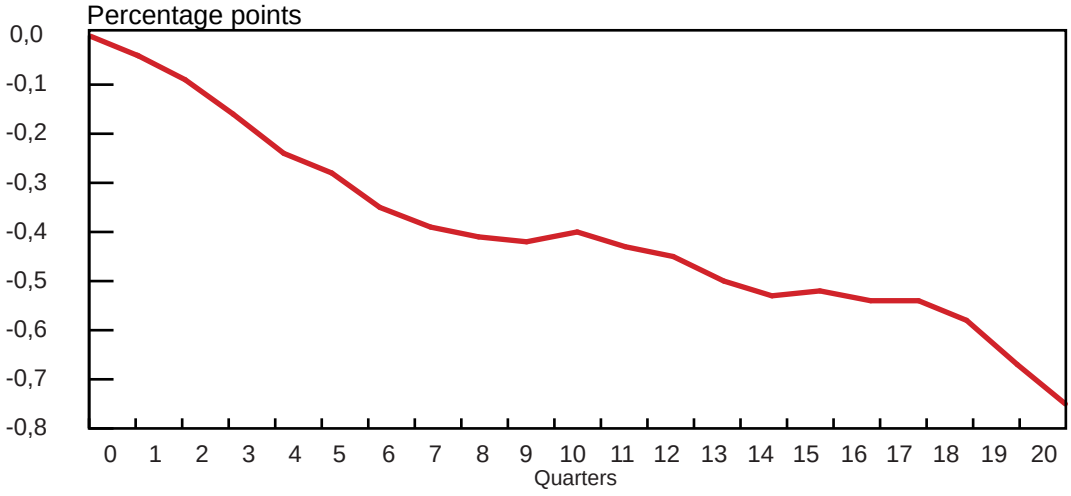
(a): The change in the level of the real gross domestic product



(b): The change in the level of the M3 money supply



(c): The change in the inflation rate as defined by changes in the consumer price index



The lower level of domestic expenditure and production caused the volume and the value of imported goods and services to fall below those of the baseline simulation. In contrast, the volume and the value of goods and services exported were broadly the same in both the simulations. The balance of payments on current account strengthened accordingly by an estimated R275 million in the first year after the increase in Bank rate, but then improved progressively to show a net gain of R2,4 billion in the final year of the simulation period.

Bank rate is treated as exogenous in the model and is set to follow a specific time path irrespective of any changes in the inflation rate. As a result, the alternative simulation performs in a manner that ensures a continuous rise in the level of the inflation-adjusted (or real) Bank rate, i.e. as inflation tends to continually drift downwards, the nominal level of an unchanged Bank rate increases steadily in relation to the contemporaneous or expected rate of inflation. All the other interest rates linked to Bank rate, such as the prime overdraft rate of the banks and the various bank deposit rates, will be similarly affected in this situation and consequently show an increase in their inflation-adjusted values. The higher cost of credit and capital in the alternative simulation, i.e. where nominal interest rates are not reduced again over the five-year period relative to that of the standard simulation, is anticipated to bear downwards on the level of aggregate spending, income growth, employment creation and government revenue. Furthermore, the interest cost of the public debt will rise relative to government revenue, causing the balance on government's budgetary accounts to deteriorate when compared with the deficit before borrowing of the standard simulation (see Table 2).

Table 2 The effect of a sustained ten per cent, or ½ percentage point increase in Bank rate

Year	Real gross domestic product*	Employment in the non-agricultural sector#	Total M3 money supply*	Inflation rate#	Balance on current account#	Government deficit before borrowing#
	%	Number	%	%	Rm	Rm
1	-0,2	-4 800	-0,9	-0,13	275	575
2	-0,6	-18 900	-1,8	-0,34	1 025	1 775
3	-0,8	-24 800	-2,7	-0,42	1 450	2 975
4	-0,9	-29 100	-3,5	-0,51	1 925	4 400
5	-1,1	-31 300	-4,6	-0,61	2 375	6 800
Average	-0,7	-21 780	-2,7	-0,40	1 400	3 300

