Financial sector reforms and monetary policy reforms in Zambia

Simatele, Munacinga C H

University of Gothenburg

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FINANCIAL SECTOR REFORMS AND MONETARY POLICY IN ZAMBIA

Munacinga Simatele

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Munacinga C H Simatele

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Central banks don't have divine wisdom. They try to do the best analysis they can and must be prepared to stand or fall by the quality of that analysis.
Mary Kay Ash

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DEDICATION

To Danny and the girls, for all the love, endurance and support

ABSTRACT

The dissertation comprises four chapters focusing on issues concerning policy reforms and monetary policy in Zambia. Chapter 1 briefly outlines the theoretical foundations for the reforms undertaken in Zambia since the mid 1980s and the process thereof. The main issues addressed were the removal of interest rate and credit controls, exchange rate devaluation and the use of indirect instruments in implementing monetary policy. Monetary policy also began to focus more on stabilisation through bringing the inflation rate down. The review indicates that although the control of inflation is still difficult and figures are still in double digit levels, annual inflation rates have reduced significantly compared to levels achieved in the early 1990s. The nominal exchange rate has been depreciating prompting increased intervention from the central bank. Despite the increase in nominal interest rates, real deposit rates have remained negative.

Chapter two analyses the monetary transmission mechanism in Zambia. Vector auto -regressions are estimated for the pre-reform and post-reform periods. Variance decompositions and impulse response functions are examined to see whether there are any changes observed in the monetary transmission mechanism after the reforms. Different systems are estimated in each period using alternate variables as measures of monetary policy shocks. The results show that contractionary monetary policy is followed by a fall in both output and prices. When compared, results from the two estimation periods show that both the responsiveness of prices and output to policy shocks and the magnitude of their forecast error variance decompositions explained by these variables have increased since the reforms. The results also show that the impact lags have reduced. There is evidence of the bank lending channel both before and

after the reforms. Of the mechanisms estimated, the exchange rate mechanism seems to be the most important mechanism for transmission of policy shocks to both prices and output during the post-reform period.

Chapter three investigates whether monetary aggregates have useful information for predicting inflation other than that provided by inflation itself. Forecasting experiments are conducted to see whether monetary aggregates and selected financial sector variables are useful in predicting inflation.We perform forecasting experiments and compare the performance of different models. We also estimate an error correction model of inflation. Of the monetary aggregates considered, M2 contains the most information and its growth rate significant in the inflation model. The external sector variables are also important. The results indicate that inflation exhibits a high level of inertia suggesting the presence of implicit indexation and significant inflationary expectations possibly due to past fiscal effects and low policy credibility. Overall, the foreign sector variables seem to be more important for movements in prices than monetary aggregates even in the long run.

The importance of the exchange rate to stabilisation policy in Zambia is underscored by the results obtained in chapters 2 and 3. In this paper, we pursue this idea by investigating the effect of central bank intervention on exchange rates in Zambia. Using a GARCH (1, 1) model of the exchange rate, we simultaneously estimate the effect of cumulative intervention on the mean and variance of the exchange rate.We find that central bank intervention in the foreign exchange market increases the mean but reduces the variance of the exchange rate. The explanation leans towards speculative bandwagons and a 'leaning against the wind' strategy. Although there is no attempt to distinguish through which channel intervention operates, we argue that this is more likely to be a signalling effect rather than a portfolio balance effect. This effect operates mainly through the supply and demand of foreign exchange in the market.

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Munacinga Simatele
Gothenburg, December 2003

PREFACE

The importance of the financial sector in economic development for developing countries has attracted a lot of attention in recent years. The perverse effects of interest rate controls, overvalued exchange rates, controlled lending and other controls have led to a large volume of research relating to financial reform. An open and well regulated financial sector promotes economic growth and stability. In the current setting with a rapidly globalising world economy, efficient financial sectors are essential for productive gains from the world market and to protect the domestic economy against foreign shocks. For most developing countries this became very evident during the oil crises of the 1970s.

With this in mind, issues of financial reform have featured very prominently both in the discussion and implementation of economic reforms in Africa. Although a liberalised system is generally more robust than a repressed one, there are complexities of the sequencing of reforms, equity, efficiency, institutional support for reforms, and general governance which present practical huddles in the new environment within which developing economies must operate. These issues raise questions of how the reformed economies are performing in the new environment and whether the reforms have actually achieved the intended goals. However, there is little direct evidence on how the reform programs have performed in these countries, especially in the financial sector.

The essays in this thesis address three related issues linking different aspects of financial sector and monetary policy reform. The changes that have occurred in the transmission of policy to the macro-economy are addressed first. This is followed by a paper that evaluates the information content of different variables for forecasting and predicting inflation. The last paper draws on conclusions in

both the first and second papers that highlight the importance of the exchange rate for monetary policy in Zambia and looks at the impact of central bank intervention in the foreign exchange market.

The understanding of the potency of monetary policy and the transmission mechanism as addressed in the first paper is very important to the success of monetary policy. Efficient implementation requires policy makers to understand the path policy takes to impact the macro-economy and the time horizon needed for impact. Key policy issues in the current policy framework arise. For example, do changes in reserve money actually lead to changes in M2 and/ or inflation? If yes, how long do these changes take to impact inflation? This information would then aid policy makers to know which instruments are more useful and which time horizon should be used to target inflation. We estimate Vector Auto Regressions (VARs) and use the results to evaluate the importance of different policy variables for developments in prices and output. We look at the total amount of variations in prices and output due to different policy variables, the direction of responses and the length of the impact lags. Such information is useful in answering questions such as those cited above. We find that the potency of monetary policy has increased since the reforms especially for price pass-through.

Conducting monetary policy is a difficult process because monetary policy affects the economy with a lag. Achieving goals requires some ability to peer into the future. Consequently, decision makers must make forecasts to help in decision making. To conduct these forecasts, most central banks take a number of variables into account. The exclusive focus on one or a few selected variables as is done in the financial programming framework implies that the policy makers believe these variables must contain enough information about movements in the target variables. Paper II is an attempt to evaluate the information content of not only the monetary aggregates used by the Bank of Zambia (BOZ) to target inflation, but other key variables such as interest rates, the domestic debt and the exchange rate which have the potential of being very useful inflation indicators. Exchange rates and the deposit rate turn out to be

the most useful indicators in the set of variables considered.

Once interest rate controls are removed and the exchange rate floated, the interest rate and the exchange rate become important components in the transmission mechanism. The more open the economy, the greater the importance of the exchange rate in the policy process and the more important this variable becomes as an optional policy conduit. A depreciation of the exchange rate increases inflation and vice versa. For this reason, the stability of the exchange rate is very important for price stabilisation. To ensure this, most central banks intervene in foreign exchange markets to smooth out short run fluctuations of the exchange rate. However, the effects of central bank intervention in the foreign exchange market are not straight forward. The efficiency of the foreign exchange market and the nature and credibility of the interventions matter. The effect of such interventions therefore is an empirical question. Paper III provides an empirical estimation of the effect of BOZ interventions in the foreign exchange market. The results indicate that intervention reduces fluctuations in the exchange rate.

The results from the empirical papers in this thesis lead to the following conclusions.

1. The potency of monetary policy in Zambia has increased since the reforms

2. The deposit rate seems to be a better indicator of the central bank policy stance than the base rate (3-month treasury bill rate). The importance of the deposit rate suggests a good policy option to monetary targeting

3. M2 is important in understanding price movements in Zambia.

4. The exchange rate seems to be even more useful. This underscores the importance of a stable exchange rate. However, foreign exchange intervention does not seem to provide the complete solution. Possible options or complements include exchange rate targeting and a dirty float.

1. FINANCIAL SECTOR REFORMS AND MONETARY POLICY IN ZAMBIA

ABSTRACT

In this chapter, we briefly outline the theoretical foundations for the reforms undertaken in Zambia since the mid 1980s and the process thereof. The main issues addressed were the removal of interest rate and credit controls, exchange rate devaluation and the use of indirect instruments in implementing monetary policy. Monetary policy also began to focus more on stabilisation through bringing the inflation rate down. The review indicates that although the control of inflation is still difficult and figures are still in double digit levels, annual inflation rates have reduced significantly compared to levels achieved in the early 1990s. The nominal exchange rate has been depreciating prompting increased intervention from the central bank. Despite the increase in nominal interest rates, real deposit rates have remained negative.

Keywords:*Monetary Policy, Financial Sector Reforms, Zambia*

1.1 Introduction

For over two decades, the Zambian economy was dominated by government ownership. The financial sector was riddled with controls implemented through direct control over credit and interest rates. There were also substantial administrative controls in place directing lending and controlling both local and international financial transactions. The exchange rate was fixed and trade was heavily regulated. A programme of overall economic reform was fully embarked upon in 1991 and financial reforms were amongst the key issues addressed.

Many financial reforms have been put in place and economic management now revolves quite a lot around monetary policy. The interest in this chapter is to briefly review the theoretical foundations for financial reforms and more specifically, issues arising out of that for monetary policy. We start by outlining the McKinnon-Shaw hypothesis and its extensions and then go on to discuss theoretical implications for monetary reforms. We then move on to discuss the evolution of the monetary sector in Zambia

1.2 Theoretical Foundations For Financial Reforms

1.2.1 Financial Reforms

The theory on financial reforms as is emphasizes today in developing countries goes back to McKinnon (1973) and Shaw (1973). Although their assumptions about the nature on money in the models differ, both theories have similar implications for financial reforms. The foundation of their analyses is that interest rates have a positive relationship with economic growth and that low interest rates would therefore impede growth. This was a challenge to earlier existing belief that directing lending to critical sectors and keeping interest rates low would stimulate investment .[1]

[1] This was based on the argument that money and capital are substitutes in the portfolio of private wealth and market failure. see Solow (1956) and Tobin and Brianard (1963)

McKinnon (1973)makes two basic assumptions. First that all economic units are self-financed and secondly that investments have indivisibilities of considerable importance. The implications of these assumptions are that an investor must accumulate money balances before he or she is able to invest. This accumulation is encouraged if there is a positive real deposit interest rate. A positive real interest rate lowers the opportunity cost of accumulating balances and encourages individuals to deposit their money in the banks. This allows accumulation of loanable funds from which investors can borrow. The indivisibilities of investment imply that the demand for money is larger the larger the share of investment in total expenditures. In this theory then, money and capital are complementary. It is often referred to as the complementarity hypothesis. Without implying direction of causality, one can say increased intermediation in this model leads to increased investment.
The theory can be formalized as a money demand function i.e.

$$\frac{M}{P} = f(Y, \frac{I}{Y}, d - \pi^e) \tag{1.1}$$

Where Y is real GNP, I is gross investment, d, the nominal interest rate, π^e, expected inflation (so that $d - \pi^e$ is the real rate of interest), M is the stock of broad money and P is the price level.
In the model, money has a first order impact on decisions to save and invest which are taken to be one decision (because of the need to accumulate for investment). The model can also be expressed as an investment function

$$\frac{I}{Y} = f(\gamma, d - \pi_e) \tag{1.2}$$

where γ is the average return to capital.
In Shaw's model, money is backed by productive investment loans to the private sector. When the money stock is large relative to the level of economic activity (say $\frac{M2}{GDP}$), the level of intermediation between savers and investors is also larger. Thus this theory explicitly emphasises the importance of financial intermediation. When a repressed economy reforms its financial sector and removes controls, higher real rates of deposit increase intermediation leading

to financial development by providing incentives to savers. It also leads to a higher average efficiency of investment by lowering the cost of borrowing through providing risk diversification, accommodating liquidity preference, lowering informational costs and increasing operational efficiency. Shaw's model is an inside money model and is often referred to as the Debt Intermediation View(DIV). The money demand equation in the model can be written as follows:

$$\frac{M}{P} = f(Y, \gamma, d - \pi^e)$$

where γ is a vector of opportunity costs in real terms of holding money.
This theory relies on neo-classical market clearing assumptions. Specifically, the market must work to equilibrate the demand and supply of loanable funds and the market must be competitive. In this view then, when interest rates are kept artificially low, there will be low incentives for saving hence little funds to lend, limiting investment and therefore the growth of the economy. In this case, intermediation is repressed. The removal of controls in a financially repressed economy therefore implies that the interest rates will increase resulting in higher savings. These higher savings mean the availability of more investment capital and hence an increase in output. The McKinnon-Shaw hypothesis is therefore the basic foundation for financial liberalization.
However it does not explain the workings of banking systems in many developing countries and how liberalization can address questions of fragmentation, bank distress and financial rationing Sikorski (1996).
A number of models have been developed to try and refine the basic McKinnon-Shaw hypothesis. One of the classical refinements is the introduction of the model of imperfect information by Stiglitz and Weiss (1981). The model demonstrates that an equilibrium financial market can be characterized by credit rationing. This arises because after long periods of repression and financial underdevelopment, banks are often not in a position to completely assess the risk characteristics of their potential borrowers. This is compounded by information asymmetries arising from either bad accounting

practices or lack of monitoring systems. Where such information asymmetries are significant, banks push up their lending rates so as to compensate for risk associated with lending. Two problems often result from this. Firstly, adverse selection problems arise because with high interest rates, the pool of borrowers is increasingly composed of high risk borrowers. Such borrowers are more likely to make risky investments which if successful would have high returns. The second is the moral hazard problem where higher interest rates induce firms to make more risky investments which have higher expected returns. The result is that some borrowers are completely rationed out of the credit market even if they have viable projects .

In addition to adverse selection and moral hazard problems, financial liberalization tends to initially increase interest rates. This results in the deterioration of banks' loan portfolios. The source of this problem is twofold. Firstly, when there has been a history of failed attempts at liberalisation as was the case in Zambia, the private sector may not have confidence in the reforms. Firms will not adjust their balance sheets or loan portfolios to accommodate the shocks resulting from the removal of controls. When the controls are actually removed, these firms experience severe financial problems and in many cases may not be able to repay their loans. As a result, banks have to increase their interest rates to compensate for lending and market risk thereby worsening the already bad loan portfolios. In many cases, these loans cannot be written off and firms begin to borrow to finance existing loans. Because the solvency of the banks to a large extent depends on the survival of these firms, the banks continue lending to these firms creating a large pool of non-performing loans. Secondly, even if the banks cannot raise interest rates on existing loans, increased deposit rates imply a negative spread on existing loans as banks cannot increase the lending rate on these loans. This compounds bank fragility.

Another issue that has been raised concerns the presence of informal markets. In most of these countries, informal markets have arisen not only because of the repression from controls but also the high cost of small and frequent

transactions. The larger part of the population in these countries have low incomes and they often conduct small and frequent transactions. This entails a significant level of transactions costs for formal institutions. A pool of potential borrowers with no access to credit develops. The result is an informal financial market operating parallel to the formal with low transactions costs and often low information asymmetry as they operate within their own communities.

The effect of interest rate liberalisation in terms of total loan supply also depends on the flow of funds between the formal and informal sectors (Taylor (1983),Wijnbergen (1983)). If the links between the two sectors are strong so that loans in the informal market are a close substitute for formal market deposits, an increase in real interest rates in the formal sector would shift the flow of funds towards itself. If the small scale businesses that rely on the informal sector for finance are a substantial part of economic activity, this might lead to a fall in output contrary to the predictions of the McKinnon-Shaw hypothesis. On the other hand if the increase in deposits in the formal sector substantially increases not only loan supply but also accessibility for such small scale businesses, the increased bank intermediation may lead to increased output as expected.

Although Shaw's DIV hypothesis implicitly addresses the issue of working markets before interest rate liberalisation, the issue of overall macro-economic stability is absent. By the time most developing countries are reforming their economies and considering or actually implementing financial reforms, these economies are usually in distress wrought by both internal and external deficits. Attaining an acceptable level of macro economic stability is a needed pre-requisite to avoid further destabilising the financial sector and jeopardising other reforms (Cavallo and Cottani (1993)).

1.2.2 Monetary Reforms

Many countries faced with repressed financial systems face problems of monetary control associated with ineffectiveness of direct credit and interest rate controls. These controls are associated with inefficiency in resource allocation. Under such a regime, monetary aggregates cease to bear a close relationship to the goals of monetary policy. Monetary reforms are central to most financial reforms. The focus is on moving to more indirect means of monetary control and therefore freeing controls on both credit and interest rates. Indirect instruments that can be used in the early stages of reform while markets are not yet fully developed include market operations such as auctions of government treasury bills or central bank refinance credits or certificates of deposits to control money market liquidity [2].

More indirect market based approaches enhance monetary control and increase the likelihood of achieving macroeconomic stability. Increasing reliance on indirect monetary controls allows the authorities to eliminate distortions in the financial markets resulting not only from controls of interest rates and credit, but also from the use of high non-interest bearing reserve requirements to control liquidity. Indirect monetary control also enhances the development of money and inter-bank markets which eventually also improve the potency of monetary policy. It is desirable therefore to introduce the use of such instruments early in the reform process.

The elimination of interest rate and credit controls has potentially important effects on monetary aggregates. The liberalisation of interest rates and credit could lead to a shift in money demand affecting both the quantity demanded and the interest rate elasticity of their demand. On the one hand since credit was constrained by direct controls before the reforms, there is a tendency for banks to run down their excess reserves by increasing lending in an

[2] The type of instruments adopted must take into account the legal and technical arrangements to distribute central bank profits and/or losses if these should occur in the use of central bank rather than treasury paper. See Johnston and Brekk (1999) for a survey of monetary instrument reforms in nine developing countries

environment already wrought with excess demand for credit.

On the other hand, liberalisation of interest rates may lead to initial increases in deposit rates relative to other rates. This would lead to increases in deposits and broad money holdings. In that case, broad money will become less sensitive to changes in the general level of interest rates. As a result of these structural shifts, the information content of aggregates would become difficult to assess during the transition stage. It also becomes difficult to control the aggregates using interest rates, so a wider range of financial indicators is required during this phase.

Comparatively, the increases in credit are likely to be higher than increases in deposits since deposits were not directly constrained before reforms but were rather just responding to changes in the deposit rate. Following this adjustment period, credit growth slows down while deposits continue to grow if positive real interest rates are maintained. Credit and deposits eventually converge allowing for balanced growth with a higher level of overall resource mobilisation. [3] If positive interest rates are not maintained, credit expansion could result in a loss of macroeconomic control and increasing inflation or worsening the balance of payments. Trying to control credit expansion by the use of interest rates or indirect monetary controls could result in large increases in interest rates. Where the capital account is open, this could lead to massive capital inflows and a subsequent appreciation of the exchange rate which in turn could have adverse effect for the real sector.

There is also a close link between the design of monetary policy instruments and operations and the structure and depth of money markets, including the supporting payments systems. As a result, reforms of monetary control procedures are best accompanied by parallel measures to strengthen money and inter-bank markets and payments systems.

The opening up of the capital account also has implications for monetary policy. Because direct methods of monetary control become very ineffective once the capital account is opened, the move to indirect monetary control

[3] See Bisat et al. (1999) for a more detailed discussion

becomes an inevitable pre-requisite. With increased capital mobility, the demand for domestically defined monetary aggregates may become more sensitive to international interest rate differentials making it more difficult to identify a stable domestic monetary aggregate. Opening up the capital account therefore reinforces the adoption of a more eclectic monetary framework and a move towards giving more weight to exchange rates in monetary assessments.
Bank regulation is another important aspect of monetary reforms. Before most of the physical aspects of financial reform such as those discussed above are put in place, there is a need to put a basic financial structure such as auditing, accounting, legal systems, and basic regulation in place (Caprio (1997)). The main goal of prudential regulation is to lower the risks and costs associated with institutional failure while achieving the increased efficiency of the financial system. This implies that while the government should leave the economy to the market, it should enhance its role to ensure fair and honest markets through prudential regulations without using it to perpetuate the controls existing before the reforms. When reforms are implemented without first putting appropriate regulation in place in an economy where the banking system is under-capitalised or insolvent, bank distress can result as has been seen in many African countries. The resulting distress can in turn complicate monetary management and limit the effectiveness of stabilisation policies.
The presence of information asymmetries magnifies the need for appropriate regulation early in the reforms. When information asymmetries are prevalent as is the case in most developing countries, problems of adverse selection lead to the setting of imprudently high interest rates. Banks end up attracting very risky borrowers resulting in high levels of non-performing loans. Putting appropriate regulation in place allows the markets to provide correct signals while helping to ensure that this takes place at acceptable costs and in an orderly manner. When liberalisation precedes prudential regulation, weaknesses in the market can lead to financial fragility, bank failures and an undermining of monetary policy.

Monetary Reforms in Zambia

Central banking in Zambia started with the Opening of the Bank of Rhodesia (Now Zambia and Zimbabwe) and Nyasaland (now Malawi) in 1961. When the federation disintegrated with the independence of Malawi, the new bank split and the Rhodesian one was named the Bank of Rhodesia in 1964 and finally renamed to Bank of Zambia later the same year when Zambia attained independence.

The organizational structure of the Bank of Zambia was for a long time the one inherited from the colonial period. The responsibility of policy and administration lay in a board of directors. The president appointed the Bank governor (who also acted as the board director) and the deputy Board director. The minister and permanent secretary of the ministry of finance appointed the rest of the board members. These appointments tended to create a very strong relationship between the central bank and the government. This relationship was made stronger by a provision in the Bank Of Zambia Act (1965) that the bank had to oblige if the minister of finance under consultation with the governor gave instructions to it. Despite other provisions in the Act, this tended to compromise the central bank's autonomy.

In addition to traditional central Bank duties, the Bank of Zambia Act (1965) provided that the central bank also had a developmental role. It was argued that since the financial system was highly underdeveloped, the central bank should help in establishing appropriate institutions. This led to BOZ participating in the establishment of the Zambia National Commercial Bank (ZNCB), the Zambia Stock exchange and buying of shares in the Development Bank of Zambia (DBZ).

The rest of the financial system was composed of five foreign banks and a few insurance companies. After independence, the government opened up a government owned bank, ZNCB, created development related finance companies and nationalized insurance and pensions industries. A post office savings bank (later called The National Savings and Credit Bank) was opened

to serve savers in the lower income brackets.

The ultimate goal of monetary policy was economic growth. The developmental role of the central bank seemed to dominate policy. The existing commercial banks at the time made very few loans to indigenous businessmen and the agricultural sector. As a result, the government put in place a lot of administrative controls to try and redistribute lending so that these sectors are covered. These included directed lending, limits on composition of boards of directors and control on interest rates. Commercial banks were also required by law to open branches in rural areas.

Between 1964 and 1974, the output and prices of copper were good. Because of this, exports were generally greater than imports and there were no major problems with the external balance. The official currency in Zambia between 1964 and 1968 was the Zambian pound which was pegged to the British pound and fully convertible. In 1968, the currency was changed to the kwacha and de-linked from the pound and linked to the US dollar and later to the SDR in 1976. At the time, interest rates were controlled by BOZ.

After 1974, a number of factors led to balance of payments problems. Firstly, there was the oil shock of 1973/74 and the resulting recession. This reduced the demand for copper and led to reductions in export revenue. The reliance of the manufacturing industry on imported raw materials and spare parts also led to reduced capacity utilisation and a fall in real GDP. The result was a shortage of foreign exchange and a negative current account.

Internally, the government budget began to be negative in the early 1970s mainly due to continuously increasing public consumption. Many socio-economic services such as education and health care were provided free for everyone. During this period, the budget was mainly financed by the copper revenues. As the copper revenues started to fall, the government maintained its consumption patterns in the hope that this was a temporal situation and resorted to borrowing both internally and externally.

During this period, both lending and deposit rates were kept low for a number of reasons. One main reason was to induce economic growth. This view was

inspired mainly by Keynesian economics that suggested that low interest rates availed cheap investment funds leading to an increase in output [4]. Low interest rates were also justified on the basis that it helped keep government and parastatal debt service costs within manageable limits. Figure 1.1 shows interest rates and inflation between 1970 and 1982. Defining the implicit real interest rates as the difference between the nominal rate and the inflation rate, we can see that interest rates were negative for almost the whole period.

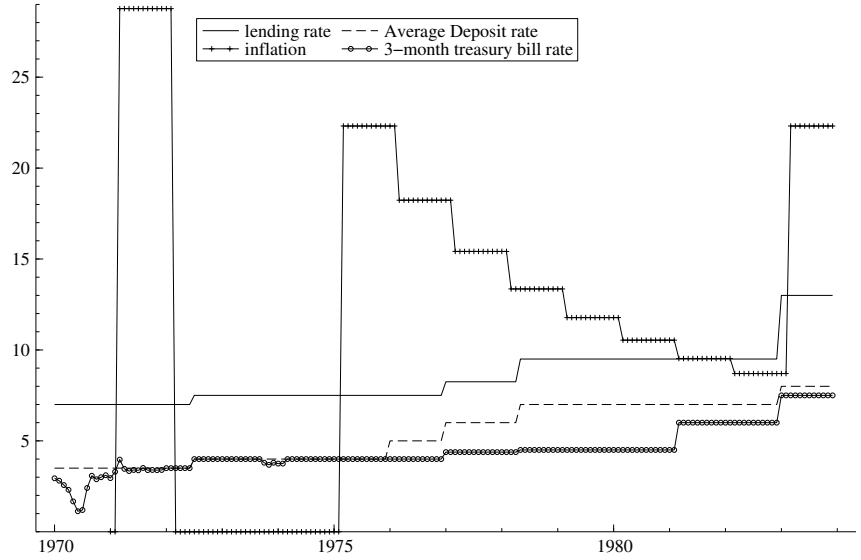


Fig. 1.1: **Inflation and Interest Rates 1970-1983**

As both the balance of payments and fiscal deficit worsened, the government increased its borrowing. The copper prices did not pick up and neither did demand. The deficit financing that BOZ provided the government fuelled inflation that had began to get serious during the oil crisis of 1973/74. Because the economy was largely controlled, there were no in-built mechanisms in the system to adjust to both the internal and external

[4] We note here that the theory in mention implies the real interest rate but this was not taken into account

pressures. The government responded to external pressure by imposing a lot of controls on trade and further borrowing. Tariffs were increased, quotas were imposed and foreign exchange in the official channels was directed to priority sectors. Internally, the government continued to bridge fiscal deficits by deficit financing and loans from the international community.

By the early 1980s, it was clear that the Zambian economy was under severe pressure. Because of the inability to fully service loans, the IMF and World Bank began to attach conditionalities to the loans given to Zambia. In 1983, Zambia received the first conditional loan from the IMF. This was the birth of the structural adjustment programs in Zambia. The main feature of these reforms was to allow a greater role for market forces in the economy. Specifically, the kwacha was to be devalued, interest rates decontrolled, international trade liberalised, public expenditure reduced, prices decontrolled, and debt servicing improved.

In response, the institutionally set interest rates were increased. Between January 1983 and January 1987 when the reforms were briefly abandoned, the lending rate increased by 154 percentage points while the treasury bill rate increased by about 195 percentage points from 9.5 % to 28%. In 1983, a basket of the currencies of Zambia's five major trading partners was introduced. The kwacha was now adjusted within a narrow range and set to depreciate at 1% per month and this percentage was increased to 2.5% by 1984. This was meant to let the kwacha settle to a realistic market value. The foreign exchange auction was introduced in October 1985 with the official exchange rate at 2.2 kwacha per dollar and by the beginning of 1987, the exchange rate had increased to 15 kwacha per dollar.

The ensuing devaluation and price decontrols led to marked increases in inflation. Between 1983 and 1987, the CPI inflation more than doubled from 19.6% to 43%. During the same period, there was significant growth in monetary aggregates, which also contributed to increases in inflation. In 1987, as the economy wide reforms progressed, maize subsidies were also removed[5].