* Calculated as the difference between the baseline and alternative simulation as percentage of the baseline results
\# Calculated as the difference between the results of the baseline and the alternative simulation

All things considered, the alternative simulation exercise points to a scenario in which the real cost of capital is not only high relative to the baseline solution, but the gap between the real cost of capital of the two simulations widens increasingly as time progresses. It is therefore not surprising that output and employment growth are weaker in the alternative simulation than in the baseline simulation. To be in any way a true replication of a real-world interest rate adjustment, i.e. one in which interest rates can be reduced once the desired results have been achieved,

provision should be made in the structure of the model for a more realistic situation where the level of nominal interest rates responds to changes in actual and expected inflation.

7.3 Alternative 2: A one-off increase in endogenous Bank rate over the first year

A second alternative simulation was performed to determine the short-term to medium-term impact of a one-off increase of ten per cent in Bank rate over the first year of the simulation period, but allowing Bank rate to respond to lower inflation in subsequent years. To this end, a policy-reaction function was added to the model so that changes in Bank rate could be described as responses to changes in certain macroeconomic variables. The introduction of the policy-reaction function can be seen as a further attempt to replicate as realistically as possible the likely macroeconomic effects of a change in Bank rate.

The policy-reaction function used to define Bank rate, consists of the following explanatory variables:

- the current account of the balance of payments as a ratio to nominal gross domestic product;

- the growth rate of real gross domestic product;

- the growth rate of the M3 money supply; and

- the actual consumer-price inflation rate.

Any improvement in the current account of the balance of payments tends to alleviate domestic liquidity pressures and helps to replenish the level of gold and foreign exchange reserves. All other things remaining the same, this will alleviate pressure for a tightening of monetary policy.

The real economic rate of growth offers a measure of the current state of domestic economic activity. If the monetary authorities perceive the rate of economic growth to be excessive in relation to the long-run potential growth rate, they may well be of the opinion that more restrictive measures are needed to ensure the maintenance of long-run macroeconomic stability.

Excessive growth in the M3 money supply will inevitably aggravate inflationary pressures over the longer term. Besides Bank rate, the South African Reserve Bank has a number of other instruments at its disposal to contain domestic monetary demand and inflation, such as currency swaps, repurchase transactions and variable minimum reserve requirements. Although these instruments can be perceived as variables capable of facilitating the creation of money, they have, for practical reasons, not been directly accounted for in the monetary sub-model. Furthermore, the primary channel or operational variable through which monetary policy decisions, and the impact of the transmission mechanism on the domestic economy, is through adjustments to the minimum rate charged for accommodation by the South African Reserve Bank, i.e. the present Repo rate or Bank rate under the previous operational procedures in the money market.

Table 3 The effect over five years of one-off increase of approximately 1½ percentage points in endogenous Bank rate during the very first year

	1	2	3	4	5	Total
Policy-reaction function:						
Bank rate (%)						
Baseline	17,19	15,61	12,93	12,27	14,36	
Alternative (2)	18,79	14,91	12,98	12,19	14,31	
Difference	1,60	-0,70	0,05	-0,08	-0,05	0,82
Results:						
Growth rate in real GDP (%)						
Baseline	-1,02	-2,19	1,29	2,75	3,27	
Alternative (2)	-1,18	-2,38	1,72	2,64	3,34	
Difference	-0,16	-0,19	0,43	-0,11	0,07	0,04
Growth rate in employment (%)						
Baseline	-1,81	-2,09	-2,18	-0,74	0,64	
Alternative (2)	-1,90	-2,20	-1,93	-0,79	0,67	0,03
Difference	-0,09	-0,11	0,25	-0,05	0,03	0,03
Inflation rate (%)						
Baseline	15,34	13,95	9,71	8,98	8,68	
Alternative (2)	15,22	13,78	9,76	8,98	8,65	
Difference	-0,12	-0,17	0,05	0,00	-0,03	-0,27

The results of the alternative simulation summarised in Table 3, show an impact over the first year that is similar to the results obtained over the first year of the first alternative simulation where the exogenously-determined Bank rate shock was increased to span the entire five-year simulation period. The second alternative simulation indicates that Bank rate increased by 1,6 percentage points relative to the baseline simulation in the first year, but then fell to 0,7 percentage points below the level in the baseline simulation in the second year. This decline in Bank rate during the second year is consequently attributed to the dynamic adjustments to the explanatory variables incorporated in the policy-reaction function.