[5] Maize is the staple food in Zambia and had thus far been heavily subsidised by the

There was heavy rioting on the Copperbelt and the government decided to abandon the IMF/World bank sponsored adjustment programmes in May 1987 [6]. The government embarked on a new development program-the New Economic Recovery Programme (NERP). One of the major issues was to influence consumption patterns to change in favour of local products. There was emphasis on internally generated resources to finance growth and development rather than relying on aid. Imports were controlled and key products were rationed. Consumption of locally produced goods and services was encouraged.

When the reform program was abandoned, the foreign exchange auction was replaced by a foreign exchange allocation system under a Foreign Exchange Management Committee (FEMAC) and the exchange rate was re-valued from K21/$ to K8/$. In February 1987, the interest rates were also revised downwards. Aid stopped flowing from the IMF and the World Bank and the plan was to rationalise the use of foreign exchange so that it could compensate for this loss of funds through net export earnings. Repayment of the existing debt was limited to 10 % of net export earnings.

During the NERP period, there was improved economic growth. Net exports were positive mainly due to a significant fall in imports. Price controls were reintroduced and in addition price monitoring was put in place. The exchange rate was re-valued and fixed again. This together with the re-introduction of controls on trade led to chronic shortages of consumer goods. These shortages fuelled prices. Government budget deficits continued and were continuously funded through printing of money leading to increases in money supply and hence increased inflation. The resulting decline in foreign aid put a lot of pressure on government expenditure and in 1989 Zambia returned to the IMF/World Bank sponsored programs in 1989 and the foreign exchange

government. When price controls were removed on other food crops such as cassava and sorghum, maize subsidies were maintained with the view to remove these subsidies gradually

[6] The Copperbelt is one of the largest and most urbanised provinces in Zambia. It holds almost all of Zambia's copper mines

auction was re-introduced.

A new program under the title New Economic Program was put in place in 1989. The features of this program were basically the same as those under NERP except that they were implemented with more intensity. The key monetary action was to mop up liquidity in the economy. The actions taken included the increase in minimum reserve requirements of commercial banks and requiring parastatals to deposit a kwacha equivalent of any external debt that they had. Government bonds were also introduced.

Nominal interest rates were increased. Between the reintroduction of the reforms in 1989 and September 1992 when the interest rates were liberalised, the lending rate increased from 18.4% to 58.5% while the treasury bill rate increased form 18.5% to 47 %. The exchange rate was devalued and later the fixed exchange rate was abandoned for a crawling peg. In 1990, a two-tier exchange rate system was introduced. The first tier was the official exchange rate determined by BOZ under FEMAC and the second tier operated with a market determined rate and was used for imports under the Open General License System (OGL). Exporters of non-traditional exports were allowed to retain 50% of their export earnings in foreign exchange.

Between 1989 and 1991, the inflation rate began to fall. The introduction of multiparty politics in Zambia in 1991 disturbed the program as the then ruling government began to back track on its commitments as a campaign strategy in the run up to the general and presidential elections.

In October 1991, a new government was ushered into power. The program implemented by the new government differed from the previous one only with the pace and rigor with which it was implemented. From 1992, Zambia entered a Rights Accumulation Program (RAP) which was meant to facilitate the clearing of arrears on debt to the IMF, which upon completion would allow Zambia access to a concessional loan facility with only 0.5 % annual interest. The new program required tight monetary and fiscal policies. The main goal for government policy was to control inflation although economic growth remained the ultimate goal. To achieve this, a series of quarterly

targets for domestic credit to the government, reserve money and specific liberalisation measures were set. The Zambia Revenue Authority (ZRA) was formed to implement tax reforms and improve revenue collection. The government tried to implement the cash budget strategy started in 1993. This strategy required that revenue had to be raised before it could be spent.
The government often missed the targets and to signal commitment to the program, it accelerated the implementation of other conditionalities especially those of liberalisation. Interest rates were liberalised in 1992. Within six months, the lending rate had risen by over 260 percentage points from 47% in December 1992 to 171% in June 1993. The deposit and treasury bill rates increased over the same period from 46.8 % to 97.9 % and 47% to 164.9% respectively.
Figure 1.2 shows that despite these rapid increases, similar increases in the price level meant that real interest rates were positive only for a short time. Two other features are worth noting Firstly, the deposit, treasury bill and lending rates move quite closely in the early years of the reforms but the spread increases quite significantly in the latter years especially for the savings rate. Secondly, while both treasury bill and lending rates are positive a short while after the reforms, deposit rates remained negative throughout the period and are more so in the latter years of the sample period.
In 1992, export retention was extended to 100% for exporters of non-traditional exports. In the same year, private bureaux de change operations were legalised, the OGL list was expanded and the exchange rates unified. In 1993, the exchange rate was liberalised and in 1994, the Exchange Control Act was repealed, the OGL system abolished and the kwacha became fully convertible.
Adam (1995) argues that some of these premature liberalisation measures distorted the sequence of implementation of the reforms and imposed significant costs to the economy. The open current account and full unification of the bureau and official exchange rates erased the implicit tax revenue accruing to the government from the private sector, since the government was

the biggest purchaser of foreign exchange from the non-government sector. Given the decision to have a cash budget, this reduction in revenue implied significant fiscal strain.

The introduction of the auctioning of government debt in March 1993 allowed treasury bill rates to be market determined. This increase led to increases in deposit rates. This in turn reduced demand for base money and therefore seigniorage revenue flowing to the government. This off course again imposed a strain on the government budget. The high rates on treasury bills also affected portfolio allocation. Investors started to invest more in treasury bills than in productive investment. At the maturity of these bonds, the economy tended to be very liquid (Brownbridge (1996)) leading to sharp increases in money supply.

Bank regulation also needed to be reformed although this was done quite late into the reforms. Until 1994, Prudential regulation and supervision lay in the Banking Act of 1971 and the Bank of Zambia Act of 1985. The Banking Act of 1971 did not cover building societies, the Post Office Savings Bank or any other financial institutions established by the written law of Zambia. There

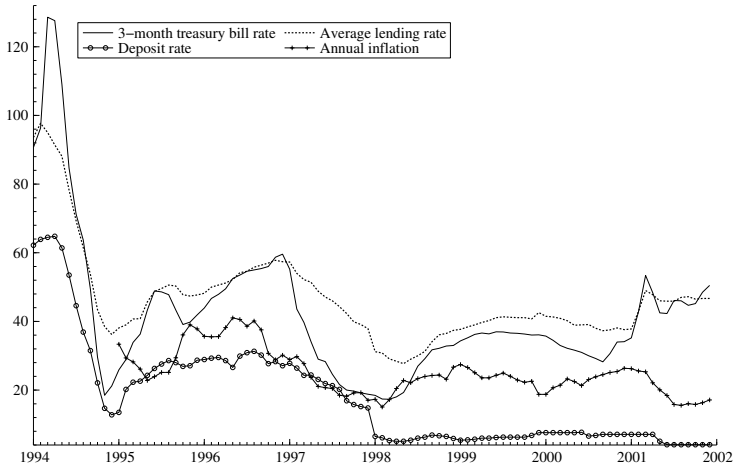


Fig. 1.2: Inflation And Interest Rates (1984-2001)

were parts of these regulations that made effective implementation difficult. Firstly, the authority to issue and withdraw licences lay in the hands of the registrar of banks appointed by the ministry of finance. This opened a window for corruption and the existence of non-profitable banks. Secondly, the Act did not provide for BOZ to issue and update prudential regulations. As a result, some regulations were in operation even when their relevance had been eroded. One such example is the minimum capital requirement. Until 1989, this remained at two million kwacha, which was worth three million dollars in 1971 and only $150 000 in 1989. It was then revised to K20 million worth only $30 000 in 1994, when a new legal structure was put in place.

The Act was also unclear as to the qualifications and experience required of managers and directors when applying for licences. Together with the low capital requirements, this allowed for the opening up of badly capitalised and managed banks after licensing was liberalised. There were no references to insider lending or loan concentration and by the time such regulation came into place, there were high levels of lending to directors and family members. A new legal structure came in the form of the Banking and Financial services Act (BFSA) 1994. By this time, there were a lot of banks that had opened with very low levels of capital and poorly qualified staff. Many of these banks had high levels of insider lending and non-performing loans. In 1990 with the run up to the first multiparty elections in Zambia, Capital bank closed on account of rumours of political interference and poor liquidity. In 1995, Meridian BIAO also started to experience liquidity problems and the government attempted to bail the bank out by providing funds.

The financing given to Meridien BIAO was very substantial and created a significant fiscal deficit. It also undermined monetary policy significantly as it increased liquidity in the economy. Despite the attempted bail out, the earlier experience with Capital Bank had a contagion effect on the bank and in the same year the bank was placed under receivership. Later the same year, three other banks experienced similar problems and were all closed. Stricter regulations were issued in early 1996 to try and avoid more bank closures.

Specifically, foreign exchange regulations were strengthened and minimum capital requirement was extended to include risk-weighted capital. Still, banks continued to close. Of the 26 banks registered in December 1995, only 15 were operational by April 2003.

Unlike the previous regulation, BFSA covers all bank and Non-bank Financial institutions in Zambia. Licensing now falls under the registrar of Banks and Financial Institutions based at BOZ. The new law sets out screening standards for applicants and criteria include capital adequacy, the history of the applicant and proposed associates, major shareholders and affiliates including the character and qualifications of proposed directors and managers. The supervisory capacities of BOZ have also been strengthened and a separate supervisory and regulation department was created. To this effect, the first Financial System Supervision report was issued in 1995. The purpose of the report was to "inform the financial sector, the minister of finance and the general public about developments in the financial sector". Bank inspections are conducted and a system of prudential indicators for determining bank solvency has been developed. Currently the BOZ conducts both on-site and off-site examination of financial institutions. In 1997, the operation of the clearinghouse was transferred from BOZ to commercial banks so that BOZ would refrain from providing unsecured credit facilities to commercial banks. Minimum capital requirement was also increased to two billion kwacha which is currently an equivalent of just over $400 000. Despite these reforms in the regulations, the bank of Zambia Act still provides that the governor of the Bank of Zambia should comply to directives given by the minister of Finance. This undermines both the independence of BOZ and its ability to deal with issues such as insolvent banks as was the case with Meridien.

Despite the problems experienced, the RAP was successfully completed in 1995 and in December 1995, The IMF approved loans totaling $1313 million and admitted Zambia onto the Enhanced Structural Adjustment Facility (ESAF). The major part of the loan ($1047 million) was provided under a three-year ESAF arrangement and the remainder under a one year Structural

Adjustment Facility (SAF) arrangement in support of the government's economic and financial reform program. The aim of the new program was to strengthen macroeconomic stabilization efforts while consolidating and advancing the structural reforms began under RAP. Specifically, the goal of monetary policy was to keep inflation on a downward trend. The exchange rate continued to float.

Currently, specific goals are set each year for growth in government credit, net foreign assets and inflation.[7] Open market operations have not worked very well in the control of inflation. As a result, other instruments such as statutory ratios, intervention in the foreign exchange market and restricting lending to commercial banks have been used. Below is a table showing targets and actual realizations of money and inflation. It is clear that these goals have been missed each year. Annual inflation has mostly been upward since 1995. The focus of monetary policy continues to be on inflation. There are serious attempts at intensifying the use of open market operations and reducing the reliance on cash and liquidity ratios. However this has proved rather difficult as commercial banks are not very willing to participate in open market operations. In 2001, the statutory reserve ratio was changed four times to try and control the growth of money in the economy.

The Bank of Zambia in conjunction with the securities exchange commission is also trying to develop the money market and the number of listed companies on the stock market has increased. This should provide an alternate source of investment capital and lead to economic growth. It is hoped that this will also improve the effectiveness of monetary policy.

[7] Zambia had a three year ESAF programme starting in 1999 and was completed in 2001. The ESAF programme was renamed the Poverty Reduction Growth Facility in November 1999. these are more based on own country-owned poverty reduction strategies drawn by each country with IMF assistance, and the participation of local civil society and development partners

Tab. 1.1: Targets and Realisations for Money and Inflation

		Reserve Money	M2	Inflation
1995	Target	88929	37%	35%
	Actual	92004	40%	46%
1996	Target	99085	10%	27%
	Actual	136030	28%	35%
1997	Target	182667	17%	15%
	Actual	191819	24%	23%
1998	Target	19.6%	19.6%	15%
	Actual	30.9	22,6%	30.6%
1999	Target	18.2	20.3%	20%
	Actual	28.6%	29.2%	20.6%
2000	Target			19%
	Actual	49.8%	37%	30.1%
2001	Target		11%	17,5%
	Actual	42.5%	11.8%	18.7%
2002	Target		16.1%	13%
	Actual	23.2%	26.7%	26.7%

Source:Mwenda (1999) and Bank Of Zambia

1.3 Summary and Conclusions

Economic reforms in Zambia have been fully implemented since late 1991. Of the key reforms, are the reforms in the financial sector. The controls in the financial sector led to a weak and repressed banking sector which together with the state owned insurance and pension parastatals consisted almost the entire financial system. Interest rates were removed, exchange rates freed, monetary policy conduct reformed and administrative controls were also removed.
Since the reforms, the main goal of monetary policy has been to achieve price and financial system stabilisation as spelled out in The Bank Of Zambia Act 1996. This has involved mainly controlling the growth in money supply through direct and indirect instruments. The reliance upon direct instruments of monetary policy is slowly being diminished and indirect methods are being

emphasised. Open market-type operations using primary auctions of treasury bills and government bonds and auctions of short-term credit and term deposits have been used. The central bank also auctions foreign exchange both to smooth exchange rate fluctuations and also to accumulate foreign reserves on behalf of the government. Money supply has continued to grow at levels higher than targeted. Despite the reforms, real deposit interest rates have remained negative. The nominal exchange rate has been depreciating prompting increased intervention from the central bank. Although the control of inflation is still difficult, annual inflation rates have reduced significantly compared to levels achieved in the early 1990s. The main focus remains on reducing inflation but as an aid to stabilisation, the central bank is investing in the development of the money and inter-bank markets.

Appendix

Tab. 1.2: Selected Economic Indicators (1970-2001)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Macroeconomic Indicators												
NGDP growth	105.4	92.6	160.9	183.4	54.1	33.8	31.6	31	16.6	44.7	67.1	
RGDP growth	-0.5	-0.1	2.1	-0.2	-8.6	-2.3	6.6	3.3	-2.0	0.32	5.9	5.2
IIP	96.3	90	96.7	88.3	77.3	73.1	71.3	77.1	68.6	52.82	37.56	42.57
CPI	4.7	9.3	26.1	59.6	82.5	120.4	162.2	240.2	298.9	408.1	531	630.3
X/GDP	37.3	25.9	28.4	19.4	32.2	15.5	32	42	28	35	31.02	21.2
Financial Sector Indicators												
M2/GDP	26	28	18.6	14.4	15.5	18.1	18.4	17.4	17.7	19.62	25.1	15.7
M1/GDP	13.27	11	8.95	6.48	5.09	7.61	6.84	6.87	6.37	7.27	7.89	6.02
tbill rate	34	42	54	122.5	24.8	51.5	69.8	23.3	43.6	36.2	31.4	47.2
Lending rate	40	46	60.6	119.6	45.8	66.7	69	37.2	37.4	42.6	37.6	45.2
savings rate	27	33	43	80.9	13.3	30.6	30.2	16.5	7.6	7.6	7.1	7.1
K$	42.75	88.97	360	500	680	956	1283	1415	2299	2632	4158	3820

Source:Bank Of Zambia, World Bank and MOFED

2. MONETARY POLICY REFORMS AND THE TRANSMISSION MECHANISM IN ZAMBIA

ABSTRACT

In the paper, we look at the monetary transmission mechanism in Zambia. Using different variables as measures of monetary policy shocks alternately, we examine variance decompositions and impulse response functions to see whether the transmission mechanism of monetary policy to the macro-economy has changed since the reforms. Contractionary monetary policy is followed by a fall in both output and prices. When we compare the two estimation periods, we find that both the responsiveness and magnitude of forecast error variances of prices explained by these variables have increased since the reforms. The results also show that most of the impact lags have reduced. We find evidence of the bank lending channel both before and after the reforms. Of the mechanisms estimated, the exchange rate mechanism seems to be the most important mechanism for transmission of policy shocks to both prices and output during the post-reform period.

Keywords: *Monetary policy,Transmission mechanisms, Reforms.*

JEL Classifications:*E52 P41 P51.*

2.1 Introduction

For almost two decades after independence, the financial sector in Zambia was highly controlled. Monetary policy was conducted using direct instruments such as controlled interest rates, controlled lending, capital controls and other administrative controls. In 1991, the country embarked on economic reforms of which a major aspect was financial reforms.

One of the main facets of financial reforms was the reform of monetary policy, a move from direct to indirect instruments of policy. The idea was to remove the financial repression believed to have come along with the controls and let the market operate more efficiently. However, the structural changes that take place as an economy reforms can change the inter-relationships amongst the macro variables within the economy. If this happens, the transmission mechanism of monetary policy to the macro economy may also be affected. Increasingly, stabilisation policy has become the centre of macroeconomic management in Zambia and this has been placed in the hands of the monetary authority. It is therefore important to understand how monetary policy changes affect the economy. Under the current policy set up, annual goals are set for inflation and output and the precision with which policy changes affect these goals depends on both the magnitude of the policy effects and the impact lags of these policy changes. Understanding the path that policy changes take to impact the macro-economy is important. Very little empirical work has been done on the monetary transmission mechanism in Africa and we could not access any such studies on Zambia. Given that African economies are different in some fundamental ways from western economies on which most empirical work on transmission mechanisms has been done, studies such as this one could offer very valuable information about how African economies work. Such information is invaluable in the design of more eclectic monetary policy as monetary and financial sectors in African economies such as Zambia's become more advanced.

In this paper we look at the transmission mechanism in Zambia before and

after the reforms. We employ the Vector Auto Regression (VAR) methodology to look at the magnitude of the effects of policy changes and their impact lags on output and inflation. We then compare how the mechanism has changed since the reforms. We estimate different systems for each period using alternate measures of policy shocks.

The paper is organised as follows. In section 2 we review both the theoretical and empirical literature. We outline the policy implementation procedures before and after the reforms in section 3. In section 4, the methodology and the data are discussed. The results are discussed in section 5 and we summarise and conclude in section 6.

2.2 Literature Review

2.2.1 Theoretical Review

Inflation in an economy can be caused in a number of ways. One of such ways is excess aggregate demand. This excess demand will increase prices because of increased production costs and also because increased demand bids up prices. Production costs can also affect inflation independent of excess demand. Such cost increases can result from higher wages or increases in the exchange rate (which in turn increases the cost of imported intermediate inputs). Prices and wages are affected by expectations of future inflation since future prices are the starting point for future wage bargaining and price setting. Any increased inflationary expectations generated by different variables such as the exchange rate movements or changes in the levels of the interest rate will independently lead to increases in inflation.

The path which changes in monetary policy take from the implementation of the policy to the macro-economy is referred to as the monetary policy transmission mechanism. The theory on monetary transmission mechanisms can broadly be divided into two views which are often referred to as the money view and the lending or credit view.

The Money View

The money view is based on the IS-LM approach. The basic mechanism here is that contractionary monetary policy leads to higher interest rates via the demand for transactions balances, which in turn affects output (IS curve). Let M be money supply, i be the real interest rate, Y economic activity or output. We can schematically represent the transmission mechanism as:

$$\uparrow M \Rightarrow \downarrow i \Rightarrow \uparrow I \Rightarrow \uparrow Y$$

A fall in i would stimulate both business and consumer spending increasing investment which in turn affects output upwards (see Taylor (1983), Meltzer (1995), Mishikin (1996),Rabin and Yeager (1997)). This view emphasises the real rather than the nominal interest rates. The relationship between real and nominal interest rates is often guided by the assumption of temporary wage or price rigidities (see Taylor (1983)). When the nominal rate changes, the sluggish response in prices leads to a change in the real interest rate. In practice, most central banks set the interest rate rather than using money supply as the instrument. The transmission mechanism therefore, in this view includes a description of the central bank's reaction function showing how the central bank adjusts the interest rate in response to changes in the economy. Other asset price channels include the exchange rate channels and the equity prices channel. The exchange rate channel mainly operates through net exports. When there are free capital flows, this channel also improves the operation of the interest rate channel (through a form of Mundell-Fleming mechanism). When domestic interest rates fall, there will be capital outflows depreciating the exchange rate and then an expansion in net exports. Let E be the exchange rate measured as units of domestic currency per unit of foreign currency and NX net exports. Schematically then the mechanism is

$$\downarrow i \Rightarrow \uparrow E \Rightarrow \uparrow NX \Rightarrow \uparrow Y$$

The equity prices channel operates through Tobin's q and through wealth effects. Tobin's q is the market value of a firm divided by the replacement cost

of capital. If q is high, the value of the firm is high compared to the replacement cost of the capital. A rise in money supply leaves the public liquid so that they have resources to spend on the stock market for acquisition of equities and equity prices rise which in turn raises Tobins q increasing investment spending and output.[1]

The Credit View

This view emphasises asymmetric information in financial markets. The two channels of transmission are bank lending and the balance sheet channels. The Bank lending channel is based on the assumption that banks are best suited to solve problems of asymmetric information in credit markets. When there is asymmetry of information, problems arise with a certain group of borrowers. This group comprises mainly small firms and individual households who only have access to credit through banks. Without substitutability of retail banks' deposits with other sources of funds, the central bank will affect both the deposits and loanable funds that banks make available to this group of borrowers. Expansionary monetary policy increases bank reserves and deposits increasing loanable funds and thereby increasing investment and consequently output . This causes banks to lend more and investment rises

$$\uparrow D \Rightarrow \uparrow L \Rightarrow \uparrow I \Rightarrow \uparrow Y$$

Where D is deposits and L is lending. The Balance sheet channel operates through decisions of firms and households and is based on the networth of the borrowers. If the borrowers have a low net worth, then they have low value collateral for loans and therefore are higher risk borrowers. With asymmetric information, adverse selection problems arise because banks cannot distinguish between high risk and low risk borrowers. Moral hazard problems will also arise when there is an increased likelihood of high risk investment by these borrowers. As a result, banks will set high interest rates to compensate for

[1] A more Keynesian explanation would be that a rise in money supply would reduce interest rates making bonds less attractive than equity

lending risk. This reduces investment lending and lowers output. Since it is the nominal interest rate that affects borrowers' cash flows, it is the short-term nominal interest rate rather than the real long-term interest rate that is important in this mechanism.

The lending view in many cases is not seen as an alternative to the money view but rather "as a set of factors that amplify and propagate conventional interest rate effects" (Bernanke and Gertler (1995)). When intermediated loans and market bonds are perfect substitutes, we are back to the traditional money view as loans and bonds will be identically priced in equilibrium. However, because of information asymmetries, this rarely happens and a credit channel usually operates.

Monetary policy can also operate through changes in the general price level. This happens because in general, contracts are drawn in nominal terms. When monetary policy changes (the money supply and hence prices), the real value of contracts changes. On the one hand, unexpected expansionary monetary policy increases prices and thereby improves the net worth of firms by reducing the real value of their debts. This reduces the problems of adverse selection and moral hazard so that investments increase and hence output. On the other hand, expected monetary policy increases prices through contract adjustment or indexation. The transmission mechanism schema is similar to the one above.

2.2.2 Mechanisms in Developing Countries

Developing countries have financial structures that are somewhat different from industrialised countries. This was more pronounced before most of the developing countries embarked on financial reforms. In these countries the menu of assets available to private agents is very limited. Despite the reforms, financial markets in these countries are still quite underdeveloped. Securities markets are either undeveloped or non-existent and most of the financial transactions in these economies are handled by commercial banks. This means

that some of the transmission mechanisms discussed above would not be operative in these countries.

For such countries, alternative transmission mechanisms may exist. One initial development that has been used in reformed financial markets is the development of primary issues such as treasury bills and /or central bank bills supported by restructuring the central bank discount window to allow for a greater role for market forces. Once the monetary authority has set its objectives, it compares the estimated supply and demand of reserves in the banking system. Using this, the net cash reserve requirement is forecast and the sale or purchase of bills is used to achieve the desired objective. Here we can identify a transmission mechanism.

$$\uparrow NTB \Rightarrow \uparrow NCR \downarrow i \Rightarrow \uparrow L \Rightarrow \uparrow Y$$

NTB is net treasury bills and NCR is net cash reserves

Central banks may also intervene to manage short-term fluctuations in liquidity. One such facility is the discount window through which the central bank can lend to commercial banks. By adjusting the rate in this window, it can affect financial market rates. Expansionary policy for example would require the central bank to lower the discount rate, which makes cheaper funds available and increases liquidity in the economy, reducing interest rates and hence increasing investment and output. Let i_d be the discount rate. The mechanism can be schematised as

$$\downarrow i_d \Rightarrow \uparrow L \Rightarrow \uparrow I \Rightarrow \uparrow Y$$

In most of these countries, there are efforts to develop money and inter-bank markets which would then make it easier for monetary authorities to practice more conventional monetary policy.

2.2.3 Empirical Review

In this section, we review some studies on the transmission mechanisms. We could not access any studies that evaluated the impact of reforms on the

transmission mechanism. Instead, we review general studies on transmission mechanisms and in addition review two studies that look at monetary policy reforms in Zambia.

A lot of recent empirical work on the transmission mechanism has been done using the VAR approach. Sims (1992), estimates separate VARs for Germany, France, the United Kingdom and the United States using monthly data. His variables include industrial production, consumer prices, and a short interest rate as measure of monetary policy, a measure of money supply, an exchange rate index and an index of commodity prices. He makes the identifying restriction that the interest rate variable potentially affects other variables contemporaneously while the interest rate is not affected by innovations in any of the other variables. He finds that the response of output to interest rate innovations is similar in all countries examined. Output has a hump shaped response to monetary policy shocks.

Bernanke and Blinder (1992) do a study on the credit channel in the US using the federal funds rate, unemployment rate, log of CPI, deposits, loans and securities. The identifying assumption is similar to that of Sims (1992) so that monetary policy is predetermined. They find that both the conventional money demand and the credit mechanisms operate. A positive shock to the federal funds rate reduces the volume of deposits held by institutions immediately after the shock and peaks after nine months. After a period of two years, the entire long run impact of the decline in deposits is reflected in loans. They conclude that their findings support the operation of a credit channel.

Christiaono et al. (1994) use US quarterly data to study the effect of monetary policy shocks. They make similar identifying assumptions as Sims (1992)and explicitly include commodity prices to avoid the price puzzle. Their variables include real GDP, the GDP deflator, commodity prices, federal fund rate, non-borrowed reserves, total reserves and net funds raised through financial markets. The policy variables used alternately were the federal funds rate and non-borrowed reserves. Their results show that the initial effect of a positive shock to the federal funds rate is to increase net funds raised by the business

sector for almost a year which declines thereafter.

A study by Anti-Ego (2000)) compares alternative domestic monetary policy strategies in Uganda. He uses base money growth, changes in the treasury bill rate, inflation and output growth to estimate a VAR with two alternate orderings, one reflecting a reactive and another a proactive monetary policy stance. His estimation period spans between 1982 and 1997. Using Granger causality tests, he finds that the treasury bill rate has not been important for movements in prices while base money has been. Complementing this analysis, he estimates some variance decompositions. He finds that inflation mainly explains its own movements in the first five quarters after which base money becomes important explaining about 30% of the variations in the reactive ordering and about 40% of the variations using the proactive ordering. The treasury bill rate explain about 20% of the long run inflation movements. He finds that own shocks and shocks to GDP mainly explain treasury bill rate movements. The treasury bill rate explains about 30% of the movements in growth.

A study of the credit channel in Uganda by Nannyonjo (2001) uses the VAR methodology. The macro variables used in the study are the index of industrial production and the consumer price index. The policy variable used is base money. By looking at Granger causality tests and variance decompositions she concludes that there is no significant role for either bank loans or the lending rate in the transmission of monetary policy shocks to output. She finds that output explains as much as 37% of variations in bank loans after two years indicating demand driven lending in Uganda. The impulse responses estimated however indicate a positive though delayed effect of bank lending on output. Although these results are not directly comparable with those of Atingi-Ego since the two studies use different variables and address different problems, both studies find that base money is important for price movements (in the Antingi-Ego study the contributions of base money are much larger).

Mwenda (1993) looks at monetary policy effectiveness in Zambia. In his study, he evaluates the impact of switching to indirect monetary policy instruments

on the growth and variability in broad money and inflation. The period of direct controls in the study covers January 1988 to October 1992. The period of indirect controls is between November 1992 and July 1997. He estimates autoregressive models to determine whether significant reductions in the growth of money supply and inflation have been observed since the switch to indirect policy instruments. He also examines the volatility in the two variables to see if there has been a reduction in the instability of these variables over the same period. He finds that whereas the growth of monthly inflation has fallen, money supply has continued to grow rapidly. The results also show that the switch in policy has been effective in reducing variability in both money supply and inflation.

Adam (1999) also looked at monetary policy reform in Zambia. He approaches the problem by estimating a currency demand function with portfolio shifts. He estimates a model using the treasury bill rate, deposit rates of interest, the depreciation of the parallel exchange rate, inflation, currency in circulation and the real Gross National Income. He finds evidence of a stable long run currency demand function with a policy induced structural break. He also finds that there is a marked increase in the underlying variance of currency demand from about 1989, which begins to reduce around 1994. His results suggest that because of the observed short run forecast variance around the money demand function, stabilization policy based on controlling reserve money is likely to have an imprecise link to inflation in the short to medium term despite the long run correspondence between the two.

In light of the review above, the contribution of this paper lies in the analysis of the transmission mechanism in Zambia. We have not been able to access any work on transmission mechanisms that has been done on Zambia. In addition such studies on African countries are very few and only two are accessible to the author. With stabilisation policy increasingly being the centre of macroeconomic management and almost entirely in the hands of the monetary authority, understanding the transmission path of monetary policy changes to the macroeconomy is key.

2.3 Monetary Policy Implementation

Until 1991, monetary policy in Zambia was conducted using direct instruments. The objective of monetary policy was output growth. Inspired by the development theories of the day, interest rates were controlled to keep investment capital costs low. The bias was towards local businessmen so that when lending to indigenous businessmen did not increase, more controls were put in place. Lending was directed and a given percentage of all bank credit was to be given to selected sectors in the economy. The composition of bank boards of directors were to be at least 51% Zambian.

Other controls that affected monetary policy included a fixed exchange rate and capital controls. Exporters had to surrender all foreign exchange earnings to the central bank, which would then redistribute these through commercial banks. During this period, money supply grew mainly as a result of deficit financing. To control the growth of money, the central bank set high statutory ratios and changed these quite frequently.

In 1992, monetary policy reforms began to be implemented. Interest rates were freed and the exchange rate was liberalised the following year. The main goal of monetary policy changed from output growth to the control of inflation. In terms of actual policy implementation, the reforms entailed shifting the emphasis from statutory ratios to more indirect methods. Efforts towards this were started in 1993 and by 1995, open market operations had replaced the frequent use of statutory ratios as the prime instrument of policy. The framework used in the post reform period rests on four identities and we discuss each in turn.

The Equation of Exchange

$$MV = PY \tag{2.1}$$

Where M is Money supply, V is Money Velocity, P is the price level and Y is the output. Under classical assumptions, V is assumed to be constant and Y at full employment. This implies that changes in M will translate into changes

in P. In reality, prices respond sluggishly so that in the short run, changes in M translate into changes in both Y and P. Goals for GDP and inflation are set annually assuming a short run situation and a constant annual velocity.

Consolidated Balance Sheet of the Central Bank

where reserve money(Mh) is a sum of net domestic assets (NDA) and net foreign assets (NFA).

$$Mh = NDA + NFA \tag{2.2}$$

NDA can be broken down into credit to the government (Dc^g), credit to non-government (Dc^p) and other net items (ONI). We can then expand equation 2.2 such that

$$Mh = Dc^g + Dc^p + ONI + NFA \tag{2.3}$$

so that

$$\Delta Mh = \Delta Dc^g + \Delta Dc^p + \Delta ONI + \Delta NFA \tag{2.4}$$

A change in reserve money is an effect of changes in credit to the government, credit to the public and net foreign reserves. The movements in NFA depend on whether there are capital controls or not. With capital controls, the movement of private funds is blocked and the change in reserves equals the trade balance. When capital controls are removed, as was done with the reforms, private funds flow freely and changes in reserves correspond to the net results of the Balance of Payments. A trade surplus (deficit) increases (decreases) high-powered money.

Balance of Payments Identity

$$CA = \Delta Mh - K \tag{2.5}$$

or

$$CA = PY - arbsorption \tag{2.6}$$

Where CA is current account and K is capital flows.

Given this framework, BOZ sits with the IMF and World Bank representatives and sets growth paths for the key variables in the model. First the target variables (inflation and economic growth) are set. Then the growth rate for broad money is set. Velocity is calculated as Y/M2 and assumed constant through the year. Then the growth rate for reserve money as the operational target is set. The components of reserve money are then broken down and the growth paths for them are also set. Discretionary monetary policy is estimated by subtracting NDA from estimated operating target levels for reserve money. Before the reforms, the government implemented conflicting policies so that it was not easy to disentangle the operation of the interest rate mechanism. Keeping interest rates low would trigger increased investment and therefore output. On the other hand simultaneously liquidity was also controlled through the use of statutory ratios. An increase in ratios would trigger a decrease in money supply. The policy process during this period therefore was not very clear, since both interest rates and money supply were being adjusted, sometimes simultaneously. However, we know from theory that a change in both statutory ratios and the interest rate will affect base money and therefore money supply. This in turn will affect prices and output. We assume that despite the rigidities in the economy at the time, the market was working enough to enable the transmission of monetary policy through interest rates to the macro economy.

After the reforms, BOZ implemented policy based mainly on equation 2.2 above. We can rewrite this equation to emphasise how BOZ can influence movements in reserve money. Reserve money is a sum of currency and reserves. Reserves are comprised of required and excess reserves while banks also hold vault cash to make daily payments. We write this relation in the equation below.

$$Mh = C + RR + ER + VC \tag{2.7}$$

Where C is currency in circulation, ER and RR are excess and required reserves and VC vault cash. Because currency is negatively related to interest

rates, BOZ can reduce (increase) reserves by raising (lowering) the interest rate through open market operations, the discount window and other indirect methods. BOZ can also influence money supply by adjusting reserve requirements. The key element in this process is the money multiplier whose relationship with reserve money and money supply can be depicted as below.

$$M = \beta Mh \tag{2.8}$$

where $\beta = (\frac{cd+1}{cd+rr})$ cd is the currency deposit ratio and rr the required reserve ratio. Given this, BOZ can adjust reserve money in the economy by raising and lowering reserve and other statutory ratios.

In practice, the principal instruments of policy include open market operations with reserve or base money as the instrument. The starting point is forecasting liquidity. Given the end of year broad money targets, desired paths for reserve money are derived. Then individual components of reserve money are arrived at. The projected paths for these variables are then used as the main benchmark for monetary policy operations. Implementation of policy now takes the form of minimising deviations of the actual paths of these variables from their projected target levels. Daily liquidity control is done through the auctioning of primary government securities, outright purchase and sale of treasury bills and auctioning of term deposits and secured loans. Because open market operations have not always been effective, other policy variables used include statutory ratios, foreign exchange intervention and moral suasion.

2.4 Methodology

In line with much of the research on monetary transmission mechanisms, a VAR is estimated. We estimate VARs for the period before and after the reforms to see if the response of macro variables to policy has changed since the reforms. This is a good approach to discriminate between alternative theoretical models of the economy and also capture the main properties of the time series of money and output, while allowing us to impose minimum restrictions to identify policy (see Baglioano and Favero (1998), Sderlind (1999)).

Given that central banks operate systematically using some form of policy rule, the VAR approach concentrates on deviations from this rule. Such deviations may result from changing the systematic component of monetary policy or from exogenous shocks. Deviations from the rule allow us to observe the response of the economy to monetary impulses that are not expected by the market. Since it is often the case that BOZ uses instruments not in its 'policy rule', it is possible that the unsystematic part of policy in Zambia may actually be quite substantial. It is also important to note that the purpose of the paper is to look a the historical responses of variables in the economy rather than to make any policy simulations.

In view of the Lucas critique, separate systems are estimated for the two different policy regimes considered.[2] The results in Adam (1999) give us reason to believe that there is stability in money demand in Zambia despite the policy shift. Since the monetary policy in Zambia relies heavily on this fact, we assume a stable policy environment and comfortably use the VAR approach.

Let us consider a bivariate AR(1) model. Let y_t be a measure of real economic activity or macroeconomic indicators such as GDP or inflation. Let x_t be the monetary policy variable such as the interest rate or reserve money. A VAR

[2] Lucas (1976) argued that the parameters of traditional macroeconometric models depended implicitly on agents' expectations of the policy process and were unlikely to remain stable as policy makers changed their behaviour. The implication for this is that parameters of backward looking models will shift between policy regimes.

system can be written as follows

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = A_0 + A[L] \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix}$$

A(0) is s vector of constants, A (L) a 2 X 2 matrix polynomial in the lag operator L, and u_{it} serially independent errors for variable i.
Suppose the structural equations can be represented as follows

$$y_t = b_{10} - b_{12}x_t + b_{11}y_{t-1} + b_{13}x_{t-1} + u_{yt} \tag{2.9}$$

$$x_t = b_{20} - b_{21}y_t + b_{22}y_{t-1} + b_{23}x_{t-1} + u_{xt} \tag{2.10}$$

which can be re-written as

$$y_t + b_{12}x_t = b_{10} + b_{11}y_{t-1} + b_{13}x_{t-1} + u_{yt} \tag{2.11}$$

$$x_t + b_{21}y_t = b_{20} + b_{22}y_{t-1} + b_{23}x_{t-1} + u_{xt} \tag{2.12}$$

and in matrix form

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{13} \\ b_{21} & b_{23} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix}$$

let

$$B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}$$

,

$$X = \begin{bmatrix} y_t \\ x_t \end{bmatrix}$$

$$\Pi_0 = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}$$

and

$$\Pi_1 = \begin{bmatrix} b_{11} & b_{13} \\ b_{22} & b_{23} \end{bmatrix}$$

which allows us to write a more compact form of the structural equation as $BX_t = \Pi_0 + \Pi_1 X_{t-1} + u_{it}$.

Assuming that B is invertible, we pre-multiply the equation by B^{-1} to obtain

$$X_t = A_0 + A_1 X_{t-1} + \varepsilon_{it} \tag{2.13}$$

where

$A_0 = B^{-1}\Pi_0$

$A_1 = B^{-1}\Pi_1$

and $\varepsilon_t = B^{-1}u_{it}$

Given that $a_{ij}$is the element of the i^{th} row and j^{th} column, we can now write our VAR in standard form.

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}x_{t-1} + \varepsilon_{yt} \tag{2.14}$$

$$x_t = a_{20} + a_{21}y_{t-1} + a_{22}x_{t-1} + \varepsilon_{xt} \tag{2.15}$$

and in matrix form,

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{xt} \end{bmatrix} \tag{2.16}$$

Note that the errors are a composite of two errors u_{yt} and u_{xt} since $\varepsilon_t = B^{-1}u_{it}$ i.e.

$$\begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{xt} \end{bmatrix} = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}^{-1} \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix}$$

so that

$$\varepsilon_{yt} = \frac{u_{yt} - b_{12}u_{xt}}{1 - b_{12}b_{21}} \tag{2.17}$$

$$\varepsilon_{xt} = \frac{u_{xt} - b_{21}u_{yt}}{1 - b_{12}b_{21}} \tag{2.18}$$

Since the u_{it}s are white noise, so are the ε_ts.

From (2.17) and (2.18), we can see that policy errors can be caused by exogenous y and policy disturbances. Let Σ_u be the 2X2 variance-covariance matrix of u_{it} and Σ_ε that of ε_{it}. Then $\Sigma_\varepsilon = B\Sigma_u B'$. To determine the impact

of policy on output, we need to look at the effect of u_{xt} but unless $b_{21} = 0, \varepsilon_{xt}$ is not equal to u_{xt} and therefore does not provide a measure of the policy shock. If we estimate our VAR in (2.14)and (2.15) as it is, B and Σ_u will not be identified without further restrictions since estimation of the reduced form in (2.14) and (2.15)will yield less parameters than the structural form in (2.9). One of the most common restrictions is to assume that the structural shocks are uncorrelated so that the off diagonal elements in the covariance matrix are zero (Sims (1972) Bernanke and Blinder (1992)). Specifically, two approaches have been followed. The first one is to restrict the B matrix so that b_{21} in equation (2.9) equals zero. In this case, the policy innovations are exogenous with respect non-policy innovations. The underlying assumption here is that policy does not respond contemporaneously to macro shocks, which may be due to information lags. The second restriction assumes b_{12}= 0 so that policy shocks have no contemporaneous impact on the macro variables. Both of these restrictions are based on the Choleski decomposition. In the first restriction, policy variables are ordered first while in the second, non-policy variables are ordered first. Because of the nature of this decomposition, the ordering of the variables is very important particularly if correlation between the residuals is high.

Another method used is to place restrictions on the long run effects of disturbances in the variables (Blanchard and Watson (1986), Blanchard and Quah (1989), Hutchinson and Walsh (1992)). A typical restriction here is that long run demand shocks have a zero impact on output. Typically the A matrix in (2.16) is set to identity. Some of the variables must be non-stationary and some shocks must be restricted to have only short run effects.

Identification is also achieved through structural VAR modelling with contemporaneous restrictions (Christiaono et al. (1996) Leeper et al. (1996)). In this identification scheme, a priori information is used to impose restrictions on the elements of the A matrix. These restrictions include assuming orthogonality of the structural disturbances, imposing that macroeconomic variables do not simultaneously react to monetary variables while feed back in

the other direction is allowed, and imposing restrictions on the monetary block of the model reflecting the operating procedures of the monetary policy authority.

Two results obtained from VARs that are useful for analysing transmission mechanisms are impulse response functions and forecast error variance decompositions. The impulse responses tell us how macro variables respond to shocks in the policy variables, while the variance decompositions show the magnitude of the variations in the macro variables due to the policy variables. If we assume our system is stable, we can iterate (2.13) backwards and let n approach infinity and solve to obtain

$$X_t = \mu + \sum_{i=0}^{\infty} A_1^i \varepsilon_{t-i} \tag{2.19}$$

where the μs are the means of y_t and x_t

and use (2.16) to get

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} \mu_y \\ \mu_x \end{bmatrix} + \frac{1}{1 - b_{12}b_{21}} \sum_{i=0}^{\infty} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix} \tag{2.20}$$

We define the 2 X 2 matrix as $\Psi(i)$ with elements $\Psi_{jk}(i)$ such that

$$\Psi(i) = \frac{A_1^i}{1 - b_{12}b_{21}} \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}$$

and we write in moving average form as

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} \mu_y \\ \mu_x \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \Psi_{11}(i) & \Psi_{12}(i) \\ \Psi_{21}(i) & \Psi_{22}(i) \end{bmatrix} \begin{bmatrix} u_{yt-i} \\ u_{xt-i} \end{bmatrix}$$

or in a more compact form

$$X_t = \mu + \sum_{i=0}^{\infty} \Psi(i) u_{t-i} \tag{2.21}$$

$\Psi_{jk}(i)$ are the impulse response functions. As we vary (i), we get a function describing the response of variable j to an impulse in variable k. For example,

the cumulated effects of u_{xt} on the y_t sequence is $\sum_{i=0}^{n} \Psi_{12}(i)$.Letting n approach infinity gives us the long run multiplier.

To derive the forecast error variance, let us use equation (2.21) to make a forecast of x_{t+1}. The one step ahead forecast error is Ψu_{t+1} and in general the n-period forecast error $X_{t+n} - EtX_{t+n}$ is

$$X_{t+n} - EX_{t+n} = \sum_{i=0}^{\infty} \Psi(i) u_{t+n-i} \tag{2.22}$$

and the mean square error (MSE).

$$(X_{t+n} - EX_{t+n})^2 = \sigma_x^2 \sum_{i=0}^{\infty} \Psi(i) \tag{2.23}$$

where σ_x^2 is the variance of x_{t+n}.

To show the decomposition more explicitly, let us narrow down on y_t.

$$(y_{t+n} - Ey_{t+n})^2 = \sigma_y^2 \sum \Psi(i)^2 \tag{2.24}$$

The share of $\sigma_x^2(n)$ due to u_{yt} and u_{xt} are

$$\frac{\sigma_y^2[\Psi_{11}(0)^2 + \Psi_{11}(1)^2 + ... + \Psi_{11}(n-1)^2]}{\sigma_y^2(n)^2} \tag{2.25}$$

$$\frac{\sigma_x^2[\Psi_{11}(0)^2 + \Psi_{11}(1)^2 + ... + \Psi_{11}(n-1)^2]}{\sigma_y^2(n)^2} \tag{2.26}$$

Since the variance decomposition tells us the share of the total variance attributable to a given structural shock, for an exogenous sequence y, u_{xt} will not explain any of the forecast error variance of y_t.

2.5 Data

In this section we discuss the data used in the estimations. Given the framework discussed in section 3, the variables used in the estimation include real GDP (output), the composite consumer price CPI (price), the different money aggregates (M2, base money=base), treasury bill rate (as short term interest rate indicating policy stance), the weighted savings rate (used as an indicator of policy in the pre-reform period), the lending rate (used to evaluate the role of the bank lending channel), liquid asset ratios (lar, as a proxy for operating ratios of commercial banks), the official exchange rate of the kwacha to the dollar (NER), and total commercial bank lending (lending).

2.5.1 GDP

The output variable used in the study is real GDP. The raw data is available in annual series and to obtain monthly series, we interpolated. In the estimations, we use output data generated by the Denton interpolation method. The Index of Industrial Production (IIP) is used as the related series.[3] For the post-reform period, the IIP series is available only at a quarterly frequency. The interpolation is therefore done with this series to a quarterly output series and then a simple linear interpolation method is used to obtain a monthly series.

2.5.2 Price Level

For this variable, we use the log of the composite CPI. The control of inflation measured as the annual growth rate of this variable is the main goal of monetary policy and BOZ sets a target

[3] The Denton Method for interpolating data uses an 'associated series' imposing the constraint that the interpolated series must obey the annual totals. The indicator series contributes its pattern to the series and adds more information especially where such movements in such a series are closely related to the series to be interpolated. See Baum (2001) and Renka (1988)

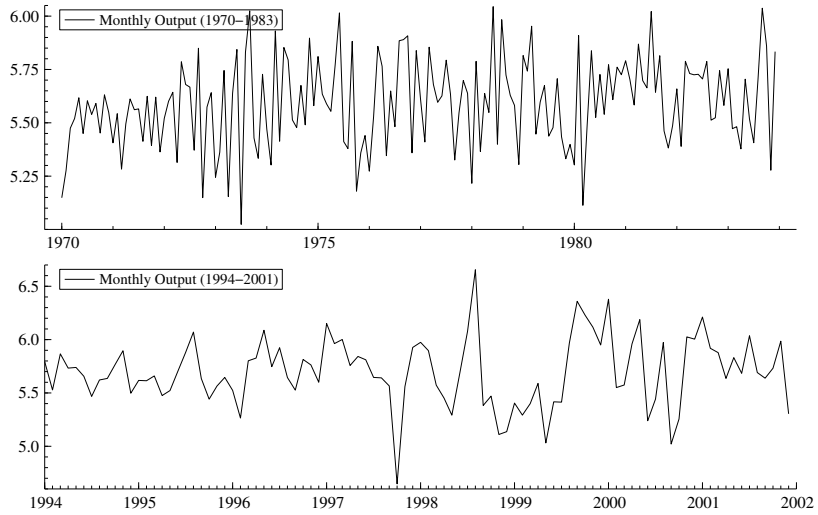


Fig. 2.1: **Real GDP Pre and Post-Reform**

for this variable every year. It is the main goal of monetary policy. Figure (2.2) shows the log of the CPI and its monthly and annual rates of change for the period 1970 to 2001. In the top panel, we have the log of CPI, in the middle panel, monthly inflation, and in the bottom panel, annual inflation. During the period of controlled prices, inflation exhibits spikes of changes as the prices were administratively controlled. Secondly, the period around 1989 and 1990 shows very huge jumps in CPI. This was mainly due to the re-introduction of IMF policies. In 1987, ties with the IMF were broken and the controls that had been removed earlier on commodities such as maize were re-introduced. In 1989, ties with IMF were restored and prices decontrolled. Food and maize subsidies were removed increasing prices quite significantly. We notice large increases in prices in the early 1990s just after the reforms. Simultaneous liberalisation in many markets led to rapid increases in prices and inflation. Another notable change occurs around 1995. During this year, inflation increased mainly due to two factors: banking crises and drought. A number of banks went into distress in 1995. The government pumped 90

billion kwacha into the banking sector to try and rescue a large bank and this created inflationary pressures. This also strained the fiscal budget reinforcing the inflationary pressures already at play. The drought also led to huge increases in maize prices and together these forces led to an increase in annual inflation from 26.8% in May 1995 to 46% by November of the same year. From the late 1990s, there has been relative control of inflation reaching as low as 18.7% in December of 2001.

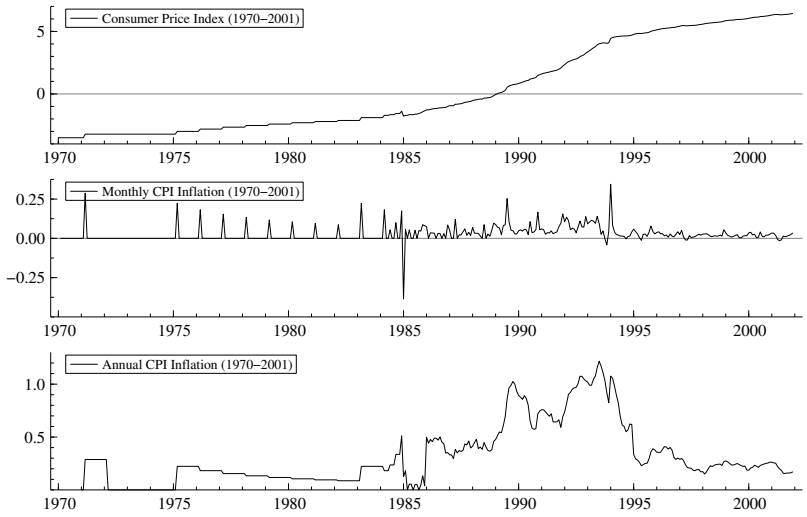


Fig. 2.2: **Consumer Price Index and Inflation**

2.5.3 Monetary Aggregates

Monetary policy in Zambia is implemented by using M2 as the intermediate target. Reserve money is used as the operating target and can be seen as a monetary policy instrument. From the graphs below, we notice that growth in all money aggregates has been fairly constant except for a few periods. In 1975/76 and around 1979, the world oil crises led to unexpected increases in the fiscal deficits resulting in extensive borrowing and printing of money. This led to large increases in money supply. After the break with IMF in 1987, there

was pressure on the government budget due to the lack of donor inflows. The government resorted to deficit financing leading to a rapid increase in money supply. In 1990/91, the period running up to the elections, the government printed a lot of money to finance the election campaigns and the election itself. A sharp increase is also seen around 1995 and 1996 with the banking crises.

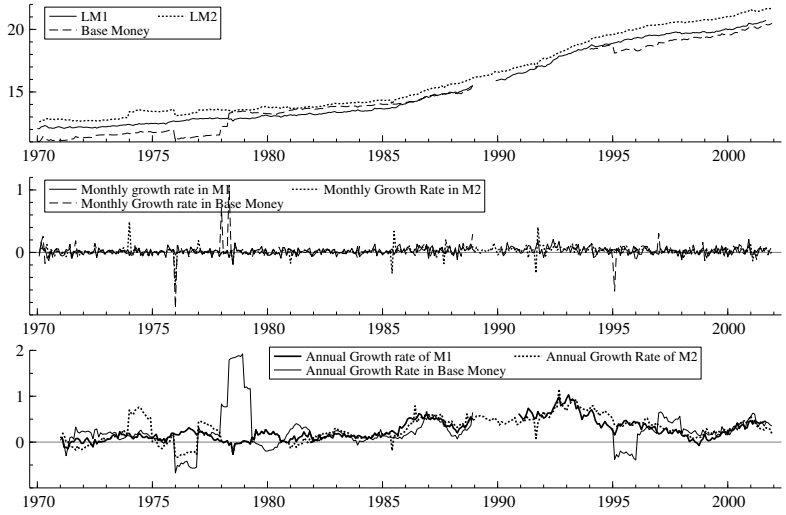


Fig. 2.3: **Monthly Growth in Monetary Aggregates**

2.5.4 Liquid Asset Ratios

We distinguish between actual and required reserve requirements. Actual liquid asset ratios are the actual ratios of reserves to liquid assets held by the banking system and we use this variable to proxy reserve requirements for both estimation periods. Required ratios are the minimum reserve to asset ratios prescribed by the central that every commercial bank must hold with the central bank. For the post-reform period, we use actual and required ratios alternately. This distinction was not available for the pre-reform period. Changes in minimum reserve ratios and other operating ratios were the main monetary policy instrument used before the reforms. Although in the post

reform period emphasis has been placed on more indirect methods of policy implementation such as open market operations, operating ratios are still used although less frequently. The variable is taken as one of the alternate policy variables in policy implementation.

The top panel of figure (2.4) shows actual liquid asset ratios for the period 1970 to 2001. The observations between September 1977 and April 1978 are unusually high. Since alternative sources of data could not be found, we used the average for each year for those observations. The dotted part of the graph shows a period when only quarterly data is available. The bottom panel of the graph shows both the actual and required liquid ratios and the required rate for 1994-2001. Focusing on the lower panel, we notice that apart from the period between 1996 and 1998, actual liquid ratios are higher than required reserves showing a significant amount of excess reserves in the banking system.

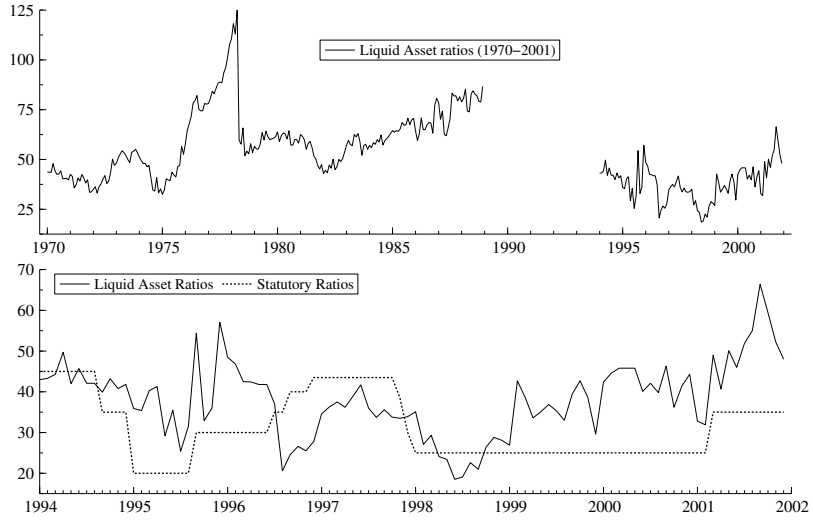


Fig. 2.4: **Actual and Required Asset Ratios**

2.5.5 Nominal Exchange Rate

The exchange rate used is the nominal exchange rate between the kwacha and the dollar. Since 1992, the exchange rate system has been unified and in the post reform period the bureau mid-rate[4] is used. This variable has become an important policy variable in that BOZ sometimes engages in foreign exchange open market operations partly as a monetary policy tool and partly to accrue foreign reserves on behalf of the government.