Although there is only a small deviation from the baseline level of Bank rate in the third year, the actual rate at which Bank rate falls from 14,91 per cent in the second year to 12,98 per cent in the third year amounts to an approximate 1,9 percentage point decline in the second alternative simulation. The actual decline in Bank rate from the second to the third year in the baseline simulation amounts to 2,7 percentage points (i.e. from 15,61 per cent to 12,93 per cent). This implies that the rate at which Bank rate declined in the second alternative scenario is approximately 0,8 percentage points less than the decline shown in the baseline simulation, indicating that the additional monetary-policy stimulus in the second alternative is smaller than in the baseline simulation.

The rate of growth in real gross domestic product in the second alternative simulation is approximately one-fifth of a per cent lower in both the first and second year. There is however a substantial improvement in the third year, in which the growth rate increased by approximately half a percentage point. The lagged response of income to the lower Bank rate and inflation rate in the second year partly con-

tributed to this improvement seen in the third year (Graph 13(a)). The slight decline in economic activity during the fourth year is primarily attributable to the lagged response of real gross domestic product to the less-stimulatory change in Bank rate from the second to the third year of the second alternative scenario.

Employment growth in the non-agricultural sector is primarily driven by the growth rate in aggregate real output. The rate of growth in employment accordingly reflects the five-year cyclical trend set by the rate of growth in real gross domestic product (as illustrated in Graph 13(b)). The strengthening of employment growth during the third year effectively makes up for the job opportunities foregone during the previous two years.

The rate of inflation as measured by the consumer price index is also lower in the second year of the alternative simulation when compared to the baseline simulation. This impact can primarily be attributed to the decline in economic activity over the first year and to the lower inflation expectations registered over both the first and second year (i.e. a direct consequence of the slower growth in the M3 money supply and credit extended to the domestic private sector). The moderate increase in inflation during the third year is attributable to the lagged response of prices to earlier demand-pull pressures (see Graph 13(c)). These pressures have been raised further by the increase in the real gross domestic product during the latter half of the second year and the third year of the simulation period.

In practice and regardless of the prevailing level of the nominal and real Bank rate, the monetary authorities will be influenced by the current state of domestic economic circumstances when deciding to change Bank rate. It is also not difficult to realise that a Bank rate increase from 19,0 to 20,5 per cent may well have a profoundly different impact on the economy in contrast to an increase of 1,5 percentage points on a Bank rate level of 10 per cent. The simulation results indicate that after twenty quarters, the net impact of an initial increase of 1,7 percentage points in Bank rate would be to increase the real economic growth rate, expand the level of employment opportunities and lower the prevailing domestic rate of inflation.

7.4 Alternative 3: The reaction of the model to a one-off lowering of inflation expectations

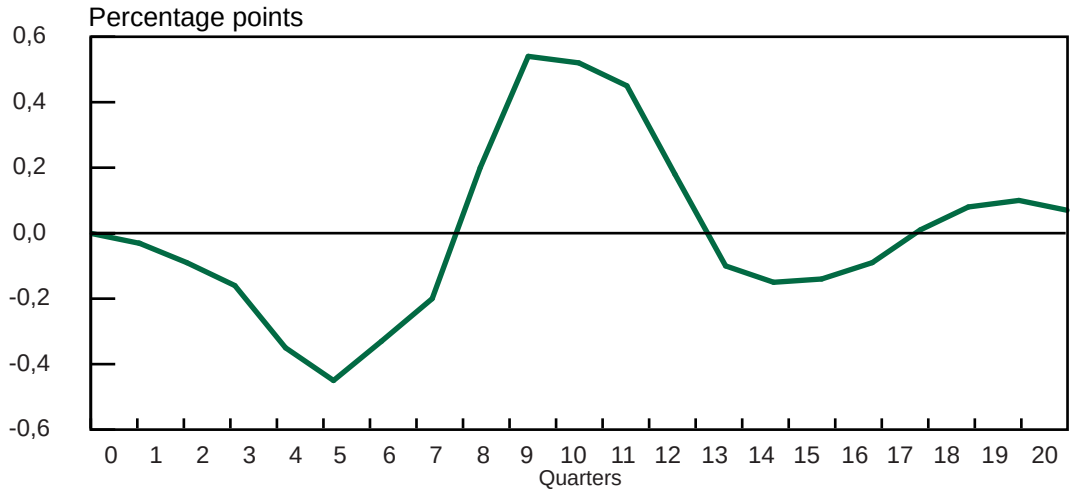
Sound monetary policy must be aimed at achieving overall financial stability, and overall financial stability can only be attained once price stability has been established. The disadvantages of high inflation are well-known in that it amongst others, leads to lower growth, fewer job opportunities and more unemployment. A definite threat to price stability comes from price expectations, which are inclined to become self-fulfilling, and extremely difficult to change once they have been established on a firm basis in the eyes of a majority of the people.

Results from the model suggest that it is extremely difficult for the monetary authorities to trigger a substantial reduction in the rate of inflation by means of monetary policy measures alone. The speed of price adjustments in response to an adjustment in the monetary policy stance may be increased and accelerated if inflation expectations were to respond quickly and strongly to changes in policy.

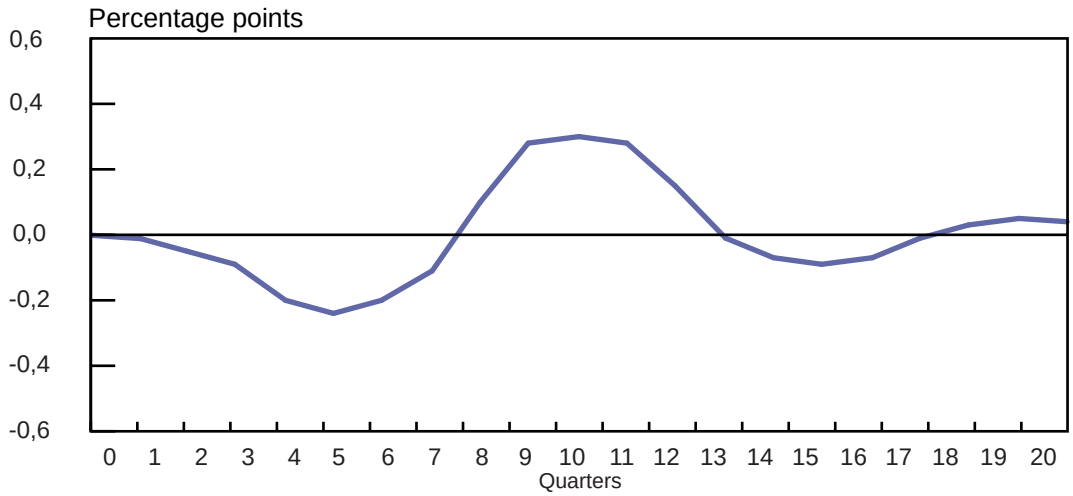
To test this presumption, a third alternative simulation was performed in which a sharp downward adjustment of 1,5 percentage points in inflation expectations was

Graph 13: The effect over five years of a one-off increase of 1½ percentage points in endogenous Bank rate during the first year