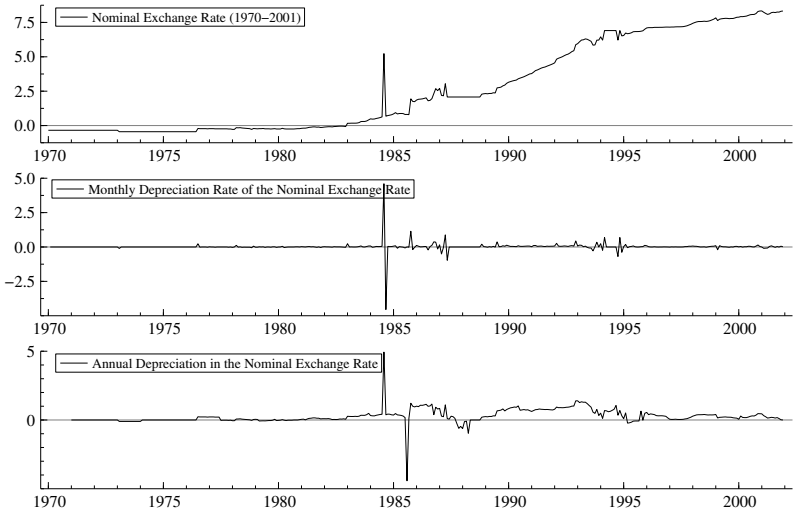


Fig. 2.5: **The Nominal Exchange Rate**

The graph in figure 2.5 shows the log of the nominal exchange rate in the upper panel and its growth rate in the lower panel. We notice a significant increase in the exchange rate around 1985 when the exchange rate auction was introduced. The official exchange rate of the kwacha to the dollar rose within a month from K2.35/$ in September to K7.50/$ in October-an increase of well over 200%! With the break in ties with IMF the exchange rate was once more fixed between 1987 and 1989 when the auction was re-introduced and in 1992 the exchange rate became market determined.

[4] The mid rate is calculated as a mean of the selling and buying exchange rates

2.5.6 Interest Rates

Three different interest rates are used in the estimations. The treasury bill and weighted savings rates are used alternately as short-term rates to capture the stance of monetary policy. The treasury bill rate is used in the estimations only in the post reform period as it was not used for policy purposes in the pre-reform period. The lending rate is used to evaluate the bank lending channel. The interest rates began to rise in the mid 1980s when the first attempts at reform were made reaching their peak in 1993 with full reforms. A decrease is observed after that reaching a low of 7% by December 2001. With high inflation rates however, real interest rates remain negative even after the reforms.

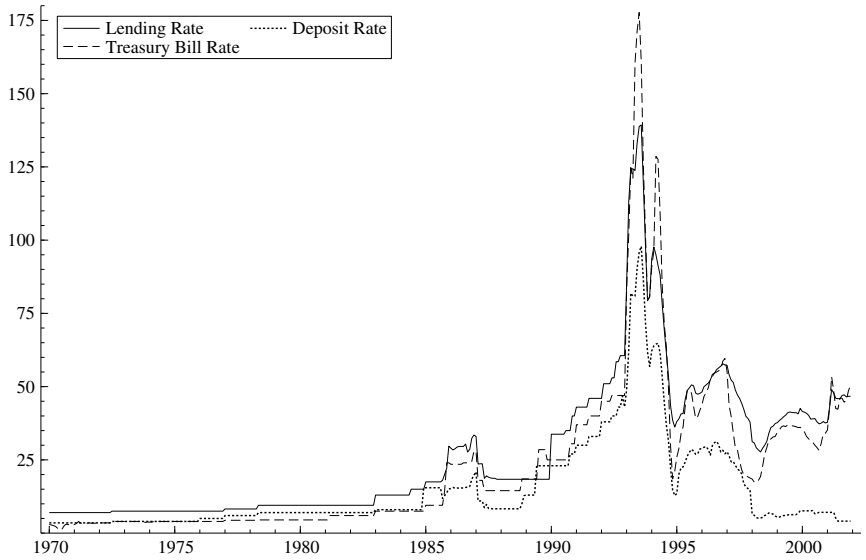


Fig. 2.6: **Interest Rates**

Total commercial bank lending is used to test for the credit channel of monetary transmission. From the graphs, we notice that total commercial bank lending is growing much faster in nominal terms after the reforms.

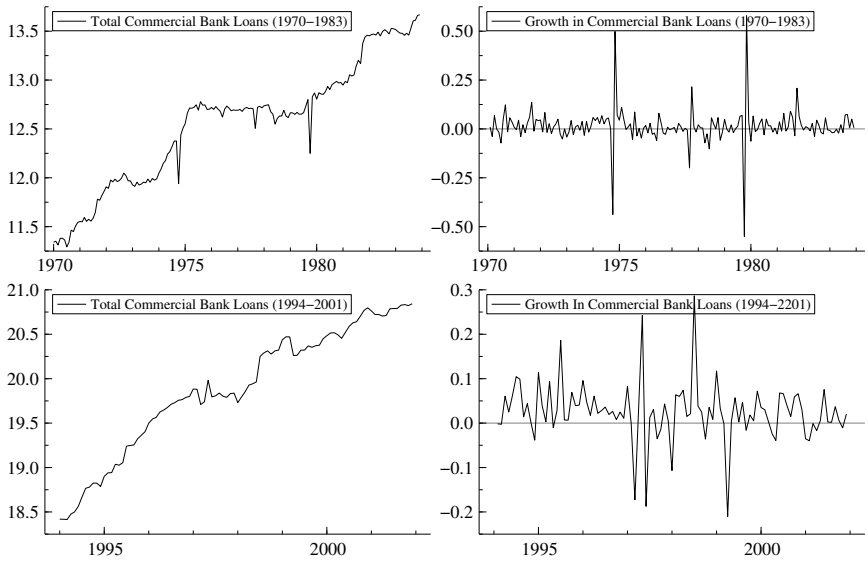


Fig. 2.7: **Commercial Bank Loans**

2.6 Estimation Results

In the discussion, we distinguish between policy and macro variables. The policy variables include the interest rates, base money and the exchange rate. Although the exchange rate may not strictly be viewed as a policy variable in Zambia, the central bank often intervenes in foreign exchange markets either to stabilise the exchange rate or to accumulate foreign reserves on behalf of the government. It is this part of shocks to the economy that we hope to capture by estimating an exchange rate mechanism. Innovations to M2 are also interpreted as policy shocks although M2 is strictly used as an intermediate target by the Bank of Zambia.

We begin by estimating variance decompositions of our macro variables. These decompositions tell us the proportional contribution of policy shocks to variations in a given macro variable. The larger the proportion of variation that is attributable to a given policy variable, the more important is that variable in the transmission mechanism of monetary policy. Although variance

decompositions show the importance of a policy variable to movements in a macro variable, the direction of these movements can only be observed from the impulse responses. We will be able to see whether an impulse in a policy variable leads to a fall or a rise in the macro variable. Again this gives us a good idea of the transmission mechanism because we can see whether a given policy action has a negative or positive impact on target variables.

Our identifying assumption is based on the fact that due to information constraints, macro-variables have no contemporaneous effect on the policy variables. This amounts to setting b_{21} in (2.10) equal to zero or using the Choleski decomposition ordering the policy variables first. This assumption is in line with the financial programming framework which assumes that deviations of money supply from target means that inflation has also deviated from target. This implies that in policy conduct, the central bank looks at the movements in the instruments first. Because a number of policy variables are used to implement policy by BOZ, we estimate different systems each representing a possible mechanism for monetary policy.

In discussing the results, we conjecture that different transmission mechanisms are at play. Since the different policy variables are changed sometimes simultaneously, it would be interesting to see the responses in a VAR with all variables included. However, due to the small sample size, we are unable to estimate such a VAR. We estimate mechanisms that test both the money and credit views of monetary transmission. In the money view, we estimate the interest rate and exchange rate mechanisms. We also estimate a mechanism that looks at the propagation of policy changes when money supply is controlled by the use of statutory ratios.

The interest rate channel is based on using reserve or base money as the policy instrument. From the open market operations, we know that BOZ auctions short term debt and deposits to commercial banks. It forecasts liquidity requirements then offers credit or debt to the banks who then offer rates at which they will either deposit (for tightening policy) or borrow (for expansionary policy) funds. The changes are then expected to translate into

changes in money supply given the money multiplier. This should then cause movements in prices and output. This model is considered as the base model because it is the one that portrays the mechanism which best describes basic monetary policy as conducted by BOZ. Hence we have our first mechanism.

$$\downarrow Mh \rightarrow\downarrow M2 \rightarrow\uparrow i \rightarrow\uparrow\downarrow y \rightarrow\downarrow p^{5}$$

The second mechanism we estimate is based on the use of statutory ratios to control growth in money supply. The mechanism becomes

$$\uparrow lar \rightarrow\downarrow M2 \rightarrow\uparrow\downarrow y \rightarrow\downarrow p$$

The exchange rate mechanism is based on BOZ activities in the foreign exchange market. Through the sale and purchase of foreign exchange on the open market, BOZ affects movements in money supply and prices. Using the nominal exchange rate as the instrument, the third mechanism is schematised as

$$\uparrow M \rightarrow\uparrow E \uparrow\downarrow y \rightarrow\uparrow p$$

We also estimate a mechanism to evaluate the credit view. We estimate a system to see whether monetary policy affects lending rates and total bank lending. The mechanism is schematised as

$$\downarrow M2 \rightarrow\uparrow i \rightarrow\downarrow L \rightarrow\uparrow\downarrow y \rightarrow\downarrow p$$

2.6.1 Forecast Error Variance Decompositions

We show in tables (2.1 and2.2) below the results for every 6th step contributions of the policy variable innovations to price and output

[5] In high inflation economies, monetary policy changes may have two opposing effects on output. The first is the contractionary effect of falling money supply which increases interest rates and has a negative effect on investment and hence output. The second is a positive effect resulting from reduced costs of inflation such as the inflation tax, an unstable business environment and other associated resource misallocations. The net result therefore depends on which of these two forces is stronger although the contractionary effect is likely to have a more immediate impact. The opposite will happen with expansionary policy

decompositions for all the mechanisms estimated.[6][7] The value in each cell is the forecast error variance decomposition contribution of the innovations in the policy variable in that column to the variations in the macro variable in the corresponding row. For example reading the first cell in table 1, base money contributes 2% to variations in output after 6 months while M2 and the interest rate contribute 2% and 4% respectively.

Tab. 2.1: Output and Price Variance Decompositions -Pre Reform Period

horizon	[a]Mech1			[b]mech2			[c]mech.3			[d]mech.4	
	Mh	M2	i	lar	M2	i	E	M2	M2	i	L
y6	2	2	4	5	2	7	2	4	2	9	1
y12	3	3	7	5	2	7	13	2	2	21	2
y18	3	3	7	5	2	9	22	2	2	27	2
y24	4	3	8	5	2	10	29	2	2	29	2
p6	5	5	10	1	7	12	14	7	5	11	1
p12	5	4	13	2	6	15	29	6	4	10	1
p18	4	10	16	2	10	15	37	13	9	7	1
P24	3	20	19	2	17	15	41	18	18	7	0.4

The figure in each cell is the variance decomposition of output(y) and price(p) attributed to innovations in the policy variable in each column.

[a]Mechanism 1 (base money,M2, interest rate output, prices)

[b] mechanism 3 (asset ratios, M2, interest rate, output, prices)

[c] mech2(M2, exchange rates, output, prices)

[d] mechanism 4(M2, lending rate, lending,output,price)

From table (2.1), we notice that the contributions of innovations in most policy variables to developments in prices and output during the pre-reform period are quite small. During the first four months, movements in prices are explained by own shocks. Thereafter, interest rates and the exchange rate become important. Interest rate innovations explain just over 10% of price

[6] Since that data is monthly, each step is equivalent to one month.

[7] In the pre-reform period, the exchange rate is ordered before money supply since during this period the exchange rate was fixed and money supply adjusted to maintain the level of the exchange rate

variations after one year and 18% after two years while exchange rates explain 29% after a year and 41% after two years. M2 shocks also become important for price developments but only after well over a year contributing 20% to price variations after two years. Innovations to interest rates and the exchange rate explain relatively large amounts of the variations in output. After a year, the lending rate explains 21% of output innovations and 29% after two years. The exchange rate becomes significant for output developments after over a year explaining 22% of output movements after 18 months and 29% after two years.

Tab. 2.2: Output and Price Variance Decompositions -Post Reform Period

horizon	[a]Mech1			[b]mech2			[c]mech.3			[d]mech.4	
	Mh	M2	i	lar	M2	i	M2	E	M2	i	L
y6	7	2	6	1	3	3	5	17	3	6	6
y12	8	5	7	1	4	4	6	17	4	6	7
y18	9	6	6	2	4	4	6	16	4	6	7
y24	9	6	6	2	4	5	6	17	4	6	7
p6	13	26	1	10	11	3	13	32	16	1	0.2
p12	12	27	1	47	21	1	28	55	23	1	0.3
p18	11	24	1	61	18	2	37	52	27	1	1
P24	10	22	2	67	15	3	42	48	32	1	2

The figure in each cell is the variance decomposition of output(y) and price(p) attributed to innovations in the policy variable in each column.

[a]Mechanism 1 (base money,M2, interest rate output, prices)

[b] mechanism 3 (asset ratios, M2, interest rate, output, prices)

[c] mech2(M2, exchange rates, output, prices)

[d] mechanism 4(M2, lending rate, lending,output,price)

Table (2.2) shows every 6th step of price and output decompositions for the post-reform period. During this period, innovations to most policy variables make large contributions to movements in prices. In the exchange rate channel and when statutory ratios are used, prices account for only 32% and 20% of own movements after a year respectively. Of the two money variables, M2

becomes more important after the reforms contributing more to price developments both at short and long horizons. In the base channel, M2 explains 22% of price variations. When statutory ratios are included, M2 explains only 15% of movements in prices while 67% is due to statutory ratios [8]. In the exchange rate channel, the exchange rate explains as much as 55% of price variations after one year and 48% after two years. In this channel, we notice that while the exchange rate explains more variations prices, M2 explains more and more variations at longer horizons.

During the post-reform period, output variations are mainly due to own innovations and innovations in the exchange rate. Base money and M2 together account for less than 20% of the developments in output after two years in the interest rate channel. When statutory ratios are included, there is no significant difference in the total money aggregates' contribution. The exchange rate becomes important for both short run and long run output developments during this period explaining 17% of the variations within half a year.

2.6.2 Response Functions

All the response function graphs are shown in the appendix. In figures (2.8) and (2.9) below, we show the responses for the base model (mechanism one) for both the pre-reform and post reform periods. With a few exceptions, the main structure of the responses of prices and output to the policy variables is the same before and after the reforms. The effect of base money and interest rates in the pre-reform period is unexpected. A positive shock to base money reduces prices while a shock to interest rates increases prices. This perverse response could be due to price and interest rate controls that existed at the time. For instance, an increase in base money would induce a desire on the part of the government to keep prices low in a bid to control inflation. Similarly, an increase in deposit rates would induce an increase in broader

[8] Most variations in M2 are due to statutory ratios

money holdings putting upward pressure on prices [9]. As expected contractionary monetary policy dampens output. In the pre reform period, a positive shock to the interest rate and the exchange rate lead to a fall in output. In the post-reform period, the responses to interest rates and the exchange rate are larger but short lived. The initial effect of a positive shock to the exchange rate is to reduce output which begins to increase after about 10 months.

[9] Although prices were institutionally set, they were periodically changed depending on the conditions in the economy

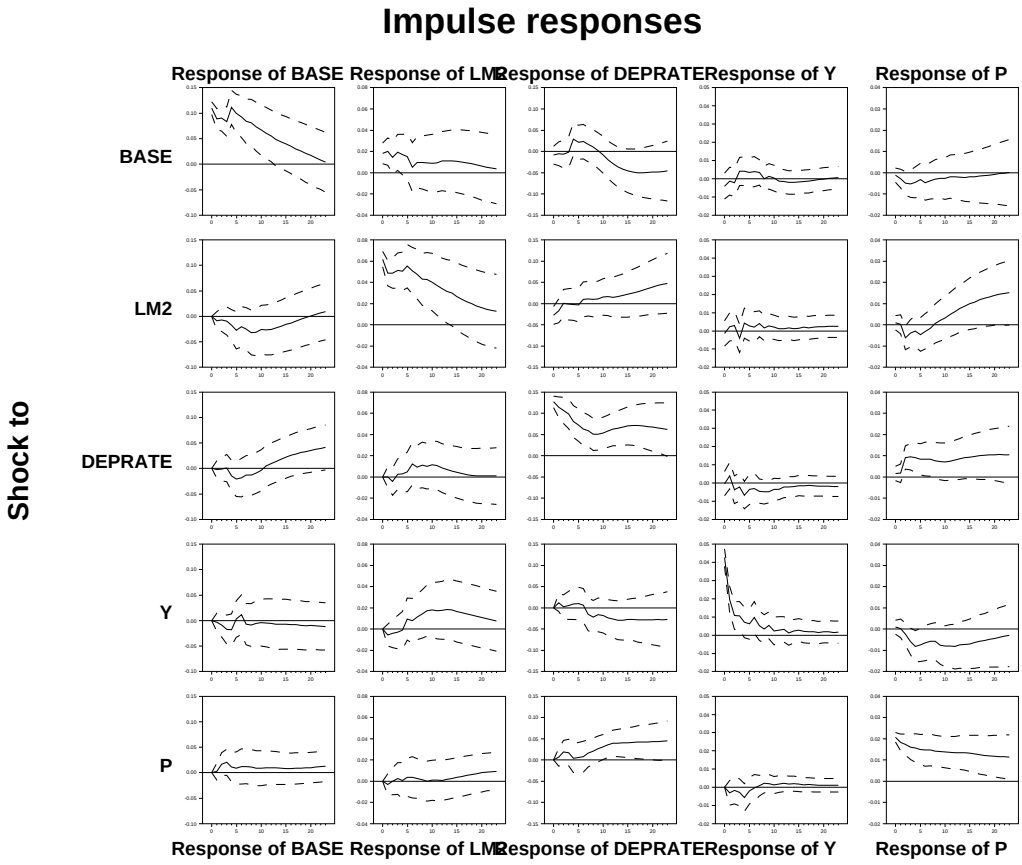


Fig. 2.8: **Pre-reform mechanism one**

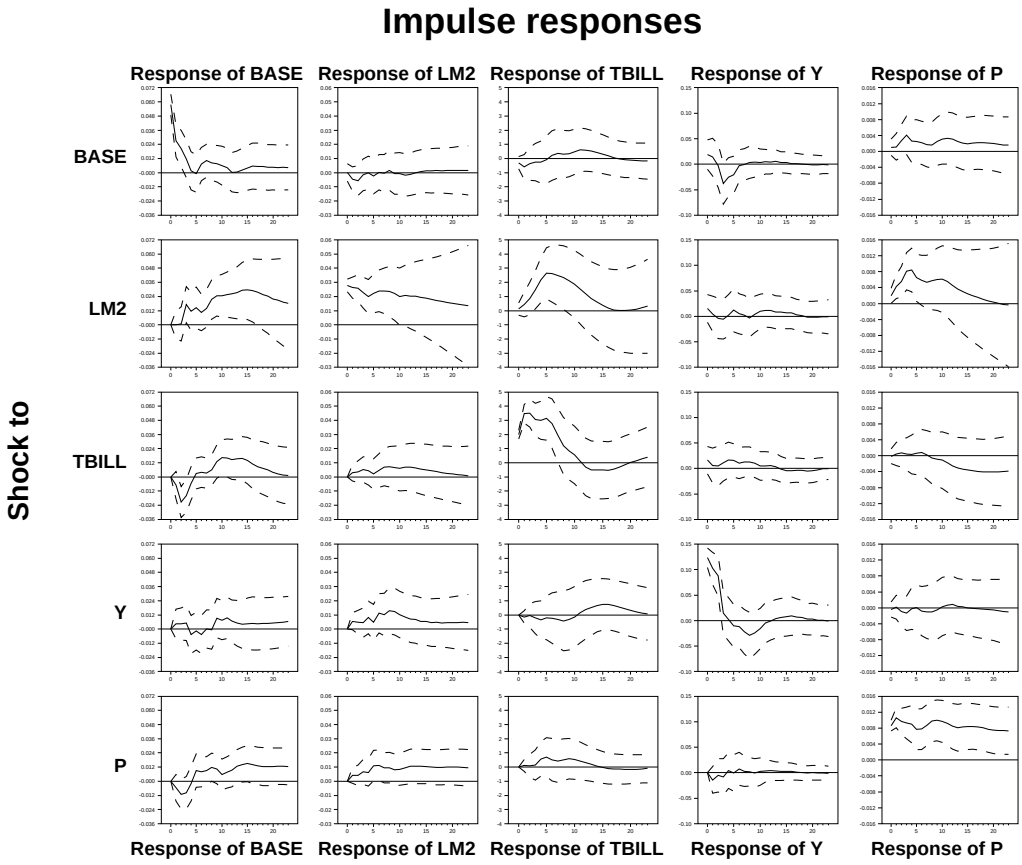


Fig. 2.9: **Post-reform mechanism one**

2.6.3 Effect of the Reforms

In this section, we compare the estimations in the two periods. Firstly, the responses of some of the variables are much larger and with shorter impact lags in the post-reform period. For example, the response of output to innovations in money aggregates is more immediate than in the pre-reform period. The M2 innovations impact lags on prices also reduce to one month during the post-reform period from 7 months before the reforms. That of exchange rates on prices reduces from 4 months to 2 months. After the

reforms, the exchange rate impacts output faster than before the reforms. Contrary to Anti-Ego (2000)'s results on Uganda, the treasury bill rate affects prices with a lag even after the reforms. The impact lags of the interest rates on both prices and output on the other hand have not changed much.

The nature of output responses to exchange rate innovations has also changed. In the pre-reform period, shocks to the exchange rate are followed by an initial small increase in output in the first four months which becomes negative thereafter. In the post-reform period, the initial impact is negative and lasts about four months. The exchange rate becomes important for output developments both in the short and long run during the post-reform period compared to being important only after a long lag in the pre-reform period. This is evident from the variance decompositions.

The behaviour in output can be explained by the nature of the Zambian economy at the time and the way it has changed since the reforms. The country was quite dependent on the external sector's revenue to finance both consumption and production. Copper exports were the main source of revenues for government expenditure. Since a lot of socio-economic goods and services were supplied by the government, shocks to the exchange rate affected revenue and hence consumption significantly. The exchange rate also affected production through the cost of imported inputs. The government had created a lot of manufacturing firms during the import substitution era, which were highly dependent on imports for their inputs. An increase in the exchange rate would increase the cost of production and hence have a negative effect on output. Since prices like exchange rates affect demand faster than supply, a positive shock to the exchange rate would lead to an increase in output whose effect may then wane as supply is later affected by increased production costs. After the reforms however, the structure of the economy changed. A lot of the industries set up under the import substitution strategy were closed or privatised. The importance of copper exports in the economy reduced and non-traditional exports such as flowers, fruit vegetable and animal products started to contribute more to both export volumes and revenue. With the

massive lay offs in the public sector under privatisation and public sector reform, the informal sector expanded quite rapidly with a large increase in petty trading and the informal sector as a whole. With these changes, retail and services became larger components of output.

An explanation consistent with the observed change in the response of output to the exchange rate lies in the way the exchange rate would affect the different components of output in the new structure. A depreciation for example would affect wholesale and retail activities first. Because this sector is highly dependent on imported consumer goods, the initial impact would be to raise domestic prices. The share of manufacturing and construction together constitute on average 14% of output over the sample period. Wholesale, retail and services on the other hand constitute about 50% of output. Over the same period, public sector wages have hardly increased even in nominal terms and private sector wages are negotiated only periodically. The increase in prices is therefore not followed by an increase in output as would be expected but rather a fall as inventories accumulate. The main components of export are agricultural, whose output or supply responds to changes in prices with a lag. After a while, as supply of the exportables increases along with foreign demand resulting from the depreciation, output will also increase as observed. Before the reforms, interest rates were important for movements in output but this changes after the reforms. Both the treasury bill rate and the lending rate explain small amounts of variations in output although output tends to respond to innovations in the treasury bill rate more than to other policy variables apart from the exchange rate. Total bank lending becomes more important after the reforms although the changes are not as marked as in the other variables. The withdrawal of extensive government involvement in economic activity and the removal of various controls have allowed the private sector to become more important. This has increased the importance of credit in output developments. The presence of information asymmetries and other forms of risk in the credit market may have hampered more expansion in credit. Information asymmetries tend to lead to setting of high lending rates

and reduction in total loans. This is evidenced in the high spread between the deposit and lending rates (see figure(2.6)). Treasury bills have also offered an alternative source of finance with the development of trading treasury bills on the secondary money market. This may explain the importance of the treasury bill rate for output movements.

Although we do not test the lending channel very rigorously in that a full test of this channel requires bank and firm level data, we test the channel at a very aggregate level by estimating the lending channel in mechanism four. We find that the channel is more important before the reforms especially for output, with the lending rate being the most important variable for output movements before the reforms. After the reforms, the channel operates more through shocks to actual lending compared to the pre-reform period when lending rates were more important. Again this could be a result of the high lending rates. Before the reforms, the government set a selective ceiling on the lending rates. Selected firms (mostly government parastatals) and industries (mainly agriculture) had access to loans at these low rates. After the reforms, these firms and industries have to compete in the credit market with all other firms. With high interest rates, only firms with sufficient collateral can have access to credit.

When we look at the forecast error variance decomposition of bank lending, we find that innovations to prices make the largest contribution to loan movements.The M2 contribution is just over 10% showing that lending may not be driven by monetary policy. This result agrees with the findings by Nannyonjo (2001)on Uganda where although she finds an important role for lending, she finds that lending is demand driven rather than determined by monetary policy. It also appears that lending is not driven by its price as the lending rate explains only 7% of movements in total loans even after two years.[10]

The impact of the lending channel is weaker if the financial condition of the

[10] some the results mentioned are not presented in tables 1 and 2 and are cited for clarity. They are available from the author.

banking sector is weak, particularly if bank capital is limited and bank loan making is tied to risk based capital requirements (Kasyap and Stein 1994). The new bank legislation enacted in 1994 tied loan making to risk based capital with a maximum of 25% of capital per borrower . When a bank's ability to make loans is tied to its capital in this way, it is likely to hold more bonds or treasury bills than it needs for liquidity purposes since it does not have enough risk based capital to support more of the higher yielding loans. As a share of total liquidity, commercial banks in Zambian hold very high amounts of treasury bills. In 2001, treasury bill holdings averaged 68% of total bank liquidity with rates being as high as 80% in some months (BOZ 2002). This may indeed dilute the effect of the credit channel since the treasury bills offer an alternative source of financing and policy changes meant to regulate liquidity in the economy through loans will have little effect.

Financial sector fragmentation may also contribute to the limited impact of the credit channel in the post-reform period. The increased size of the informal sector where most of the traders lack collateral for formal sector loans creates a parallel loan market to which most of these traders resort to for financing. Although this phenomenon existed before the reforms, the size of the parallel financial markets has increased after the reforms due to the removal of ceilings, administrative controls and a decrease in formal employment. This parallel market as a source of alternative financing dilutes the effect of policy changes as do treasury bills for commercial banks both through the money and credit channels.

The sluggish response of the lending rate to policy shocks may also dilute the impact of credit on the economy. Since about 1998, the lending rate has remained persistently high widening the spread between the lending and deposit rates quite significantly. One of the reasons this could have happened is the high operating costs and non-performing loans observed in Zambian commercial banks. Banking industry non-performing loans were as high as 31% in 1997 with some bank's rates being as high as 50% (Ndulo and Simatele (1999)). Over the past five years, the level of non-performing loans in the

industry have averaged 20% per year (BOZ (2002)). The effect of such costs is that commercial banks set imprudently high lending rates to compensate for lending risk. The result is that lending rates don't fluctuate much in response to policy but are rather influenced by risk assessment in the loans market.
The behaviour of the response of prices to interest rate shocks also changed after the reforms. Our results show that a positive policy shock is followed by an increase in prices. A problem arises when we interpret innovations to the interest rate as an indicator of policy since a positive innovation to the interest rate is followed by an increase in prices. This phenomenon in the literature has been referred to as the 'price puzzle'. The price puzzle has often been attributed to the exclusion of some leading indicators that are not in the estimated system to which central banks react. One such indicator that has been used is the commodity price index. We observe this behaviour in the price level during the pre-reform period. Unfortunately, we could not access any commodity price data to enable us to re-estimate the system to see if this puzzle would disappear. In the post-reform period however, the price puzzle is less obvious and disappears when the deposit rate of interest is used as an indicator of policy rather than the treasury bill rate. This indicates that the former may be a better indicator of the monetary stance of BOZ than the treasury bill rate.
Unlike in the pre-reform period (when prices were controlled), inflation exhibits persistence in the post-reform period. Although both indexation and inflationary expectations may theoretically explain this behaviour in inflation, the most plausible explanation is that of inflationary expectations. The reason is that there is no extensive indexation in Zambia although implicit indexation is very likely. Inflationary expectations on the other hand offer a more plausible explanation due to the continuous failure of the central bank to meet its inflation targets since the reforms. Monetary authority credibility is lost this way and despite public announcements by the central bank about the inflation goals, the public tends to build inflationary expectations in their contracts.

All the policy variables during the pre-reform period except for the deposit rate (whose variations are due to operating ratios) are quite exogenous to the estimated systems. After the reforms, we find that of the policy variables, only the exchange rate is exogenous to the estimated system. There is quite a lot of feed back to the monetary aggregates which explain as little as 25% of own variations in some cases. When there is significant feedback from the non-policy variables to the policy variables, policy implementation becomes difficult. For example, movements in base money are mainly due to innovations in M2. Developments in M2 are explained mainly by innovations to the exchange rate, output and prices in the first year. Although this may only reflect that policy is backward looking or reactive rather than proactive or forward looking, it may also be that feedback from the macro- variables is significant.

When we compare the different mechanisms, the exchange rate channel seems to be the most important for developments in prices before the reforms while both the exchange rate channel and the use of statutory ratios are most important after the reforms. For developments in output, the lending and exchange rate channels are the important channels before the reforms while the exchange rate channel is the most important after the reforms. Most variations are due to innovations in M2, statutory ratios and the exchange rate.

The results obtained in this study though not directly comparable with those reviewed are not very different. We can relate to the two studies by Mwansa (1998) on inflation in Zambia and Anti-Ego (2000) on Uganda. Although the studies used different variables, both studies included prices and money and the later study also included the treasury bill rate. Our study differs from the one by Mwansa (1998) in the periods covered since half of the sample period in Mwansa's study covers a period before full implementation of the reforms. However, our results on the role of exchange rates for prices are similar to his. In both studies, the exchange rate is more important for price movements than money supply. Anti-Ego finds an important role for the treasury bill rate in both price and output movements and that base money impact lags to prices

are significantly longer than those of the treasury bill rate. In line with his results, we find that the treasury bill rate is important for output variations. Our results on the price movements however differ. Unlike him, we find little importance of the treasury bill rate for prices and its impact lags are not much shorter than those of base money.

2.7 Summary and Conclusion

In this paper, we estimated VAR systems for two periods in post-independence Zambia; the pre-reform and post-reform periods. For each period, we used alternative measures of monetary policy shocks and estimated four possible transmission mechanisms. The first three mechanisms estimated fall under the money view where in addition to base money movements, interest rate and exchange rate innovations are interpreted as indicators of the stance of monetary policy. We also tested the propagation of monetary policy when money supply is controlled by the use of statutory reserves. We tested the credit channel by estimating two VAR systems that include total bank lending and the lending rate alternately.

The forecast error variances decompositions show that more of the variability in prices and output are explained by shocks to money aggregates, the exchange rate and statutory ratios after the reforms than before. Although the money aggregates are important for explaining price movements, the exchange rate seems to be more important for movements in both prices and output. When both M2 and the exchange rate are put in the system, the exchange rate explains more of the movements in both prices and output (more at shorter horizons for prices). Of the policy variables, we find that only the exchange rate is exogenous to the estimated systems. We also find a role for the credit channel.

The impulse responses we estimate are plausible and in many cases reveal standard results. We find that expansionary policy is followed by an increase in prices. We also find that expansionary policy is followed by an increase in

output albeit short lived in most cases. During the pre-reform period, we find evidence of the perverse effects of price and interest rate controls. The results show that the impact lags have reduced since the reforms. The price puzzle also shows up when interest rates are interpreted as indicators of policy stance. This disappears during the post-reform period when the deposit rate is used as an indicator of the stance of policy suggesting that the deposit rate may be a better indicator of BOZ policy than the treasury bill rate. When compared to the pre-reform period, responses in prices are larger in magnitude while those of output are not very different.

It has often been said that base money has been very difficult to control in Zambia. This makes the implementation of the financial programming policy framework under which monetary policy operates in Zambia difficult. The significant amount of feedback to the monetary aggregates from the non-policy variables seen in the estimations suggests further investigation into money demand in Zambia probably by extending studies such as those of Adam (1995,1999) to cover periods beyond 1996.

From our results, we conclude that the potency of monetary policy has increased since the reforms. Although monetary policy in Zambia focuses almost exclusively on monetary aggregates, we find evidence that exchange rates may be more important for developments in both prices and output. Although our results are very plausible, the approach we use in the study looks at the effect of unexpected policy changes. Despite the likelihood that the magnitude of this type of shocks is significant in Zambia, further investigation into the monetary transmission mechanism using other methods that take into account systematic policy as well would help in showing the robustness of the results of this study. Testing of the bank lending channel may also be more usefully done with more disaggregated output and bank data and this would show a more detailed picture of how monetary policy is transmitted to the macro-economy.

There are some caveats to bear in mind. Firstly the post-reform period covers only seven years and may not be enough to capture completely the dynamics

in the economy. Secondly, there are still a number of structural changes going on in the country that are not captured in the method used here that could have a bearing on the results. However, we believe that the results obtained here are relevant to policy making and that the study raises important issues relevant to both policy and research.

2.8 Appendix A:Impulse Response Functions

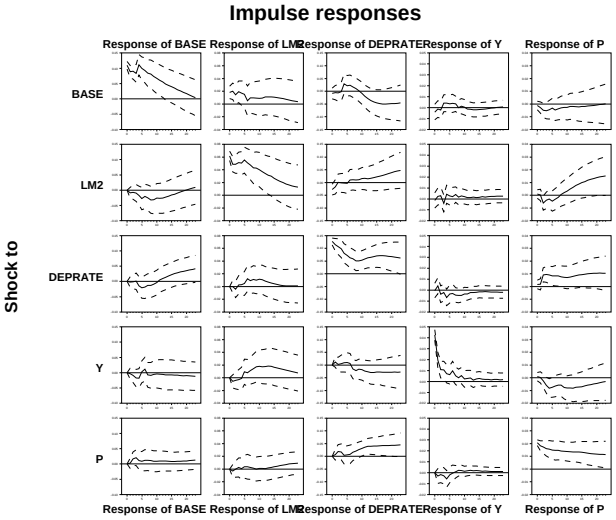


Fig. 2.10: **Pre-reform Mechanism One**

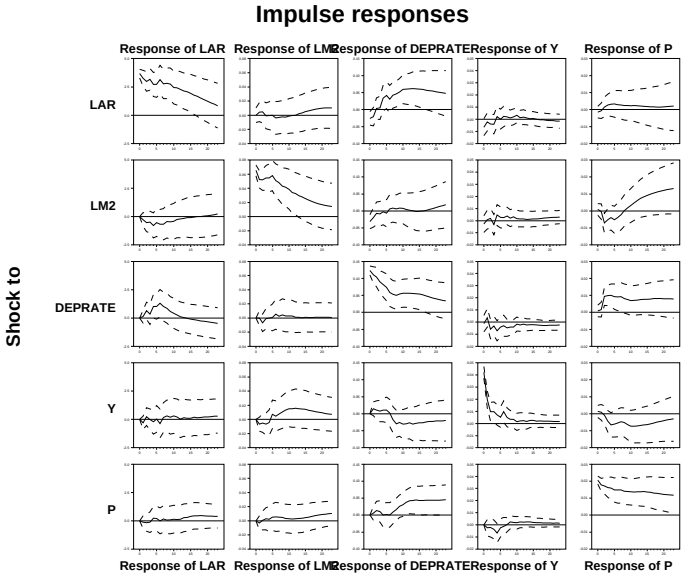


Fig. 2.11: **Pre-reform Mechanism Two**

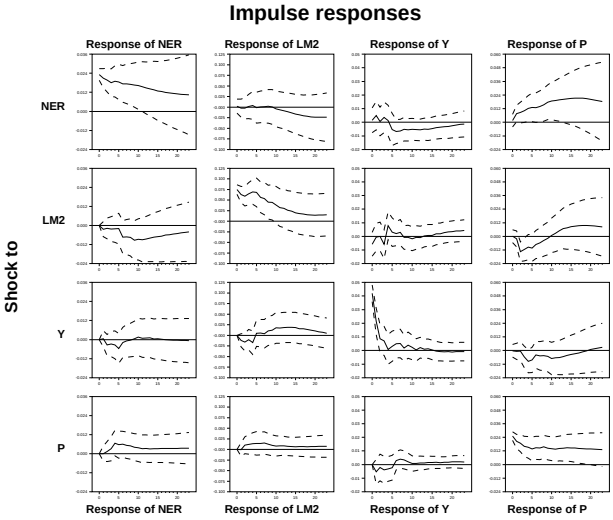


Fig. 2.12: **Pre-reform Mechanism Three**

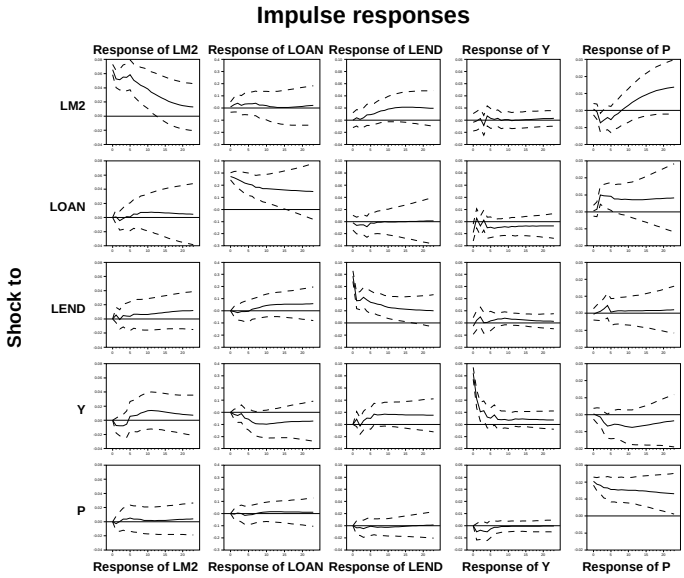


Fig. 2.13: **Pre-reform Mechanism Four**

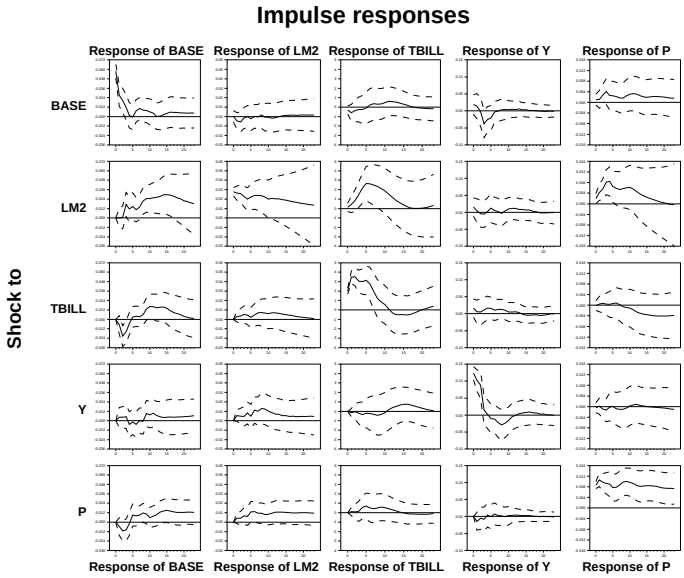


Fig. 2.14: **Post-reform Mechanism One**

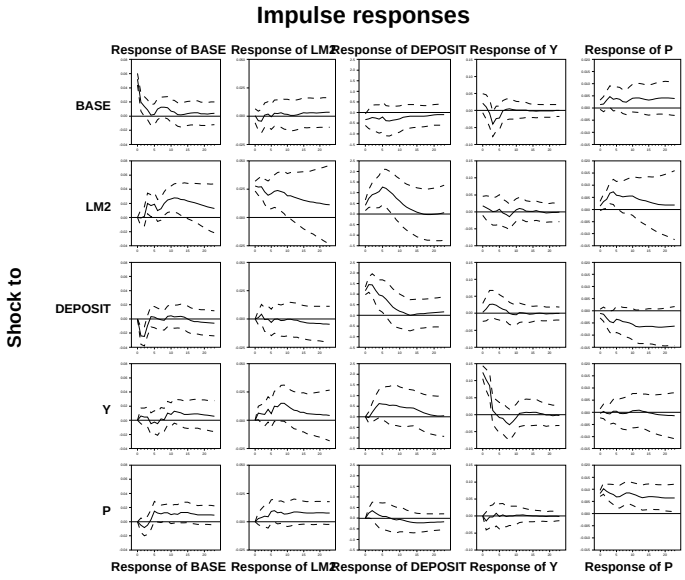


Fig. 2.15: **Post-reform Mechanism One b**

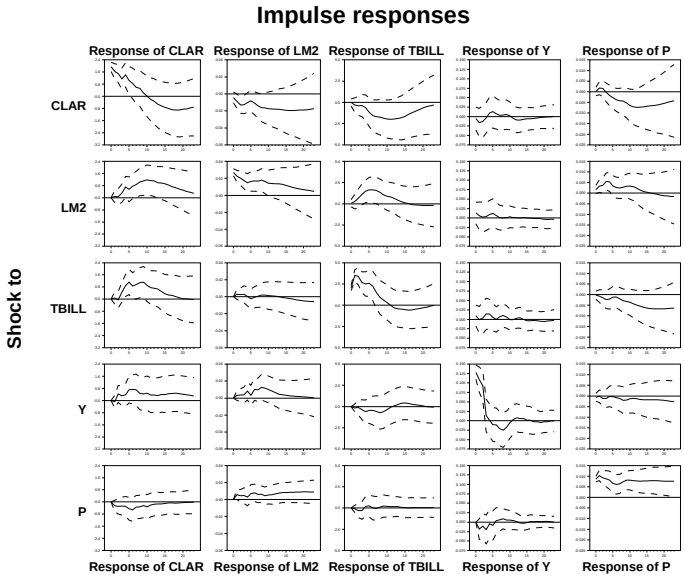


Fig. 2.16: **Post-reform Mechanism two**

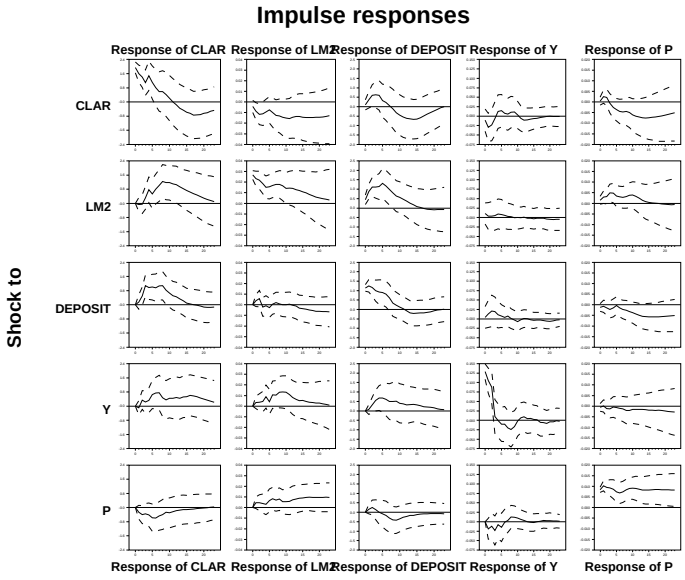


Fig. 2.17: **Post-reform Mechanism Two b**

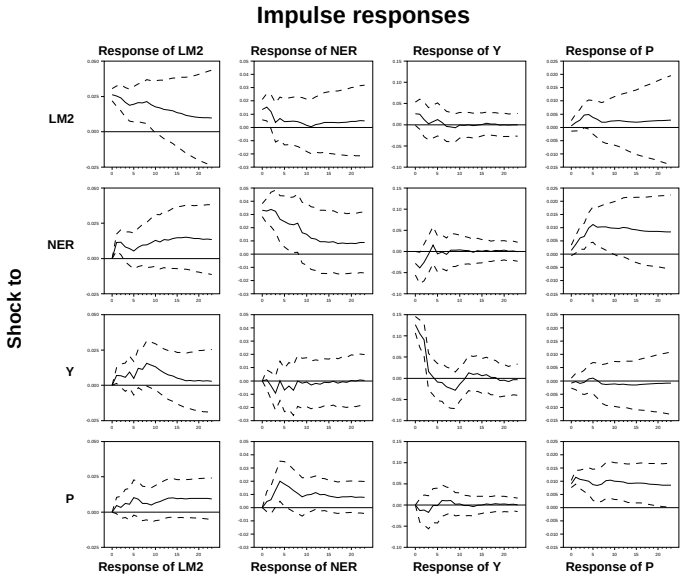


Fig. 2.18: **Post-reform Mechanism Three**

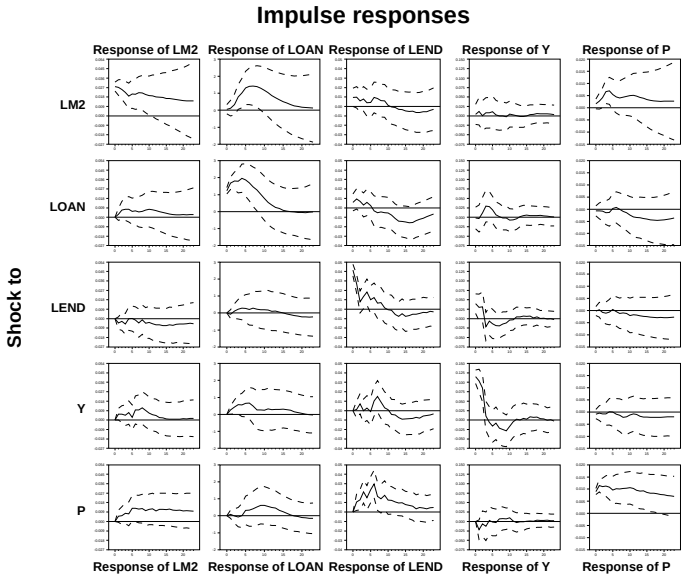


Fig. 2.19: **Post-reform Mechanism Four**

2.9 Appendix B: Sources Of Data Variable

Tab. 2.3: Sources of Data

Variable	Source
Output	World Development indicators 2002, calculated 2001
	value based on announced growth rate of 2.2% for that year
CPI	Bank Of Zambia Data base and Ministry of Finance and
	Economic Development Economic indicators, various years
Monetary aggregates interest rates	Bank of Zambia data base and
Bank lending, asset & statutory ratios	Annual Reports and Statistics fortnightly
& exchange rates	

3. CAN MONEY TELL US ABOUT INFLATION?

EVALUATING THE INFORMATION CONTENT OF MONEY FOR PREDICTING INFLATION IN ZAMBIA

ABSTRACT

The paper, investigates whether monetary aggregates have useful information for predicting inflation other than that provided by inflation itself. We perform forecasting experiments and compare the performance of different models. We also estimate an error correction model of inflation. Of the monetary aggregates considered, M2 contains the most information and its growth rate significant in the inflation model. The external sector variables are also important. The results indicate that inflation exhibits a high level of inertia suggesting the presence of implicit indexation and significant inflationary expectations possibly due to past fiscal effects and low policy credibility. Overall, the foreign sector variables seem to be more important for movements in prices than monetary aggregates even in the long run.

Keywords: *Information, Monetary Aggregates, Monetary Policy*
JEL Classifications: *E52, O23, P44.*

3.1 Introduction

Implementation of monetary policy in Zambia as in most other African countries is based on the IMF financial programming framework. Using this framework implies the assumption that movements in money are informative for inflation and output and those movements in money precede movements in prices and output. As such, the Central Bank changes its instruments in line with deviations of growth in money from target. One of the ways in which the usefulness of money can be determined is to check how much information is contained in it for forecasting the subsequent behaviour of inflation and output.

In chapter II, we found that although money supply explained about 40 percent of variations in inflation, the exchange rate seemed to be more important for movements in both prices and output. In this chapter, we follow up on this result and explore the importance of information contained in money aggregates for movements in prices vis-á-vis that contained in other variables such as exchange rates, domestic interest rates, foreign prices and the government domestic debt. This is a very important issue because for money aggregates to be used in the conduct of monetary policy in any way, they must at least contain useful information. Research in both developed and developing countries has shown that the usefulness of money aggregates in this respect varies from country to country and period to period. The extensive economic reforms that have taken place in Zambia since 1992 could have altered the perceived relationship between inflation and the monetary aggregates.

A few studies have looked at money demand and supply and its relevance to the price level in Zambia. However the existing information needs to be updated to incorporate more years in the reform period. Moreover, these studies have focused mainly on the role played by monetary aggregates. Besides looking at the monetary aggregates, this study assesses the usefulness of other financial variables vis-á-vis the monetary aggregates and try to gauge which of these variables contains the most information for predicting inflation.

This information is crucial not only for day to day conduct of monetary policy in the current framework but also in the transition to more indirect methods of policy implementation started in 1993.
The empirical approach used is to conduct forecasting experiments and estimate an inflation equation. The results show that while M2 contains information for forecasting inflation, the foreign sector variables may be even more useful.
The paper is outlined as follows. In section 2 we give a brief background on inflation and money in Zambia. In Section 3, we discuss the theoretical framework followed by a review of the literature in Section 4. In Section 5 we have the methodology and data discussion and in section six the results. We summarise and conclude in Section 7.

3.2 Monetary Developments and Inflation After the Reforms

For most of the period after independence, Zambian monetary policy relied on direct instruments with economic growth as the ultimate goal. With increased dis-intermediation, financial and economic collapse resulting from these controls and other problems in the country, the central bank switched to indirect controls in 1992. Interest rates were liberalised, wages and prices decontrolled, and exchange rates freed. Capital controls were also removed. Open market operations mainly using liquidity as an instrument were introduced in 1993 but only in 1995 were daily auctions of credit and deposits really put in place.
With the switch to indirect instruments came the change of the goal of monetary policy to the reduction of inflation. This change was prompted by the belief that monetary policy has only temporal effects on real variables and long run effects on prices. Empirical evidence over the years has shown that low inflation is a prerequisite for economic growth. Given the high levels of inflation in Zambia at the time especially since the reforms, there was need to bring inflation under control before a sustained path to growth could be

attained.

Basing implementation of policy on the IMF financial programming framework, control of growth in money supply became a very important factor in the control of inflation. Targets are set each year for growth in broad money and inflation. Implementation of policy has involved monitoring the deviation of growth in money from target. Controlling the growth of money supply proved to be a difficult task especially in the years just after financial deregulation. The almost simultaneous deregulation of both the domestic and foreign sectors led to problems from different sources .

One such source was the requirement for the Bank of Zambia (BOZ) and the government to build up international reserves. This was done through the purchase of foreign exchange off the market. The Bank often reports that such interventions have lead to increases in money supply. This problem seems to be more pronounced in years when donor inflows for Balance of Payments support are erratic. In some cases, BOZ also offloads foreign exchange on the market in a bid to stabilise the exchange rate. Foreign exchange market intervention is also common in election years as the government tries to use the level of the exchange rate as a campaign issue. It is not uncommon to notice that months preceding an election, the exchange rate holds a given level for quite some time and shoots up shortly after the elections .

Expansion in net domestic assets (NDA) has also been a major source of growth in money supply. The main sources of increases in NDA have been net claims to the government and central bank lending to distressed commercial banks. In 1997, BOZ moved the location of the clearing house from its buildings to the commercial banks in an attempt to cut down its lending to banks. The table below shows growth in money supply and its components. It is clear that although growth in NDA has been reduced, it is still the largest contributor to the growth in money and the major contributor amongst the sub-components is credit to the government.

Inflation was also erratic during this period. The table below shows that within the sample period (1994-2001), the inflation rate has been above target

throughout. The most frequently reasons cited for high inflation are currency depreciation, food prices and fiscal budget performance. Other sources of inflation cited include banking crises and growth in money supply.
In December 2001, annual inflation was 18.7% almost the same as the sample period low of 18.6% in 1997. Figure 3.1 shows annual CPI inflation.

Tab. 3.1: % Growth in Broad Money and Its Components

	1993	1994	1995	1996	1997	1998	1999	2000
Growth in M2	101.5	62.8	53.3	34.4	24	22.6	29.2	67.5
Targets					17	19.6	18.2	25.2
NFA	-165	-104	-5.7	-43	12.6	-73.3	3.3	-72.3
NDA	266.7	166.9	60.9	77.4	11.4	95.9	25.9	139.8
D/ Credit			43	26.7	5.1	58.4	36	68.3
Govt			1.8	3.9	1.3	48.2	12.3	43.2
Non-govt			41.1	22.8	3.8	10.3	12	3.6
Other Net Items			17.9	50.7	6.3	37.5	-10.1	71.5
Growth in M1	42.3	22.5	24.1	7.7	11.7	4.7	25.5	54.9

Source: Bank Of Zambia and IMF statistics

Tab. 3.2: Target and Actual Inflation rate (1994-2001)

	Target	Actual	Reasons cited
1995	35	45.5	↑ Banking crises, depreciation, drought
1997	15	18.6	↓ Good fiscal performance
1998	15	30.6	↑ Exchange rate depreciation
1999	20	20.6	↓ Stable exchange rate, reduced food prices (despite increased energy prices)
2000	19	30.1	↑ Increased Money supply, depreciated exchange rate, increased fuel prices, electricity tariffs, fall in agricultural prices prevented further increase
2001	17.5	18.7	↓ stable foreign exchange market

Source: BOZ annual reports Note: Arrows show the direction of movements in annual inflation

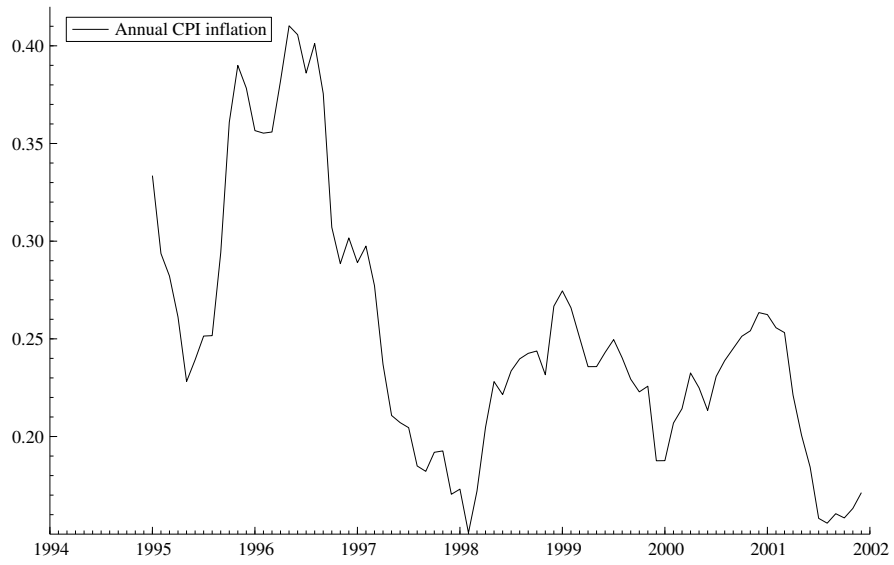


Fig. 3.1: **Annual CPI Inflation**

3.3 Conceptual Framework

The basis of using money as either an information or intermediate variable is that there is some reliable relationship between the movements in money and prices. However, movements in prices may result from movements in other variables that may contain more information about prices than does money. Typically, many central banks collect and analyse a number of indicators. Emphasis placed upon one particular indicator to the exclusion of other indicators implies that the monetary authority believes that the particular indicator is the most important for movements in inflation and other variables do not add any valuable information to the information set.