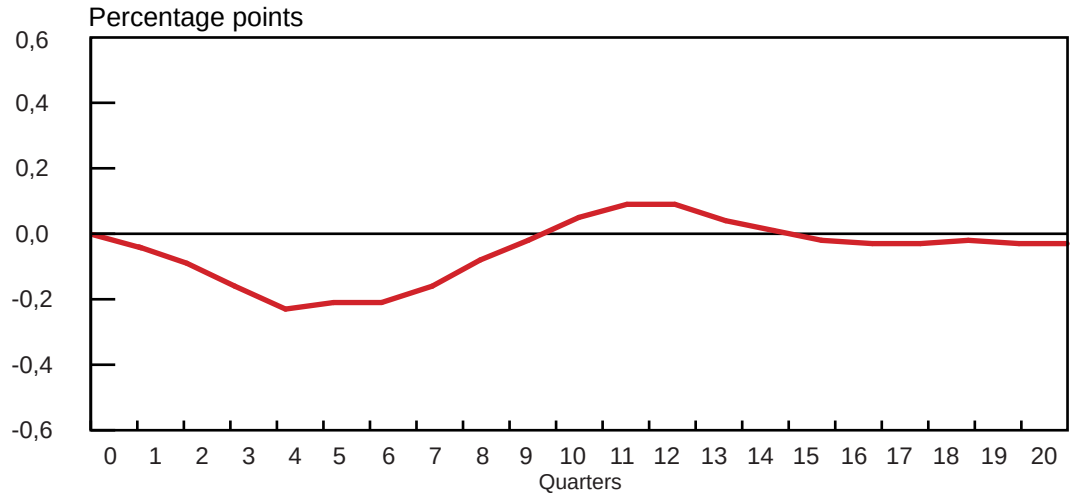
(a): The change in the growth rate of real gross domestic product



(b): The change in the employment rate in the non-agricultural sector



(c): The change in the inflation rate as defined by changes in the consumer price index



assumed. Bank rate was allowed to react endogenously to changes in certain macroeconomic variables by means of the policy-reaction function described above in the discussion of the second alternative simulation.

Graph 14 illustrates that the rate of inflation as measured by the consumer price index declined immediately by approximately 0,8 of a per cent, and then remained at this lower level for the remainder of the twenty quarters. Yet, the simulation results indicate that it takes approximately two quarters for Bank rate to react to the decline in inflation. However, once it started to react, it responded quickly and resembled the decline in inflation as from the fourth quarter onwards.

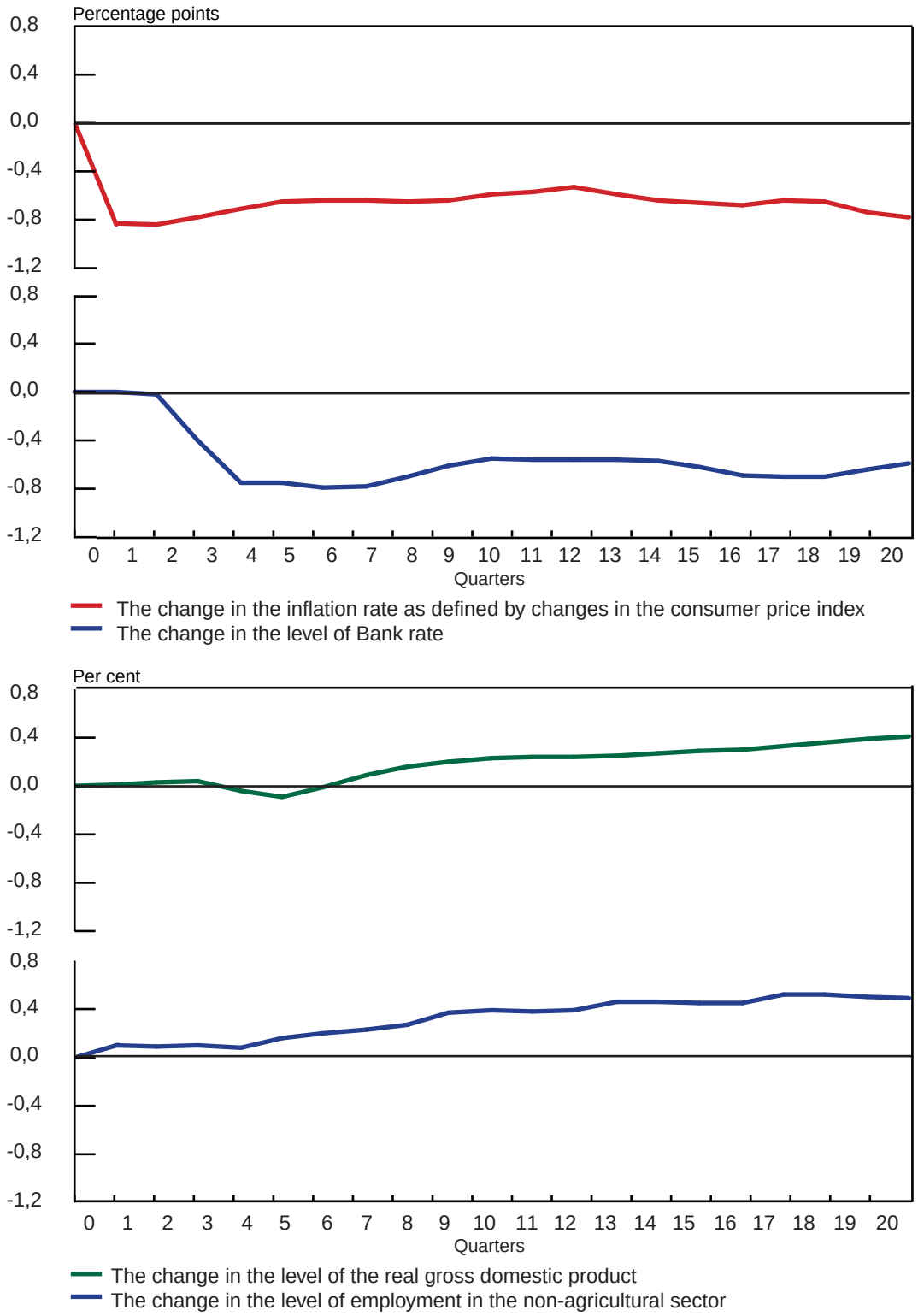
The quick decline in inflation essentially meant that the inflation-adjusted Bank rate was substantially increased during the first three quarters of the simulation, but then declined slightly between the fourth and the eighth quarter. For the remainder of the simulation period, the level of Bank rate seems to track the decline in the inflation rate. This in effect means that the level of Bank rate adjusted for inflation remains similar to that of the baseline simulation for the remaining eleven quarters.