If we consider a small open economy, we see that factors that affect both aggregate supply and aggregate demand would affect the price level. For example, on the one hand increases in money supply, changes in money demand and increases in government expenditure, which increase aggregate demand, will cause an increase in prices. On the other hand, supply side

factors such as technology shocks, changes in capacity utilisation resulting from restructuring, exchange rates and productivity can also lead to price changes. With high import dependency, foreign prices can also have a very significant effect on domestic prices.

The financial programming framework used to implement monetary policy in Zambia and many other African countries under Structural Adjustment Program (SAP) however emphasises the role of the growth of money supply. The reason for this focus is mainly due to the assumption that only growth in money supply leads to persistent increases in inflation (Romer (1996)). This assumption rests on the premise that the equation of exchange holds in some form. Consider the income version of the equation of exchange shown below.

$$MV \equiv PY \tag{3.1}$$

Where M is money supply, V velocity, P a price index and Y is real output. Under classical assumptions, V is assumed to be constant or fixed and Y at full employment. Expressed in logs, the equation becomes

$$m + v \equiv p + y \tag{3.2}$$

Under classical assumptions, changes in money balances translate directly into changes into prices i.e $\Delta m \equiv \Delta p$ conditional on Δy and a stable money velocity. In reality, output is rarely at full employment especially in developing countries. There are structural rigidities in most of these economies that inhibit full capacity utilisation of resources and thereby immediate adjustment. The key to this relationship between money and prices is money demand which links money to prices, interest rates and output through spending and saving decisions which individuals make. The amount that is held either as balances or as deposits depends on amongst other things, the levels of interest rates, prices, innovations in the banking sector and general economic activity. Velocity (the frequency at which individuals conduct their transactions) depends largely on levels of income, changes in prices and innovations in the

payments system. We have said above that for the supposed relationship to hold, velocity must be relatively stable. When this is the case, and money grows faster than output, prices will increase and if money grows very rapidly, then we have an inflationary situation.

When money demand is unstable, controlling inflation using money supply becomes very difficult. Factors such as changes in financial regulations, financial innovations, and changes in portfolio preferences can lead to instability of money demand. This is very likely to have happened in Zambia since the reforms.[1] A lot of controls that were in place in the financial markets were removed in the early 1990's and with increased competition, there has been a lot of innovation especially in the banking sector. The introduction of interest earning checking accounts, plastic money and increased access to consumption loans could very well have changed money demand in the country.

In addition to money supply, other financial variables are monitored by central banks. This is necessary because policy is forward looking and monetary policy works with a lag. Since output and inflation are often difficult to measure at short frequencies, policy makers often have to rely on many indicators that are closely related to the policy goals. We briefly discuss some of the variables we think are necessary to the Zambian situation below.

3.3.1 Interest Rates

Many central banks conduct monetary policy by setting or targeting short-term interest rates. Increases in interest rates usually signal tightening monetary policy and should slow down inflationary pressures. Once these rates are set, the market mechanisms then work to determine the detailed structure of the lending and deposit rates. For this to work, an efficient monetary transmission mechanism is required. However, interest rates are not always a clear indication of the stance of monetary policy as they contain information

[1] We note here that Adam (1999) finds a stable money demand in Zambia with a portfolio shift. However, a lot of changes have been implemented since 1996 especially with respect to the payments system, bank regulation and innovation.

about both the interest rate and expected inflation.
Due to some of the changes occurring as discussed above, these mechanisms may not work very well in a developing country like Zambia. One of the reasons may be changes resulting from the reforms such as the removal of interest rate controls, which may initially lead to high levels of non-performing loans, which are compounded by inadequate loan management eroded over long periods of financial repression. The lack of competition may also lead to sluggish responses of interest rates to policy changes.

3.3.2 Exchange Rates

The exchange rate can be used as an indicator of inflationary pressures. In some cases, it is also used as an intermediate target. It reflects both domestic and foreign pressures. A depreciation is associated with positive inflationary pressures and affects inflation through the '*aggregate -demand*' and the '*direct exchange rate*' channels.[2] When the real exchange rate rises, the domestic prices of imported and exported final goods increases. The rise in exportable goods' prices can be either due to increases in costs of inputs arising from the depreciation or from increased demand since the depreciation makes domestic goods cheaper in foreign markets. This results in increased CPI inflation.
The effect of exchange rates however may be transitory. Factors such as the degree of openness, domestic capacity utilisation and changes in policy may also affect the degree of effect exchange rates may have on inflation (Kozicki (2000)). For example, if the country has capital controls, the effect of exchange rates on inflation may not be as large as when the capital account is open since the effect of capital movements (such as predicted by interest parity) will be absent. However, in some cases, the exchange rate can have long term effects on inflation. In countries such as Zambia, which had an overvalued exchange rate for a long time before the reforms and which are still

[2] See Svensson (2002)

heavily import dependent, there is likely to be persistent exchange rate effects on inflation after the liberalisation of the exchange rate.

3.4 Review Of Literature

3.4.1 Methodological Issues

From the early work of Sims (1972) empirical consideration of whether financial variables can usefully be employed in conducting monetary policy has focused not only on the ability of these variables to predict movements in output and inflation but also on whether they could help predict fluctuations that are not predictable by information contained in output and inflation themselves. Empirical work has focused on the use of Vector Auto Regressions (VARs). The main attraction of tests from VARs is that they provide a natural basis for testing conditional predictability. As long as the financial variables contain some information that can independently predict movements in output or inflation, policy makers can exploit that information (Friedman and Kuttner (1992).

Many studies have employed Granger-causality tests between financial sector variables and output or inflation (Friedman and Kuttner (1992), Estrella and Mishikin (1997), Andersson and Sj (2000). Variance decompositions have been used to check how much of the forecast error variance in output or inflation is attributable to a given financial sector variable (Friedman and Kuttner (1992), Chandra and Tallman (1996), Emery (1996), Andersson and Sj (2000).

Gray and Thoma (1998) have argued that some of the results obtained using Granger-causality and variance decompositions may be sensitive to changes in the sample. They may even be heavily influenced by the presence of one outlier in the data. They suggest the use of recursive regressions such as used in Emery (1996), which can reveal the sensitivity of the results to changes in the sample.

VARs have been used to conduct forecasts of output and inflation in systems that contain a financial sector variable (Chandra and Tallman (1997), Gray

and Thoma (1998), Black et al. (2000). Using different measures to compare the accuracy of the forecasts, the results from different financial variables are then compared. In this way, the relative importance of different variables is also checked. Because the ultimate test of an equation lies in its out of sample tests, many studies have also extended the analysis to compare in sample and out of sample forecasts while others have used conditional forecasting.
Single equation estimations of output and inflation have also been used to check the information content of financial variables. If a financial variable enters the equation significantly, then it contains useful information for policy (Chandra and Tallman (1997)). Numerous studies of inflation have also been done without particular reference to the issue of information content of the financial variables. However, almost all these studies include some financial sector variables like exchange rates and interest rates as explanatory variables so that if these variables enter these equations significantly, they can be said to contain some inflation information.

3.4.2 Empirical Review

A number of studies looking at the information content of monetary aggregates for inflation and output have been carried out. The studies we could access however are mainly on developed countries. However, many inflation studies on developing countries in general and Africa specifically although not focusing on monetary aggregates per se, have included money aggregates,exchange rates and interest rate measures as explanatory variables. These can give us an indication of the importance of these variables for inflation.[3] We will therefore review a few studies specific to the topic and then some inflation studies on African countries.
A number of studies have employed the VAR methodology. By evaluating F-statistics and forecast performance measures, empirical work has shown that the issue of whether monetary aggregates are important for inflation or not

[3] This is with the caveat that most of these studies use samples across different policy regimes and therefore are subject to the Lucas critique.

varies from country to country and from one period to another.

One of the studies important to the discussion here using US data is that by Friedman and Kuttner (1992). They use F- statistics to determine the importance of money variables in a VAR model. They find that both M1 and M2 are significant for inflation before 1980 and the significance disappears when the data set is extended beyond that period. Of particular interest, they find that the commercial paper bill spread was a good information candidate for industrial production. This conclusion sparked a debate and some of the resulting papers are those of Emery (1996) who estimates recursive regressions and uses both Granger-causality and variance decompositions. He attributes the importance of this variable to the presence of outliers in the data. Hafer and Kutan (1997) explore the importance of the commercial bill spread and argue that the conclusion on its significance was a result of wrong stationarity assumptions about the money variables. He finds that by carefully modelling the data, money variables are still useful beyond the 1980s. Black et al. (2000) perform forecasts of inflation and output using the same data. They estimate an AR (1) model as a base model and calculate its mean absolute percentage error. They then forecast inflation adding one variable at a time to the AR (1) model and compare the MAPEs of the different models. They find that money improves the forecasts of inflation.

Studies testing the importance of monetary aggregates have also been carried out using Australian data. One such study is that by Orden and Fisher (1993). They obtain variance decompositions and find that money shocks contributed up to 30% in variations of prices. Chandra and Tallman (1996) also use the VAR approach on Australian data. However, unlike in the Orden and Fisher (1993) study that measured inflation using the GDP deflator, they use the CPI to measure the price level. They also extend the sample period to cover the period after financial deregulation. They find that although M3 is important in some systems in the block exogeneity tests, it is not significant as an inflation predictor in any of the specifications. M2 is significant in exogeneity tests only towards the end of the sample but has no predictive importance either.

Some studies use single equation estimations of inflation to check the importance of money aggregates to inflation. One such study is Chandra and Tallman (1997)'s extension of their 1996 study. Using the 5% significance level as their decision rule, they find that only M3 is important to inflation. This agrees with the exogeneity test results in their 1996 study.

A number of inflation studies have been carried out with data from different African countries. The results obtained seem to be similar in most of these studies. Whereas in a few cases monetary aggregates are important for movements in prices, other variables such as the exchange rate, foreign prices and interest rate measures seem to be more significant in explaining movements in inflation.

Durevall and Ndung'u (2001) estimated a dynamic error correction model of inflation for Kenya covering the period 1974 to 1996. They find that money supply affects prices only in the short run. The excess money demand error correction term is not significant at any conventional levels. However they find a significant role for the three-month treasury bill rate. In a study of the monetary transmission mechanism in Uganda, Nachenga (2001) also finds a highly significant role for the treasury bill rate. He also finds that the first lag of growth in money supply is significant.

Sacerdoti and Xiao (2001) estimate a similar model for Madagascar covering the period 1971 to 2000. They also find that the money variable is insignificant at all conventional levels. They find a very significant role for the exchange rate. Similarly, Durevall and kadenge (2001) find that after the reforms, money supply ceases to be an important determinant of inflation in Zimbabwe. Instead, the exchange rate and foreign prices become more important.

Two studies of inflation in Zambia were accessible. The first one is by Mwansa (1998) who estimates both an error correction and VAR model of inflation. Using quarterly data for the period 1985 to 1996, he finds that the second lag of M1 is marginally significant for inflation. In the VAR model, he finds that shocks to M1 explain 15% of the variations in inflation after 1 year while shocks to the exchange rate explain as much as 22% of inflation variations

after 6 months.

The second study is by Andersson and Sj (2000) and is more directly related to the discussion in this paper. Using single equation and multivariate causality tests, they analyse the relationship between money and inflation. The study covers the period 1987 to 1993 in which the first attempt at monetary policy reforms were being made. Using an error correction term, they test for Granger-causality between money and prices and find that money predicts prices. In the multivariate results, they find that the price level is Granger caused by a combination of money supply and the exchange rate.

The current study differs from these two studies in two main aspects. Firstly, we incorporate a broader number of variables in the study. We not only look at the ability of money to predict prices, but we explicitly compare the performance of the monetary aggregates to that of other variables such as interest rates and government debt. Secondly, the study covers a longer period in the reform period and does not incorporate any years in the pre-reform period thereby avoiding the problem of fundamental structural shifts.

3.5 Empirical Methodology

In the estimations, we begin by conducting forecasting experiments. This is used as an alternative to Granger-causality tests to check for the information content in a variable that can be used to forecast inflation.Although Granger-causality provides information about whether a variable contains information useful for predicting prices, it is not sufficient for forecastability (Clements and Hendry (1999)). To be able to say more about whether a variable contains information that is useful to policy makers in forecasting future values of inflation, we conduct out-of-sample forecasts. The forecasts for the different variables are evaluated using the mean absolute percentage error (MAPE) which allows us to compare the performance of different information variables. We consider an autoregressive (AR) model as a base model and use it to forecast inflation. We then estimate a conditional model, which includes

inflation and a financial variable one at a time. We also use this conditional model to forecast inflation. If this model produces a MAPE lower than that of the AR model, such a model is said to contain useful information for forecasting inflation.

We will also estimate an inflation model to determine whether money supply enters the inflation equation significantly when we condition on more information. We conclude that money has important information for inflation if any of the money lags are significant at most at 5%. Using both the VAR analysis and a single equation analysis acts as a robustness check. This is important for this study, as we do not have access to similar studies against which we can compare our results.

3.5.1 Auto Regressive Analysis

The models estimated take the form shown in the equation below.

$$p_t = \alpha + \sum_{i=0}^{n} \beta p_{t-i} + \sum_{i=0}^{n} \phi x_{t-i} + \varepsilon_t \tag{3.3}$$

p_t is the price level measured by the CPI and x_t is the variable used in addition to price in the model. β and ϕ are constant parameters. ε is the error term and t the time subscript. The number of lags is selected such that we use the lowest number of lags that eliminate residual autocorrelation in the regression model.

For forecasting, we define MAPE below for periods 1 to N of a single series where N is the number of observations. We start by obtaining the forecast error for a single period ε_t where ε is the error and t is a time subscript. Then,

$$\varepsilon_t = p_t - \hat{p}_t \tag{3.4}$$

where $\hat{p}$ is the price level forecast

The percentage error *(PE)* then is

$$PE = \frac{p_t - \hat{p}_t}{p_t} x100 \tag{3.5}$$

so that the absolute percentage error for period t is

$$APE = \mid \frac{p_t - \hat{p}_t}{p_t} x100 \mid \tag{3.6}$$

and the MAPE

$$MAPE = \sum_{t=1}^{N} \frac{APE}{N} \tag{3.7}$$

The MAPE has been said to be asymmetric in that it treats over estimations and underestimations differently. However, it still remains one of the most widely used and reliable measure of forecast performance and so we proceed to use it here (See Meade (2000), Goodwin and Lawton (1999), and Willemain (1991) for discussions of the MAPE). The MAPE was found to be a more suitable measure than the mean square error(MSE) and the mean absolute error(MAE), which are not directly comparable across estimation periods and models (Makridakis et al. (1998).

3.5.2 Single Equation Estimation

For the period under study, Zambia is assumed to be a small open economy. Although most studies of inflation in Africa recognise the fact that inflation is driven by a combination of factors falling across different theoretical assumptions, most recent studies focus on money demand and the external sector either through the PPP relationship or through the PPP and UIP relationships. In this study, we take a more general approach as in Metin (1995) and Hendry (2001) and incorporate a wider number of factors in the estimation. We postulate different possible relationships between inflation and different factors and we discuss them each in turn below.

Money Sector

We begin by looking at the role of money creation where inflation can be produced by a rapid increase in the quantity of money supply relative to output (see Friedman and Scwartz (1982)). The starting point is the money demand function. In line with the general literature, we assume that demand

for money is primarily a demand for real balances. In the absence of money illusion, an increase in the level of prices induces an increase in the demand for nominal balances leaving the level of real balances the same so that we can say that in equilibrium, individuals hold nominal balances in proportion to their nominal income.

We assume that money demand is a function of transactions and asset motives. To keep the level of transactions the same, economic agents adjust their demand for nominal balances as prices change. Changes in the interest rate also induce changes in the amount of balances held as they affect the relative price of alternative uses of wealth. In an economy with no capital controls, changes in foreign interest rates and exchange rates also affect the amount of money held in the economy because alternative investment opportunities arise for domestic economic agents in foreign capital markets. To capture these motives, we assume that money demand is a function of income (y), money's own rate of return (i_{dep}) and the opportunity cost of holding money (i_{tbill}) and depreciation of the exchange rate (Δe).

Since economic agents hold money in proportion to nominal income in equilibrium, inflation in the money market is generated by deviations from this equilibrium. Equilibrium in the money market requires that money supply (M^s) be equal to money demand (M^d). Let P be the price level so that our money demand equation can be written as in equation (3.8).

$$\frac{M^s}{P} = M^d(y, \Delta e, i_{dep}, i_{tbill}) \tag{3.8}$$

The relationship between money and the variables is such that:
$\frac{\delta M^s}{\delta Y} > 0, \frac{\delta M^s}{\delta i_{dep}} > 0, \frac{\delta M^s}{\delta i_{tbill}} < 0, \frac{\delta M^s}{\delta \Delta e} < 0,$

Foreign Sector

We also look at the role of foreign prices in determining domestic prices. Although asset markets can also play an important role in determining the exchange rate and therefore affect domestic prices, we assume away such a

view in this study. This stance is justified because although the capital account was open almost throughout the sample period, high transactions costs and underdeveloped financial asset markets imply that the role played by capital movements and hence foreign interest rates was very minimal. In the study we therefore postulate a simple PPP theory. Tests indicate that there is a stable exchange rate with a trend stationary real exchange rate.[4] Therefore, the real exchange rate is assumed constant in equilibrium so that

$$p = e + p^* \tag{3.9}$$

where $p, p*$ and e are logs of the domestic price, the foreign price and the exchange rate respectively. The source of inflation in this relationship is the deviations from this equilibrium.

Excess Demand

Here we look at the role of excess demand for real goods in determining inflation. Theory suggests that excess demand for final goods leads to inflation as increased demand above supply bids prices upwards. This has been measured in the literature as a deviation of output from its natural rate or from trend. Empirical approaches include calculating some measure of potential capacity as in Hendry (2001) or using deviations of output from trend as in Metin (1995). Availability of data leads us to adopt the later approach in the study. Production and other structural rigidities may cause demand to be in excess of supply which could be inflationary enabling the analysis of these excess demand situations. One particular case for Zambia is that of excess maize demand in times of drought. Maize is the staple food almost all over the country and excess demand tends to drive maize prices up quite significantly in times of drought. Unfortunately we did not have access to monthly data for the whole sample period that would allow us to specifically check the importance of maize demand in determining the price level.

[4] see section 6.2.1

Public Sector

We also wish to incorporate the role played by fiscal policy in propagating inflation. Since it was not possible to obtain consistent data on the government deficit, we use total government domestic debt as the fiscal measure. The role of labour costs, wages and unemployment is also important in determining inflation. However, we are unable to test this relationship due to the absence of relevant data.

3.5.3 Data

Time Series Characteristics

In this section we discuss the data used in the estimations. The data used are monthly for the period January 1994 to December 2001. The sources for each series are indicated in appendix C. Alongside the graphs, we discuss what order of integration each series exhibits. Table (3.3) shows the unit root tests for the variables used. All the data in the table are in log levels. In checking for the unit root, we used the Philips-Perron tests . The Phillips-Perron test may be more appropriate as it is a generalisation of the ADF test and is less restrictive on its assumptions about the residuals [5]

Output and prices are plotted in figure 3.2. Output is measured by real GDP interpolated from an annual to a monthly series using the Denton method.[6] The unit root test shows that this series is trend stationary. We use this variable only in the fully specified inflation equation model. The price level is measured by the composite consumer price index (CPI). We plot this series

[5] This is a method developed by Phillips and Perron (1988) and is a generalisation of the Augmented Dickey-Fuller (ADF) test. The assumptions about error properties are less stringent than in the ADF method. The null hypothesis is that $\rho = 1$ in the equation $\Delta y = \mu + \rho y_{t-1} + \varepsilon$

[6] The Denton Method for interpolating data uses an 'associated series' imposing the constraint that the interpolated series must obey the annual totals. The indicator series contributes its pattern to the series and adds more information especially where such movements in such a series are closely related to the series to be interpolated. See Renka (1988) and Baum (2001)

Tab. 3.3: Unit Root Tests

Variable	levels	1st difference	Integration order
m2	-2.92	-12.97**	I(1)
m1	-1.58	-10.96*	I(1)
p	2.267	-6.45**	I(1)
y	-4.223**		I(0)
idep	-0.45	-6.667**	I(1)
itbill	-2.69	-5.193**	I(1)
ibond	-4.355**		I(0)
deficit	-1.799	-12.67**	I(1)
P*ssa	-1.43	-7.76**	I(1)
P*usa	-3.23	9.082**	I(1)
erand	-1.593	-7.73**	I(1)
edollar	-3.23	-8.01**	I(1)
debt	-1.239	-8.962**	I(1)

*(**) significant at (5%),(1%) levels of significance

Tests were obtained using the Phillips Perron method

and its first difference (monthly inflation) in the upper panel of figure 2. For most of the sample period, inflation has been fairly stable. Large fluctuations are observed in the early part of the sample, which are the early years after the reforms, and periods of very high inflation.

M1 and M2 are used in the estimation alternately. In Figure 3.3 we plot the log levels in the upper panel, monthly growth in the middle panel and the real series (deflated by the CPI) in the lower panel. The real series are mean adjusted. The Phillips-Peron tests show that the series exhibit a unit root in nominal terms. The series are however stationary in first differences.

We use three interest rates in the study and these are plotted in figure 3.4 The three-month treasury bill rate is used as the alternate interest rate, the average deposit rate as the own interest rate and the 12-month bond rate as the long rate. The 12-month bond was the longest period bond available for most of the sample period. The three interest rates are quite highly correlated

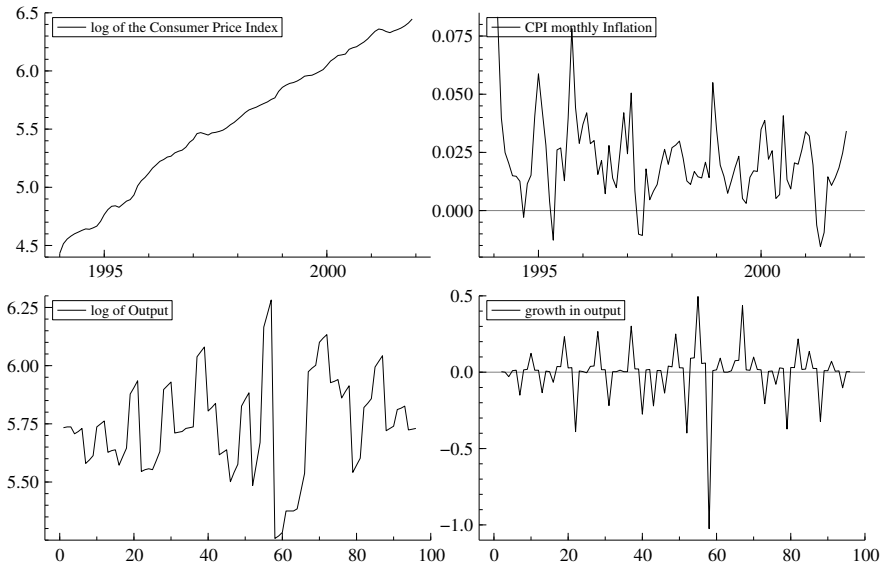


Fig. 3.2: **Prices and Output**

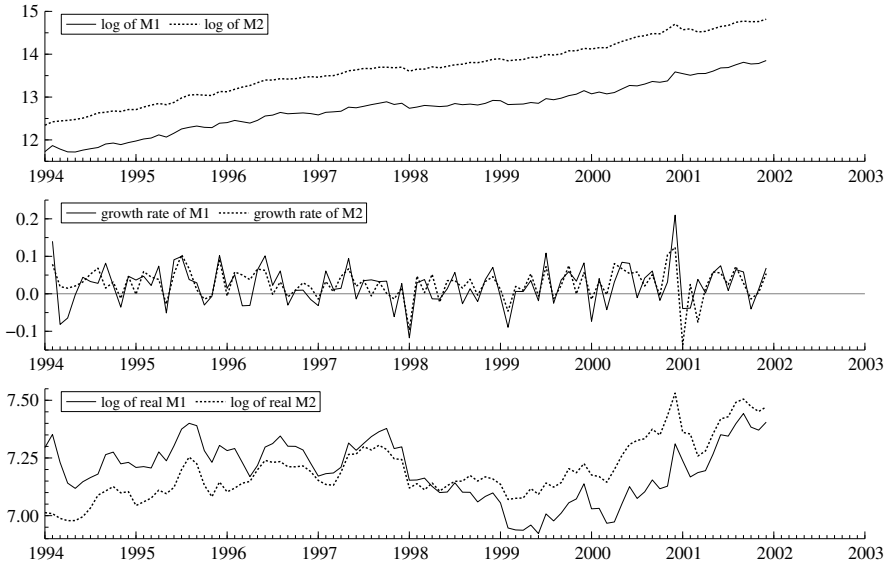


Fig. 3.3: **Monetary Aggregates**

early in the sample until mid-1996 when the bond rate sharply declines for a few months and begins to increase again. The deposit rate begins to decline in late 1997 and the spread from the treasury bill rate continues to widen for the rest of the sample period. The unit root tests show that the deposit and bond rates are stationary although there is a possible structural break in early 1998. We redo the test starting December 1994 and the deposit rate is now I(1). The statistic reported in the table reflects the later.

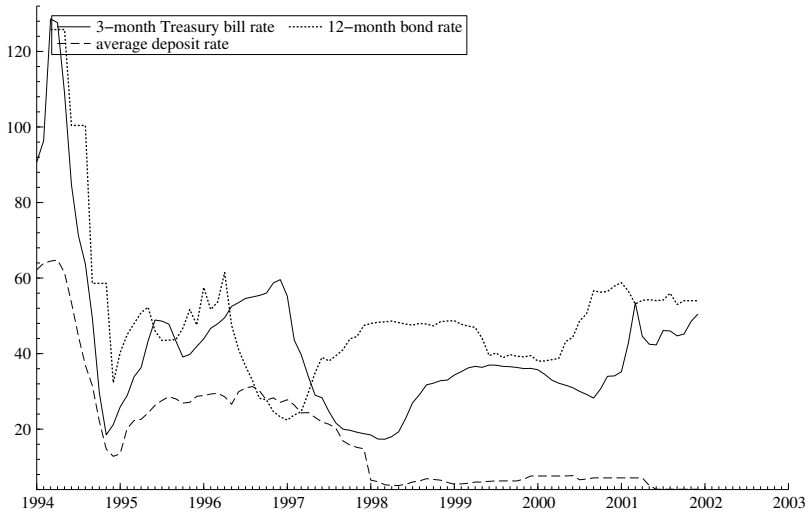


Fig. 3.4: **Interest Rates**

The nominal exchange rate is measured by the rate of the kwacha to the rand and the kwacha to the dollar. These rates are used alternately in the estimations. For the foreign prices, we use the South African CPI (p^*_{ssa}) and the US wholesale price index (p^*_{usa}). The South African variables were chosen because South Africa is Zambia's major trading partner especially in consumer goods and it was thought an appropriate alternative to averaging over major trading partners . The use of the US variables is motivated by the fact that most official transactions are conducted using the US dollar. We plot these variables in figure 3.5 below. We also plot in the bottom panel the real

exchange rates for both the dollar and the rand defined as the log of the domestic price minus the log of the foreign price and log of the relevant exchange rate. The exchange rate has been increasing over time although a short period of decline is observed shortly before the 2001 elections. The prices and nominal exchange rates have a unit root and stationary in first differences. The dollar real rate is stationary while that of the rand is not.

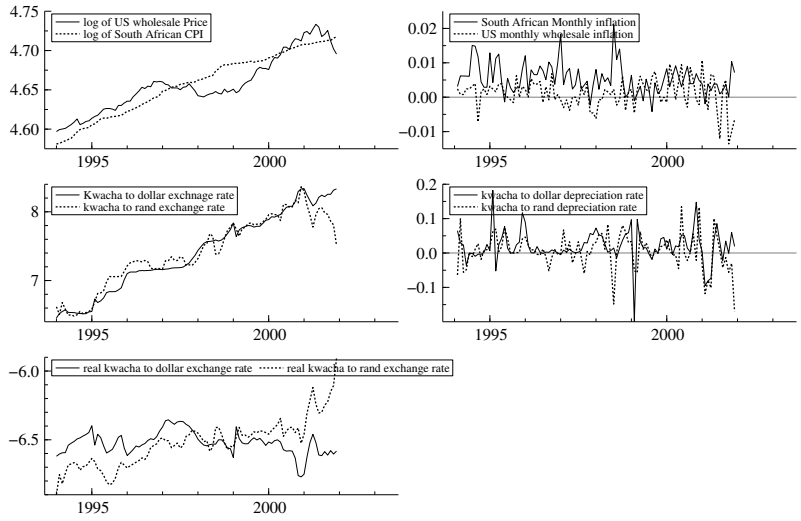


Fig. 3.5: **Foreign Prices and Exchange Rates**

We also use domestic debt as measured by government securities outstanding (treasury bills plus government bonds)as a fiscal measure. The series and its growth rates are plotted in figure 3.6 below. The variables in levels move together until 1998 when domestic debt shows a downward trend but begins to rise again after 2000. The growth series exhibit a lot of volatility for both variables.

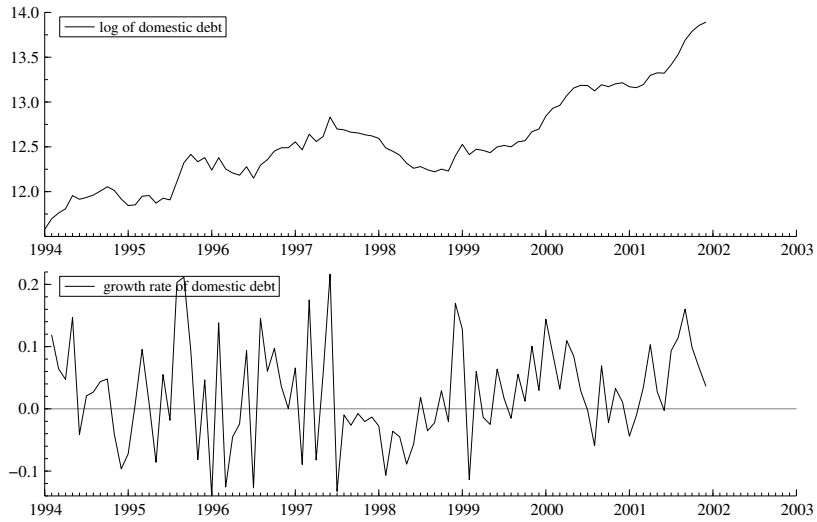


Fig. 3.6: **Domestic Debt**

3.6 Estimation Results

We begin our discussion of the results with the forecasting experiments and then move on to discuss the estimation of the inflation equation. All estimations that involve the interest rates are done from December 1994 to avoid the possible structural break. We include seasonal dummies in both the forecasting and single equation estimations. In the forecasting experiments, we explore the information content of the financial variables by looking at the relationships between prices and different possible information variables. These forecasting experiments are done in an auto regression setting as shown in equation (3.3). In the inflation equation, our interest is to see if the financial variables and in particular the monetary aggregates enter the inflation equation significantly. This is particularly important in that it allows us to check the performance of the variables when we control for the presence of other variables. It has often been argued that when interest rates are added, money tends to loose its explanatory power.

3.6.1 Forecasting

In this section, we discuss the forecasting experiments. The forecasts are all out of sample forecasts.The focus on out of sample forecasting experiments is an attempt to simulate real time policy decision making. Since the data used are revised, the type of information available to us differs from that available to the decision maker at the central bank. Each model is composed of the price level and one possible information variable. Each forecast is a one step ahead forecast over a moving window of four years. One step ahead forecasts were preferred as a way of mimicking the horizon the central bank faces given the data. The initial estimation is done between January 1994 and December 1997. We then make a forecast for January 1998. Then the estimation sample is rolled over to start February 1994 and end January 1998 and then we make a forecast for February 1998 and so on.

We then calculate the MAPE based on (3.7) to decide if a variable adds significant information for forecasting or not. This decision is based on the relative performance of a benchmark model. The benchmark model used is the best fitted autoregressive model for the price level. Preliminary analysis showed that the best fit model was an AR(1) model and this can be seen from Figure 3.10 in the appendix which shows the correlation function for the price level . We therefore estimate an AR(1) model as the base model. This model is also estimated using rolling regressions over the same moving window. The higher the MAPE for a model relative to the benchmark model, the less information the additional variable has for forecasting inflation. This approach is superior to just looking at the performance of one model for our interest because it allows us to compare 'competing' information variables. More importantly, we can check the importance of the information from the monetary aggregates relative to information from other variables by comparing their MAPEs.

The data are used in log levels. The use of rolling regression precludes the use of co-integration in this analysis as co-integration was only identified at a few

Tab. 3.4: Mean Absolute Percentage Errors (1998-2001)

	Out of sample[a]
AR(1)	0.16
M1	0.115
M2	0.112
Rand exchange rate	0.104
Dollar exchange rate	0.099
Treasury bill rate	0.117
Deposit rate	0.106
Domestic debt	0.106

[a]The out of sample forecasts are one step ahead forecasts with the model estimated between January 1994 and December 1997 and then forecast for the period 1998 to 2001.

horizons for most sets of variables. Forecasting with non-stationary variables produces forecast errors of similar forms as in stable cases (Luketpol (1993)). The method used to evaluate the forecasts does not suffer from the disadvantages of say the Mean Square Error (MSE) where the error grows with the forecast horizon.

After obtaining the forecasts, we compute the percentage error for each period. We then use these to calculate three types of MAPEs. The first is a MAPE for the entire period. Each MAPE calculated here shows the accuracy of the model over the entire forecast horizon. We show the results in table (3.4). From the table we see that the MAPEs for all the variables are less than that of the benchmark AR(1) model. Using our decision rule, we can say that these variables have important information for forecasting inflation over the sample period. We can also say that the most important variables are the exchange rates since they have the lowest MAPEs. Conversely, the least important variables are the treasury bill rate and M1.

To see more clearly the performance evolution over the sample period of the different variables in forecasting inflation, we calculate two other types of

means. The first is a 12-month moving average of the percentage errors and a second - a cumulative mean where a mean of the percentage errors was obtained by adding one period at a time and obtaining a mean until the whole forecast horizon was covered. The results give us a time moving view of how important each variable is for forecasting inflation.

The 12-month moving averages measure the accuracy of the model in forecasting inflation for the 12 months prior to time t. For example, if we take the first observation in the AR(1) model with a MAPE of 0.2%, we can say that using the AR(1) model to forecast inflation between December 1997 and December 1998, we would have been within 0.2% of the actual value and 0.21% of the value between January 1998 and January 1999 and so on. We graphed the obtained MAPEs in figure (3.7) below. To make it easier to read the graphs, we graph them in two panels so that the top panel shows results for the money aggregates and the exchange rates while the lower panel shows the interest rates and the government domestic debt. A graph that shows all the MAPEs in one figure is shown in the appendix.

All the variables' MAPEs lie well below those of the AR(1) model through the whole sample period. The variables with the smallest MAPEs are the exchange rates the deposit rate and domestic debt. The M2 MAPEs are also quite low especially towards the end of the sample although they increase slightly in 2001. The variable with the largest MAPEs is the treasury bill rate. M1 does not perform very well through most of the horizon and the MAPEs of the dollar exchange rate rise in the later part of the sample.

The cumulative MAPEs are shown in figure (3.8). These graphs show a more long-term view of the performance of the information variables in predicting inflation. Again the top panel consist of the money variables and the exchange rates while the bottom panel consist of the interest rates and the domestic debt MAPEs. Apart from M1 which exceeds the AR(1) MAPES for a brief moment, all the MAPES lie below those of the benchmark model.The exchange rates, the deposit rate and domestic debt seem to provide the most useful information for predicting inflation while both the money aggregates

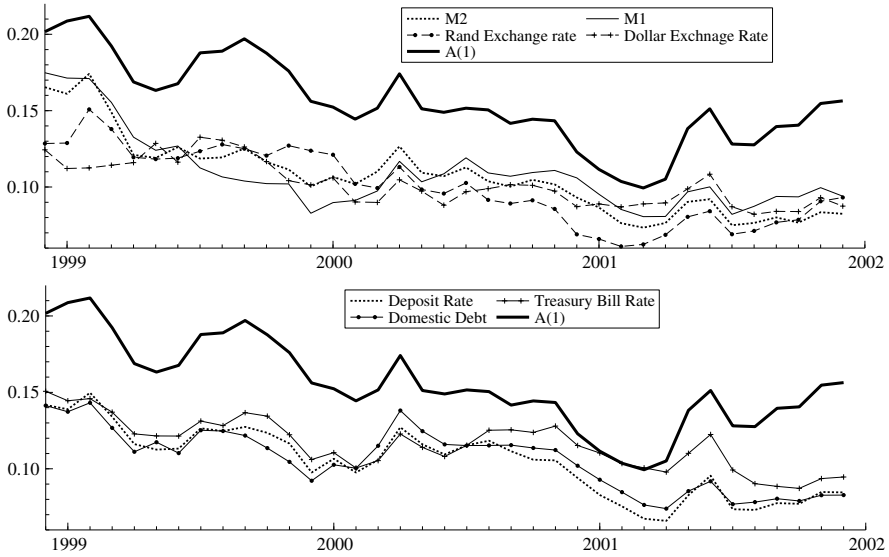


Fig. 3.7: **12-Month Moving MAPES**

and the treasury bill rate are not as important.

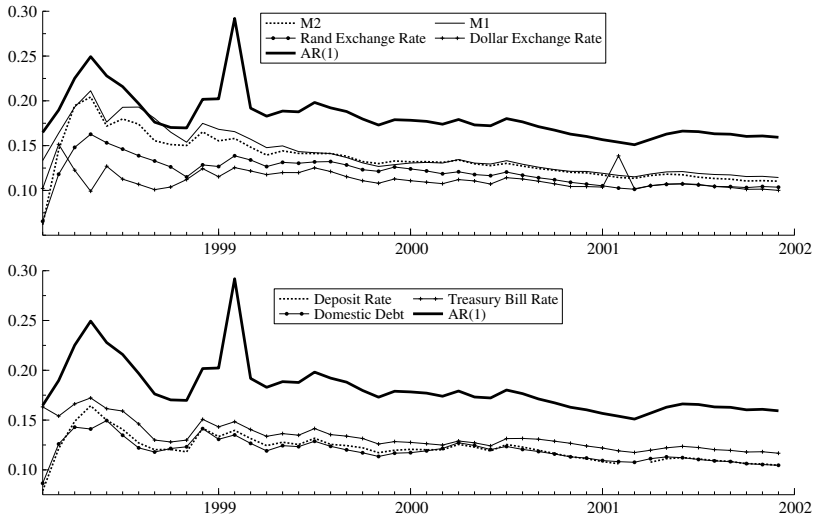


Fig. 3.8: **Cumulative MAPEs**

The forecasting experiments that we conduct in this section show that over the whole sample period most of the variables examined serve as important information variables for price movements. When both long run and short run horizon experiments are considered, we find that the foreign exchange rates, the deposit rate and the domestic debt provide the most information about price movements.

3.6.2 Inflation Equation

In this section, we extend the above analysis and consider how the discussed variables perform in the presence of other control variables and whether these variables have a causal effect on inflation. To do this, we estimate a fully specified inflation equation. We start by looking at the co-integration relationships discussed in section 5.2. We then report the estimation of the error correction inflation model estimated.

Co-integration Analysis

We tested for co-integration in the monetary and foreign sectors using the Johansen procedure. We identified co-integrating relationships in both sectors and we outline the identified relationships below. The full co-integration test results and the weak exogeneity test results are in appendix B.
In the monetary sector, the analysis for M1 showed that this relationship was unstable. The M2 relationship is shown in equation 3.10

$$ecm2 = (m - p) - 1.2y - 0.016i_{tbill} + 0.01i_{dep} \tag{3.10}$$

We imposed homogeneity by restricting the coefficient on y to -1 and it was accepted at $\chi^2(1) = 0.15(0.698)$. With this restriction, the relationship is shown below.

$$ecm2 = (m - p) - y - 0.015i_{tbill} + 0.01i_{dep} \tag{3.11}$$

The signs on the interest rates are unexpected. The treasury bill rate is positively related to real money demand probably because it is like a maximum deposit rate. Adam (1992) interprets it as the own rate of return on money in the long run and this could explain the positive sign.
We also found co-integration in the external sector using both dollar and rand exchange rates although these relationships hold only in the presence of a time trend. The trend could explain the long-run evolution of the real exchange

rate that may be due to changes in terms of trade, reforms or changes in productivity growth.

$$ecp^d = p - 0.744e - 0.007p*_{usa} - 0.004trend \tag{3.12}$$

$$ecp^r = p - 0.924e - 0.05p*_{ssa} - 0.008trend \tag{3.13}$$

The coefficient on the foreign price in both relationships is rather small. We imposed the PPP restriction by setting the e and p* prices to -1. Both restrictions were accepted conditional upon including a trend and we have the following relationships

$$ecp^d = p - e - p*_{usa} - 0.024trend \tag{3.14}$$

$$ecp^r = p - e - p*_{ssa} - 0.026trend \tag{3.15}$$

The inflation equation we estimate includes the disequilibrium relations estimated. We also regress nominal income on a constant and a trend and use the residuals as a measure of excess demand. The other variables enter the equation in first differences as a measure of the short run effect of these variables on inflation. We will estimate an equation of the form

$$\Delta p = a_0 + \sum a_i y_{t-i} + \sum b_i \Delta m_{t-i} + \sum c_i i_{dept-i} + \sum f_i i_{tbillt-i} + \sum g_i \Delta p_{t-i} + \sum j_i \Delta e_{t-i} + \sum l_i \Delta debt_{t-i} + \sum \eta i_{bondt-i} + ecm_{t-1} + ecpt_{-1} + u_t$$

where *ecm* and *ecp* are the money and external sectors' error correction terms.

Error Correction Model of Inflation

In this section, we discuss the estimation of an error correction model of inflation. Despite that our interest in the paper is to look at the role of financial sector variables, the estimation of a fully specified inflation equation

allows us to check how the variables of interest perform in the presence of other control variables. In estimating the equation, we included 4 lags on each variable and searched for a parsimonious model by sequentially dropping the insignificant lags until only significant variables were left.

We estimated the equation with M1 and M2 alternately as monetary aggregates and the rand and dollar exchange rates alternately with each monetary aggregate. M1 is only significant in the equation where the dollar is used as the exchange rate but it has the wrong sign. We therefore report only the results in which M2 was used here and show the results with M1 as the monetary aggregate in the appendix B. The results of the parsimonious model with M2 are shown in table (3.5). The reduction statistics are shown at the bottom of the table.

The diagnostic tests are also shown at the bottom of the table and the recursive coefficients and statistics are shown in appendix B. All the tests show that the models are well specified. There is no evidence of residual autocorrelation according to the AR tests, no ARCH indications or presence of heteroskedasticity (hetero test). The errors appear normal and the regression equations are well specified according to the normality and RESET tests. Most of the variables have the expected signs and the recursive coefficients and statistics show stability in the parameters.

Of the variables of interest, we find that M2 is important. The third lag of the growth rate of M2 is significant in both equations and is correctly signed. The error correction term however is insignificant. The net effect of M2 on inflation in both equations is about 8-9%. The external sector variables are significant. The error correction terms based on both exchange rates enter the inflation equation and are significant at the 1% level suggesting a significant long run relationship between Zambian prices and foreign prices. The contemporaneous value of the dollar depreciation rate is also significant at 1% and is correctly signed. The magnitude of the error correction term on the rand is very close and in some cases exactly the same as those obtained in other studies on African countries (see Durevall and Ndung'u (2001), Sacerdoti and Xiao

Tab. 3.5: Error Correction Model of Inflation With M2 1994:1 To 2001:12

	rand			Dollar		
	coefficient	t-value	p-value	coefficient	t-value	p-value
Constant	0.001	0.196	0.846	0.005	1.16	0.25
Δp_{t-1}	0.4	4.77	0.000	0.4	4.72	0.000
Δp_{t-3}				0.19	2.02	0.047
$\Delta(m-p)_{t-3}$	0.094	3.44	0.001	0.08	2.66	0.01
Δe_t				0.06	2.42	0.018
$\Delta debt$	0.04	2.49	0.015	0.032	2.12	0.038
$\Delta i_{tbillt-1}$	0.001	2.13	0.036			
Δi_{dept-2}	-0.002	-2.45	0.017	-0.002	-3.88	0.000
i_{bond}	0.008	2.92	0.005			
$i_{bondt-1}$	-0.0006	-2.30	0.025			
$i_{bondt-3}$	-0.0007	-2.86	0.005	-0.001	-4.83	0.000
$i_{bondt-4}$	0.0006	2.50	0.015			
ecp_{t-1}	-0.04	-3.15	0.002	-0.12	-5.06	0.000
			diagnostic tests			
$AR(1-4)^a$	F(4,71)		0.886(0.477)	F(4,73)		1.36(0.242)
$ARCH4^b$	F(4,67)		0.548(0.70)	F(4,67)		0.669(0.675)
$Normality^c$	c2(2)		3.96(0.138)	c2(2)		5.69(0.06)
$Hetero^d$	F(24,54)		1.162(0.319)	F(18,60)		0.822(0.668)
$RESET^e$	F(1,74)		0.47 (0.495)	F (1,76)		2.923(0.0913)
R2			0.60			0.60

** denotes significance at the 1% and 5% levels

[a]The AR(1-4) test is an LM test for 4th order residual autocorrelation calculated according to Harvey (1981)

[b]ARCH tests the presence of autoregressive conditional heteroskedasticity Engle (1982)

[c] Normality test based on Doornik and Hansen (1994) with a small sample correction

[d] Based on White(1980), the test checks for unconditional heteroskedasticity

[e]The RESET test due to Ramsey(1969), tests the null of correct model specification

The unrestricted model yielded s=1.07% for 59 variables (SC=-4.359) with the rand and s=0.8% for 59 variables (SC=-4.927) with the dollar

The Parsimonious model yielded s=1.09%, for 15 variables (SC=-5.63) with the rand and s=1.06% for 11 variables (SC=-5.836) with the dollar

(2001)).
The coefficient on the first lag of inflation is significant at the one percent level with about 40% of previous period inflation feeding into current inflation. This result is quite similar to results obtained in other studies for African countries . The interest rates are significant but the treasury bill rate is positively signed. The studies by Durevall and Ndung'u (2001) and Nachenga (2001) also find a positive coefficient on the treasury bill rate. The contemporaneous effect of the growth rate in domestic debt is significant in both equations and is correctly signed.

3.7 Does Money Tell Us Anything About Inflation In Zambia?

We have in section six examined the usefulness of various variables in forecasting inflation. If a conditional model has MAPEs lower than those of the base model, we can argue that the variable in such a model is useful for forecasting inflation. This is particularly important with the out of sample forecasts. We can also say that the model with the least MAPE has more information for forecasting inflation than the other models. The full inflation equation results augment this analysis by checking the performance of the variable conditioning on the presence of other variables in the equation. If a variable performs well in most of the above analysis, we conclude that such a variable does have something to say about movements in inflation.
We find that the monetary aggregates have predictive power through most of the sample period. Although M2 MAPEs do not exceed those of the benchmark model the variable does not perform well relative to other variables such as the foreign exchange rates, the deposit interest rate and domestic debt. From the single equation estimations, we find that a growth of 1% in M2 predicts a 0.9% increase in inflation after three months. We find evidence of some synergy between M2 and the dollar exchange rate. The short run effect of the exchange rate is only significant when the dollar is used as the exchange rate. This result is very similar to that obtained by Andersson and Sj (2000).

They find that they can only establish a link between money growth and inflation in a co-integrating VAR model only if the dollar exchange rate is part of the system. This result shows that analysing monetary policy independent of the foreign sector in Zambia may be misleading.

M1 does not perform well in forecasting through most of the forecasting horizon. In the single equation estimation, the variable is not significant. The difference between M1 and M2 in Zambia is time and savings deposits. One of the likely reasons for this that it is time and savings deposits that banks convert into loans. Since this is the vehicle through which money supply is more likely to affect inflation, we expect that a high deposit to loan ratio would be evidence of a significant effect of time and savings deposits on inflation. Figure 3.9 below shows that the ratio has been quite high during the estimation period falling below 60% only once in 1997.

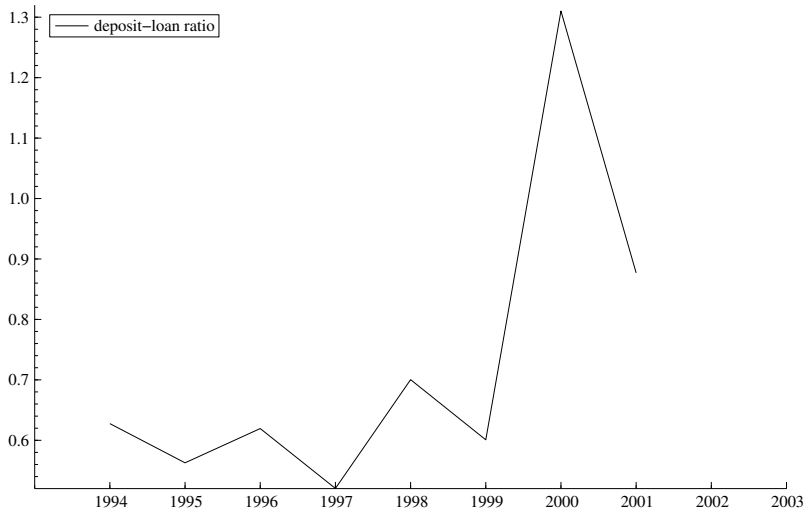


Fig. 3.9: **Deposit -Credit Ratio**

The deposit rate however has been declining significantly since 1995.[7] The spread between market rates such as the 3-month treasury bill rate and the

[7] see figure 3.4

deposit rate has increased over the years. It is unlikely therefore that interest rates are the driving force behind the observed increase in time and savings deposits. The more likely reason for this increased demand is innovations in the banking sector. The array of portfolio choices available to the public has increased. A number of banks have also introduced personal and other loans related to time deposit holdings as collateral.

The exchange rates perform fairly well in both the forecasting and single equation results. The dollar MAPEs rise in mid 1999 to early 2000 but fall quite significantly towards the end of the sample. One possible explanation for this is near dollarisation of the economy from about early 1999. A number of domestic transactions were denominated in dollars. Some foreign owned cellular mobile companies opened and demanded that payments be made in dollars. This practice spread to real estates where many real estate owners demanded payment in dollars for rent of property.[8] Over the same period, the government owned mining company Zambia Consolidated Copper Mines (ZCCM), which was one of the major foreign exchange earners, was privatised. The level of total reserves also declined by more than half over this period from $103 million at the end of 1999 to just $45 million by mid 2000 when it began to steadily increase again. By Mid June 2000, the central bank began to counter the effects of increased dollar demand by increasing foreign exchange market intervention. All these factors could account for the observed behaviour in the dollar as such changes can lead to increase in exchange rate volatility.

In the inflation equation, both the long and short run terms of the dollar exchange rate are significant at the 1% level. The error correction terms indicates a 12% disequilibrium correction each period. A significant long run relationship between the domestic and South African prices is established. The coefficient on the rand error correction term indicates a 4% disequilibrium correction each period.

[8] It is now illegal to make such payments using any currency other than the kwacha. A law has now been passed in Zambia that only non-Zambian citizens should pay for transactions in foreign exchange

The forecasting results show that the MAPEs of the treasury bill rate are amongst the highest. The MAPEs of the deposit rate are low in most horizons and in fact at the end of the sample, the deposit rate is one of the best performing variables. The results from the error correction model show that this variable is significant but with very small coefficients. The results as a whole show that while the deposit rate may not contain a lot of information, it could perform well as a leading indicator. The government debt variable performs well over most of the forecasting horizons and even better than M2. In the single equation results, it has a 4% contemporaneous effect.

Inflation exhibits a high level of inertia with over 30% of previous period inflation feeding into current period inflation. A number of reasons could account for this amongst which is fiscal dominance. If the conduct of domestic monetary policy is dictated or constrained by fiscal demands, the country becomes vulnerable to inflationary pressures of a fiscal nature. Where this is not checked, it induces the creation of formal and informal indexation mechanism, which can lead to inflation persistence. Widespread formal indexation is absent in Zambia, but informal indexation is likely to exist. Wage and salary negotiations are infrequent in the public sector, which is still the largest employer in the country. In the private sector, Trade Unions negotiate for wage increases almost every year, which in a way provides an implicit wage indexation. One way of reducing these fiscal effects is to increase central bank independence. Provisions in the Bank Of Zambia Act (1996) give the Minister of Finance powers over the conditions of service of the governor and powers to give directives to the Central Bank. These provisions compromise central bank independence and my need to be modified to give the central bank more autonomy.

Another reason could be poor initial policy credibility, which can lead to high levels of inflationary expectations resulting from long periods of high inflation. Prior to 1991, the Zambian government had a history of backtracking on reforms. This could have created a situation where the public has no confidence in the government and policy announcements cannot influence

public expectations. If this is the case, BOZ may need to address the issue of policy transparency. Transparency tends to lower inflationary expectations by providing an implicit commitment mechanism on the part of the central bank (Svensson, 1998). This way policy becomes more credible and the public can form expectations that are closer to the policy targets. Since the 2002 fiscal year, policy targets are announced to the public. If these targets are actually realised, this could help restore public confidence in policy announcements. Unfortunately, statistics show that both the money growth and inflation targets were not met in the fiscal year 2001/2002.