Over the first five quarters, the level of real gross domestic product in the third alternative simulation remained similar to that of the baseline, but from the sixth quarter onwards the level of real gross domestic product increased appreciably at an ever-increasing pace. The level of the real gross domestic product is set to be approximately half a per cent higher than in the baseline in the final quarter of the simulation period.

Employment levels surpassed those of the baseline throughout the simulation period. Formal employment in the non-agricultural sector was raised by approximately 5 000 jobs in the first year and by 27 000 in the final year of the simulation.

The results of the model illustrate the merits and substantial long-run benefits that could be gained from reducing inflation. The rate of real economic growth as well as the number of employment opportunities could hence be expected to increase in response to lower inflation. Such gains could be enhanced and accelerated if inflation expectations were to react more quickly to the implementation of counter-inflationary policy steps.

Graph 14: The reaction of the model to a decline in inflation expectations



8. Summary and concluding remarks

This paper summarises a monetary sub-model to be incorporated into the South African Reserve Bank macroeconometric model in order to describe the interrelationships between financial variables such as interest rates, monetary and credit aggregates and the goods and services markets of the South African economy.

The monetary sub-model emphasises the role of Bank rate as a monetary policy instrument. Results obtained from simulations with the complete model suggest that changes in Bank rate are indeed capable of influencing the magnitude of monetary aggregates such as the total M3 money supply and the claims of the monetary banks on the private sector. Changes in the monetary aggregates are driven by changes in interest rates and total domestic income. Reductions in real income in the short-term result from the adverse effect that higher interest rates exert on aggregate gross domestic expenditure, but sustained longer-term benefits in the form of higher income and employment growth accrue from an enduring reduction in overall inflation.

It is often argued that there is a trade-off between inflation and growth. This view claims that real growth can be stimulated through an expansionary monetary policy at the price of some higher rate of inflation. This may well be true over the short-term, as borne out by the simulation exercises described in this paper. Over the long term, however, lower inflation is bound to become visible in higher levels of real income and employment.

Within the context of the full model, inflation responds relatively slowly to tighter monetary policies which may well be interpreted by some as being impotent to combat inflation. However, such a delay is perfectly reconcilable with the theoretical model of the price-formation process that is currently incorporated in the macroeconometric model of the South African Reserve Bank. The price-formation process accentuates the role of monetary policy in persuading economic participants to rather use the future expected inflation rate in their decision-making processes and not the most recent historical inflation rate.

As labour costs remain at the core of the inflation process, it is the change in wages, which to a large extent is driven by inflation expectations, that ultimately counteracts the spiral of inflation expectations and the inflation rate in the model. In addition, expectations react fairly slowly to conventional monetary policies specifically aimed at reducing the growth in the money supply. Conservative monetary policy applied consistently over time is therefore absolutely essential in stabilising the overall price level at the lowest cost to the country. The results of the various simulation exercises demonstrate that gains in the form of faster income and employment growth can be enhanced and accelerated if inflation expectations were to respond more quickly than usual to a tightening of domestic monetary conditions.

9. Appendix

Code Name	Description of variable
$CABOP_{nsa}$	Current account of the balance of payments, not seasonally adjusted
$CABOP_{sa}$	Current account of the balance of payments, seasonally adjusted
$CAPM_{nsa}$	Capital movements, not seasonally adjusted
$CAPM_{sa}$	Capital movements, seasonally adjusted
DEP_{ct}	Cheque and transmission deposits
DEP_{lt}	Long-term deposits
DEP_{odd}	Other demand deposits
DEP_{sm}	Short-term and medium-term deposits
DEP_{trn}	Total interest-bearing deposits
DUMEVK	Dummy variable for disruptive occurrences, (yield on Eskom stock)
$GGFOR_{nsa}$	Gross gold and foreign exchange reserves, not seasonally adjusted
INV	Domestic investment variable, gross domestic fixed investment
$LARBO_{sa}$	Net other assets of the monetary sector
LRR_{nsa}	Liabilities related to reserves, not seasonally adjusted
M1	M1 monetary aggregate
M1A	M1A monetary aggregate
M2	M2 monetary aggregate
M3	M3 money supply
M_{cn}	Notes and coin in crculation outside the banking sector
MC_{govt}	Net claims of the monetary sector on the government sector
MC_{priv}	Net claims of the monetary sector on the private sector
$NGFOR_{nsa}$	Net gold and foreign exchange reserves, not seasonally adjusted
$NGFOR_{sa}$	Net gold and foreign exchange reserves, seasonally adjusted
$\dot{P}$	Inflation rate, defined as $((P_{pc}/P_{pc}(-4))-1)*100$
P_{cpi}	Consumer price index, (Index 1990=1)
$\dot{P}_{exp}$	Inflation expectations, defined as $((P_{exp}/P_{exp}(-4))-1)*100$
P_{exp}	Price expectations, (Index 1990=1)
P_{pc}	Deflator for private consumption expenditure, (Index 1990=1)
R_{bar}	Interest rate on three-month bankers' acceptances
R_{esk}	Yield on long-term Eskom stock
R_{kkr}	Interest rate on short-term demand deposits, (31 days)
R_{klr}	Interest rate on long-term deposits, (12 months)
R_{kmr}	Interest rate on medium-term deposits, (6 months)
R_{mlr}	Interest rate on mortgage advances
R_{por}	Interest rate on prime overdraft facilities
R_{rbd}	Bank rate
R_{trn}	Combined weighted interest rate on interest-bearing deposits
R_{ttr}	Treasury bill tender rate
SAV	Domestic savings, (personal, corporate and government)
TT	Time trend, escalating with 1 as from the first quarter 1960
$VASDR_{nsa}$	Special drawing rights and valuation adjustments
Y_{dem}	Aggregate domestic final demand, at constant 1990 prices
Y_{exp}	Gross domestic expenditure, at constant 1990 prices
Y_{fk}	Gross domestic product at factor cost, at constant 1990 prices
Y_{pdm}	Aggregate private-sector demand, at constant 1990 prices

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