The results as a whole show that while the monetary aggregates, especially M2 contain useful information about inflation movements, the external sector variables may be even more useful in predicting inflation movements in Zambia.

3.8 Summary and Conclusion

In the paper, we have sought to establish whether monetary aggregates have useful information for forecasting inflation other than that provided by inflation itself. We have approached the problem in two ways. First we conduct forecasting experiments and using moving averages calculate mean absolute percentage errors. We then evaluate whether each monetary variable improves the forecasts of a simple AR(1) model of inflation. We find that M2 performs better than M1 but not as well as the exchange rates or the domestic debt.

We also estimate an inflation equation and determine alternately whether M1 and M2 enter the equation significantly. We find that M1 is not significant while M2 is significant. We also find evidence of synergy between the monetary aggregates and the dollar exchange rate. Only the foreign sector long run term is significant. The second lag of the deposit interest rate and the contemporaneous value of the domestic debt are significant in the model. The results obtained are robust across the two methods used and we conclude that

although the monetary variables contain some information about inflation, foreign sector variables may be more useful in predicting inflation in Zambia. We suggest that monetary policy be more transparent to address the issue of expectations as inflation exhibits a high degree of inertia. There is also need to increase central bank independence so as to reduce the effect of fiscal pressure on monetary policy. A closer look at the role of other factors such as fluctuations in food production and the informal sector (both financial and otherwise) may be very useful.

Although we are very confident in the results obtained, we recognize the shortness of the sample and admit that the dynamics of inflation may not be so adequately captured in such in a short period. We did not have access to information such as maize prices or output, which are likely to have a significant effect on inflation in Zambia. A study that includes such a variable would be very useful in consolidating the findings in this paper. Exploring the nature of exchange rates in Zambia would also be very useful to policy considering its importance for inflation.

Appendix

Appendix A

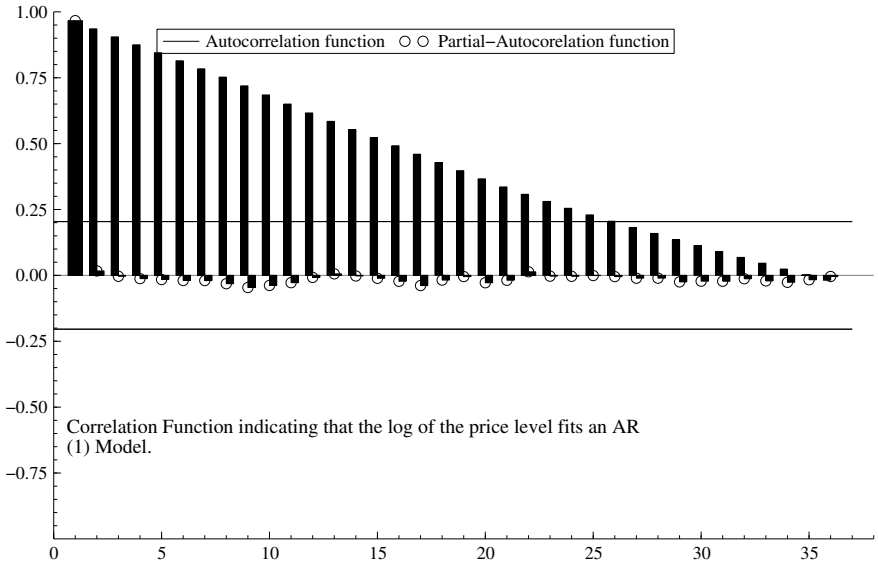


Fig. 3.10: **Price Level Correlation Function**

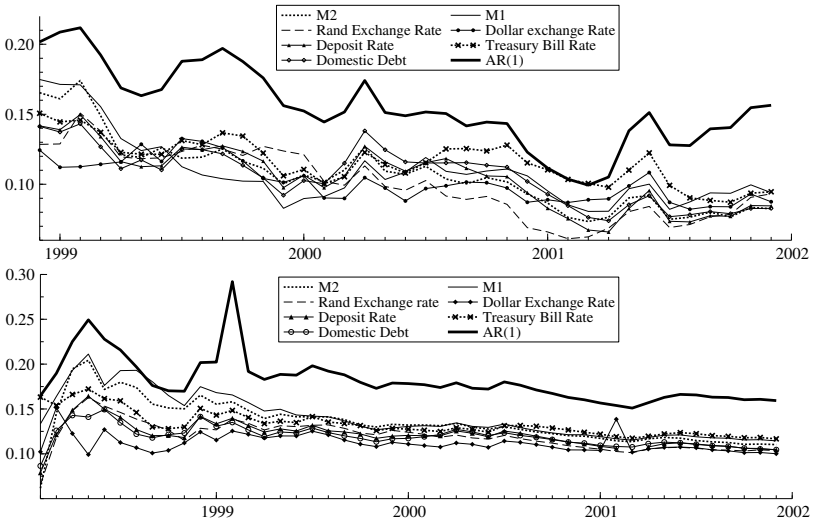


Fig. 3.11: **12-Month and Cumulative MAPEs**

Appendix B1 Co-Integration Results

Below we show the detailed results for the co-integration relationships estimated in section 5.3. The graphs of the co-integrating vectors are shown after the tabulated results.

$$ecm2 = (m - p) - 1.2y - 0.016i_{tbill} + 0.01i_{dep}$$

Tab. 3.6: Cointergrating Relationship for M2

Eigen value			0.327	0.17	0.063	0.014
λ_{trace}			56.98	22.91	6.797	1.24
λ_{trace} p-value			0.005	0.258	0.607	0.266
	Adjustment coefficients		Significance tests		Weak Exogeneity tests	
	coefficient	Standard error	χ^2	p-value	χ^2	p-value
m-p	-0.1	0.04	6.98	0.008	7.813	0.005
y	0.23	0.16	9.02	0.003	2.56	0.109
i_{tbill}	7.06	2.44	10.978	0.001	13.515	0.000
i_{dep}	-2.37	1.42	6.659	0.01	2.732	0.098

The co-integrating vector had 10 lags on each variable

Vector autocorrelation (1-10) F(160,10)=1.437(0.272)

Log likelihood ratio test of homogeneity restrictions :$\chi^2(1)$=0.15(0.698)

The adjustment coefficients errors reported are for the restricted model

Tab. 3.7: Co-integrating Relationship for The Rand Exchange Rate

Eigen value				0.272	0.148	0.031
λ_{trace}				42.77	16.089	2.61
λ_{trace} p-values				0.05	0.494	0.905
Adjustment coefficients			Significance tests		Weak exogeneity tests	
	coefficient	Standard error	χ^2	p-value	χ^2	p-value
p	-0.073	0.003	4.48	0.03	10.92	0.001
e	-0.196	0.01	2.81	0.09	2.539	0.111
p^*	-0.0016	0.0008	0.017	0.9	1.651	0.199

The co-integrating vector had 12 lags on each variable and a time trend

Vector autocorrelation: (1-12) F(108,227)=1.34(0.19)

Log likelihood ratio test of PPP restrictions:$\chi^2(1)$=0.15(0.698)

The adjustment coefficients errors reported are for the restricted model

Tab. 3.8: Co-integrating Relationship for the Dollar Exchange Rate

Eigen value				0.234	0.188	0.0084
λ_{trace}				44.489	19.988	0.775
λ_{trace}-p-values				0.033	0.231	0.998
Adjustment coefficients			Significance tests		Weak exogeneity tests	
	coefficient	Standard error	χ^2	p-value	χ^2	p-value
p	-0.003	0.0006	3.78	0.05	5.24	0.022
e	-0.003	0.002	0.86	0.35	0.037	0.848
p^*	-2.7651e-005	0.0002	6.73336e-005	0.99	4.4939e-005	0.995

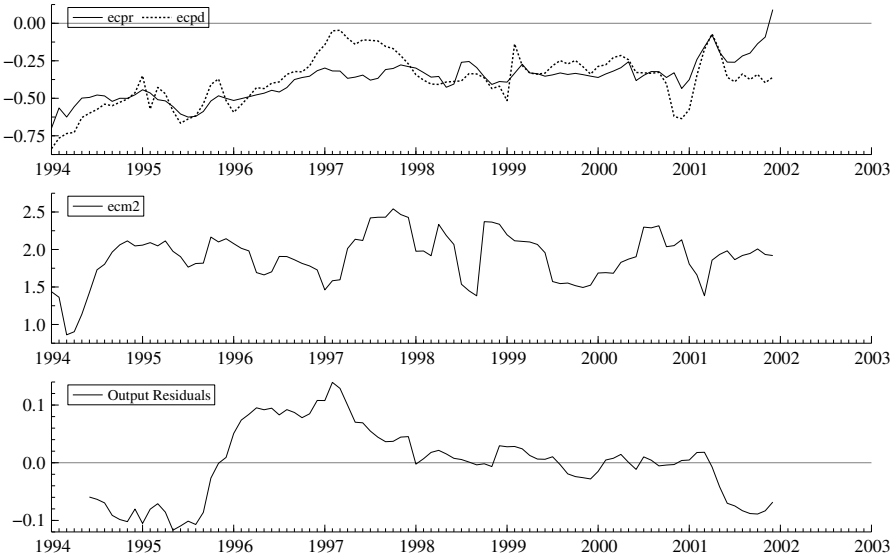
The co-integrating vector had 12 lags on each variable and a time trend

Vector autocorrelation: (1-12) F(4,75)=0.759(0.555)

Log likelihood ratio test of PPP restrictions:$\chi^2(1)$=0.208(0.648)

The adjustment coefficients errors reported are for the restricted model

Appendix B2 Co-integrating Relationships Graphed



Appendix B3 OLS Inflation Equation With M1

	rand			dollar		
	coefficient	t-value	p-value	coefficient	t-value	p-value
Constant	0.01	2.07	0.042	0.008	1.5	0.138
Δp_{t-1}	0.31	3.21	0.002	0.3	3.48	0.001
Δp_{t-2}				-0.27	-3.03	0.003
ΔM_{t-2}				-0.06	-2.42	0.018
Δe_t				0.082	3.39	0.001
Δe_{t-4}				0.06	2.37	0.02
$\Delta debt_{t-2}$				0.03	2.29	0.025
i_{bond}				0.0006	2.26	0.026
$i_{bondt-1}$				-0.0008	-3.24	0.002
$i_{bondt-3}$				-0.0008	-3.18	0.002
$i_{bondt-4}$			0.0007	3.25	0.002	
Ecp_{t-1}	-0.035	-2.98	0.004	-0.13	-5.71	0.000
			Diagnostic tests			
	AR 1-4		F(4,76)	0.966(0.432)	F(4,72)	0.638(0.637)
	ARCH4		F(4,72)	0.231(0.92)	F(4,68)	0.0769(0.989)
	Normality		c2(2)	6.84(0.033)	c2(2)	3.732(0.1547)
	Hetero		F(11,68)	0.1.077(0.392)	F(24,51)	0.639(0.889)
	RESET		F(1,79)	0.057(0.812)	F(1,75)	0.314(0.577)
	R2			0.53		0.64

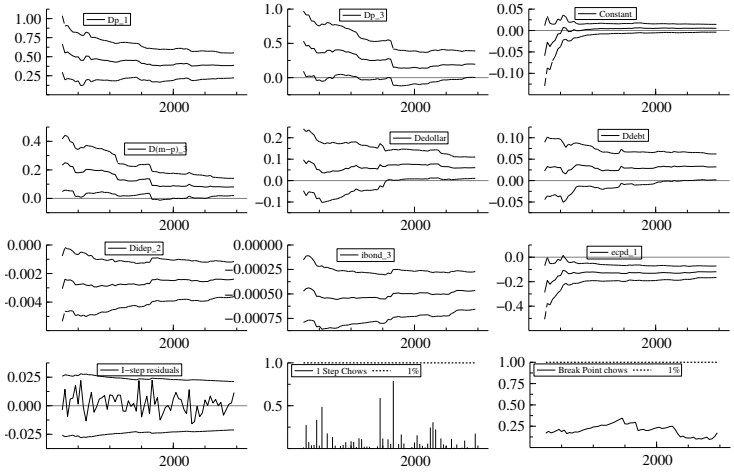


Fig. 3.12: **Recursive Diagnostics-Dollar Rate**

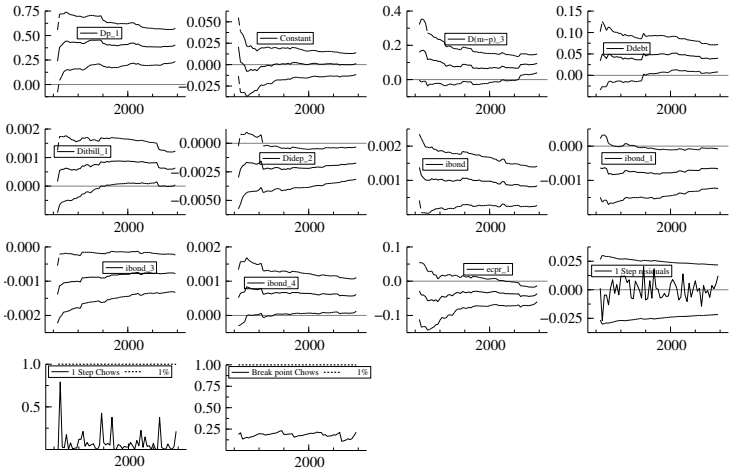


Fig. 3.13: **Recursive Diagnostics-Rand Rate**

Appendix C: Sources Of Data Variable

Tab. 3.9: Sources Of Data

Variable	Source
Output	World Development indicators 2000, calculated 2001
	value based on announced growth rate of 2.2% for that year
CPI	Bank Of Zambia Data base and Ministry of Finance and
	Economic Development Economic indicators, various years
Monetary aggregates interest rates	Bank of Zambia data base and
Bank lending, asset and statutory ratios	Annual Reports and Statistics fortnightly
and exchange rates	
South African CPI	Statistics South Africa
US CPI	Federal Reserve Bank data base
Domestic Debt	Economic Development Indicators, statistics fortnightly
12-month Bond Rate	Bank Of Zambia Data base

4. FOREIGN EXCHANGE INTERVENTION AND THE EXCHANGE RATE IN ZAMBIA

ABSTRACT

The paper, investigates the effect of central bank intervention on exchange rates in Zambia. We use a GARCH (1,1) model of the exchange rate simultaneously estimating the effect of cumulative intervention on the mean and variance of the exchange rate. We find that central bank intervention in the foreign exchange market increases the mean but reduces the variance of the exchange rate. The explanation leans towards speculative bandwagons and a 'leaning against the wind' strategy. Although there is no attempt to distinguish through which channel intervention operates, we argue that this is more likely to be a signalling effect rather than a portfolio balance effect. This effect operates mainly through the supply and demand of foreign exchange in the market.

Keywords: *Exchange rates, Central Bank, Intervention, Volatility, Sterilisation.*
JEL Classifications: E52, E58, F31.

4.1 Introduction

Foreign exchange intervention occurs when the monetary authority of a country buys or sells foreign exchange in the foreign exchange market in order to affect the exchange rate. Since 1992 when the exchange rate was floated in Zambia, the Bank of Zambia (BOZ) has periodically intervened in the foreign exchange market. As part of the International Monetary Fund (IMF) conditions under the structural adjustment package, the BOZ has also intervened in the form of foreign exchange purchases in order to accumulate foreign reserves for the government.

The issue of whether these interventions affect the exchange rate and how this happens has important implications for policy and has been a subject of much debate in the literature. Distinguishing between sterilised and non-sterilised intervention is very important. On the one hand, there is general agreement that non-sterilised intervention can affect the exchange rate through its effect on money supply. On the other hand, the effectiveness of sterilised intervention is still controversial(See Danker et al. (1996), Lewis (1988b), Humpage (1989), Baillie and Humpage (1994) and Dominguez (1998).

Our interest in the paper is to determine whether foreign exchange intervention has an effect on exchange rates in Zambia[1]. As a start, we would like to determine whether intervention in Zambia is indeed sterilised. This is of importance because stabilisation policy in Zambia is based on the control of money supply with M2 as an intermediate target and base money as the policy instrument. Policy implementation is conducted by minimising deviations of M2 from target. If intervention is not sterilised, then interventions are likely to affect money supply growth and thus simply be part of monetary policy.

The question of the effect of interventions on the exchange rate in Zambia has both research and policy interest. Research interest because very few such studies if any have been done on Africa and only one such study under way is

[1] The exchange rate in the study is defined as the number of kwacha (Zambian currency) per unit of foreign exchange

known to the author. It is of policy interest because, if sterilised intervention has an effect on the exchange rate in Zambia, this offers the monetary authority an additional policy tool independent from general monetary policy. The paper is organised as follows. In section 2, we discuss the theory on intervention, followed by a brief discussion of the exchange rate and intervention in Zambia in section 3. The methodology and data are discussed in section 4 while the results are presented and discussed in section 5. We summarise and conclude in section 6.

4.2 Theory Of Intervention

Broadly divided, the literature distinguishes between sterilised and non-sterilised intervention. Sterilised intervention occurs when the monetary authority offsets its foreign exchange market intervention usually with an equal change in the net domestic credit either simultaneously or with a very short lag. On the other hand, intervention is non-sterilised when it occurs without any offsetting changes.

The relationship between exchange rates and monetary control stems from the central bank's balance sheet[2]. From the liabilities side, we have the base money*(Mh)* made up of reserves and currency and the central bank's net worth. On the assets side, we have net foreign assets (*NFA*) and net Domestic assets (*NDA*). Intervention in the foreign exchange markets will alter *NFA*. If net worth is negligible, we can write a summary of the balance sheet as in equation 4.1.

$$Mh = NFA + NDA \tag{4.1}$$

Sterilisation requires offsetting action on the part of the central bank such as open market operation sales or purchases of securities. This will result in an equal change in domestic assets. Without sterilisation, the monetary base

[2] The discussion here follows that of Von Hagen (1989), and the reviews in Edison (1993) and Sarno and Taylor (2001)

must also change i.e.

$$\Delta Mh = \Delta NFA$$

The extent of sterilisation depends on how much simultaneous change takes place in *NDA* as *NFA* changes. There is full sterilisation when changes in *NFA* are totally offset by changes in *NDA* i.e.

$$\Delta NFA = \Delta NDA$$

and

$$\Delta Mh = 0$$

So that there is no impact on the monetary base. Non-sterilised interventions on the other hand will induce changes in the monetary base. These changes will in turn translate into changes in broader money aggregates and interest rates. This will affect expectations, capital flows and ultimately the exchange rate. Because of this, studies of intervention have generally focused on the effect of sterilised intervention.

4.2.1 Sterilised Intervention

A useful taxonomy of how sterilised intervention affects the exchange rate is broadly divided into two. These are often referred to as the portfolio balance channel and the signalling channel.

The Portfolio Balance Channel

The basic idea behind this channel is that investors balance their portfolios between domestic and foreign assets on the basis of their expected returns and the risk associated with those returns. The key distinguishing feature in the model is the assumption of different risks associated with local and foreign assets. The channel operates by changing the relative supplies of these assets and thereby the relative riskiness. Sterilised foreign exchange interventions will have little or no effect on interest rates since by definition it will not affect the money supply. However, it will change the relative supplies of these assets.

The exchange rate will then shift to affect the domestic value of foreign assets and the expected return for holding them as investors try to re-balance their portfolios in the asset market. It is important for the portfolio balance channel that foreign and domestic assets have different returns and risk levels. Without this assumption, domestic and foreign assets become perfect substitutes and investors will be indifferent between them with no need to re-balance their portfolios after an intervention.

Studies testing the portfolio balance channel have used two main approaches. The first is a direct test of the model by estimating a reduced form solution of the portfolio balance model called the demand approach. The second approach focuses on an indirect method by solving the portfolio balance model for the risk premium and testing for perfect substitutability of bonds denominated in different currencies. Most traditional approaches have not provided strong evidence for this channel despite many attempts to overcome the perceived econometric problems encountered in estimating these models (Rogoff (1984), Danker et al. (1996), Lewis (1988b), Gosh (1992)).

An approach pioneered by Frankel (1992), extends the traditional approach by incorporating mean variance optimisation. This approach links expected rates of return with bond supplies by requiring that the coefficients of an inverted asset demand function be closely related to the variance-covariance matrix. This approach and the extensions made to this approach failed to yield support for the channel (Engle and Frankel (1984), Lewis (1988a), Engle and Rodriguez (1989)). The study by Dominguez and Frankel (1993) finds that intervention is statistically significant in a regression for the risk premium providing strong support for the portfolio balance. This study attempted to overcome some of the major problems encountered in previous studies. Actual intervention data was used and survey data was used instead of invoking expectations.

Signaling Channel

This channel contends that even when there is perfect substitutability between domestic and foreign assets, intervention can still affect the exchange rate through expectations Mussa (1981). The basic idea is that agents see exchange rate intervention as an indicator of future monetary policy. When there is intervention, agents change their exchange rate expectations because they expect a change in future monetary policy as a result of the intervention. Investigation of the signalling hypothesis has taken two main strands. The first strand studies the impact of intervention on the exchange rate expectations in the context of portfolio balance models while the second strand focuses on whether or not intervention actually signals monetary policy. The early studies by Humpage (1989)and Dominguez (1990), generally find mixed results. In their 1993 study, Dominguez and Frankel test both the signalling and portfolio balance hypotheses. They find significance of both channels. More recent studies include those of Kaminsky and Lewis (1996), Bonser-Neal and Tanner (1996) and Dominguez (1998). Kaminsky and Lewis (1996) examine the signalling story by checking whether central bank intervention signals future monetary policy. They find that indeed intervention provides significant information about future monetary policy but the signal is in a direction opposite to that predicted by the signalling hypothesis. The two latter studies focus on the impact of intervention on the volatility of exchange rates. Bonser-Neal and Tanner (1996) test the hypothesis that central bank intervention is stabilising. Generally they find that intervention affects exchange rate volatility but in a destabilising way. Apart from one sub-period, all the coefficients on intervention in a volatility equation were positive. Dominguez (1998) finds similar results.

4.3 Foreign Exchange Intervention in Zambia

Prior to 1991, Zambia operated a fixed exchange rate system whose nature changed over the years 1964 to 1991. Between 1964 and 1968, the official

currency in Zambia was the Zambian pound which was pegged to the British pound and fully convertible. In 1968, the currency was changed to the kwacha and de-linked from the pound and linked to the US dollar and later to the SDR in 1976. During this period, there was no active foreign exchange market intervention by the central bank. The exchange rate was maintained through administrative controls such as import licensing. Licensing was based on a priority list of goods and services determined by the government's development objectives. Import quotas and high tariffs were also used. Exporters were required to surrender their foreign exchange earnings to the central bank, which then redistributed the foreign exchange through commercial banks.
The policy of a fixed exchange rate fell out of favour because of balance of payments (BOP) problems in the country. As the country sought increased BOP assistance from the international monetary Fund (IMF), there was pressure from the fund to either devalue or float the exchange rate.
In 1983, a basket of the currencies of Zambia's five major trading partners was introduced. The kwacha was now adjusted within a narrow range and set to depreciate at 1% per month and this percentage was increased to 2.5% by 1984. The foreign exchange auction was introduced in October 1985 with the official exchange rate at 2.2 kwacha per dollar and by the beginning of 1987, the exchange rate had increased to 15 kwacha per dollar. In 1987, as the economy wide reforms progressed, maize subsidies were also removed.[3] There was heavy rioting on the Copperbelt, and the government decided to abandon the IMF/World bank sponsored adjustment programmes.[4] The kwacha was revalued to 8 kwacha per dollar and the foreign exchange auction system was replaced by allocation of foreign exchange through a foreign exchange committee (FEMAC). The resulting decline in foreign aid put a lot of pressure on government expenditure and in 1989 Zambia returned to the IMF and the

[3] Maize is the staple food in Zambia and had thus far been heavily subsidised by the government. When price controls were removed on other food crops such as cassava and sorghum, maize subsidies were maintained with the view to remove these subsidies gradually

[4] The Copperbelt is one of the largest and most urbanised provinces in Zambia. It holds almost all of Zambia's copper mines

foreign exchange auction was re-introduced.

In 1990, a two-tier exchange rate system was introduced. The first tier was the official tier with the exchange rate at 27.8 kwacha per dollar. The second tier was the market tier with the exchange rate at 40 kwacha per dollar. This latter window was used for imports under the Open General Licence (OGL) system. In the same year, exporters of non-traditional exports were allowed 50% retention of their foreign exchange earnings and this was extended to 100% in 1992. The two tiers were unified in 1991 and private foreign exchange rate bureaux were legalised in 1992.

Zambia entered the Rights Accumulation programme (RAP) in 1992. This programme was meant to facilitate the clearing of arrears on debt to the IMF and if the conditions were met, the country would be entitled to a concessional loan with only 0.5% annual interest. The auction was phased out in 1993 and in December of the same year, BOZ started foreign exchange dealing with commercial banks three times a week. The Exchange Control Act was repealed, the OGL system was abolished and the kwacha became fully convertible. By 1995, commercial banks were allowed to maintain foreign exchange accounts. The RAP was completed in late 1995 and there was a surge of donor inflow in the early months of 1996. Zambia Consolidated Copper Mines (ZCCM) was allowed 100% retention of its foreign exchange earnings in April 1996.[5]

In the post-liberalisation period, short-term fluctuations in the exchange rate have mainly been subject to three types of flows. The first has been increased amount of BOZ intervention in the foreign exchange market to accumulate reserves under the financial programme with the IMF[6]. Accumulation of these

[5] ZCCM was a copper mine cooperation wholly owned by government which has since been privatised. Before 1996, it was required to surrender its foreign exchange earnings to the government through the central bank.

[6] Financial programming is done in several steps. Once target values for the policy objectives have been set, both endogenous and exogenous variables are also set, permissible money supply growth is calculated. Total funds available for financing the domestic budget are then estimated. It is believed that growth in domestic credit has a long run effect on foreign re-

reserves requires BOZ to purchase dollars off the market putting upward pressure on the exchange rate. At the same time, the central bank also buys and sells its own foreign exchange on the market in order to smooth the short-term fluctuations in the exchange rate IMF (2001). If the BOZ interventions in the exchange rate market are to achieve the desired objective of smoothing fluctuations in market, they must be able to send a clear and unambiguous message to market participants. This kind of multiple activities in the market by the central bank tends to send mixed signals to the market and thus the desired results may not be seen. Donor inflows have also increased since the completion of the RAP in 1996 and these are also likely to have an impact on the short-term fluctuations in the exchange rate.

Between 1993 and 1996 when ZCCM was allowed 100% retention, intervention was mainly in the form of onward sale of foreign exchange surrendered by exporters about three times a week. After 1994 it was mainly ZCCM receipts that were sold to the market. We show in figure 4.1, the total and cumulative foreign exchange rate intervention. Intervention is measured as open market dealing in the foreign exchange market by the BOZ and is shown as sales net of purchases of US dollars. These interventions are done for the purpose of smoothing exchange rate movements.

We notice from the intervention graph that most intervention activity entails net sales of dollars to the market. This suggests that the main objective of these interventions was to appreciate the exchange rate. We also see frequent interventions in early 1996 and the amounts are relatively high. There is also increased intervention activity in 2001. This is a period when the exchange rate was depreciating substantially and this increased activity may again reflect the need to pressure the exchange rate downwards. There was a lot of

serves, establishing a given target level for growth in reserves makes it possible to estimate the maximum allowable increase in domestic credit (Agénor (2000)). When these goals are set for the year, the central bank deals in the foreign exchange market to meet the given yearly targets. Bolnick (1999) discusses the impact of some of the tight requirements under financial programming

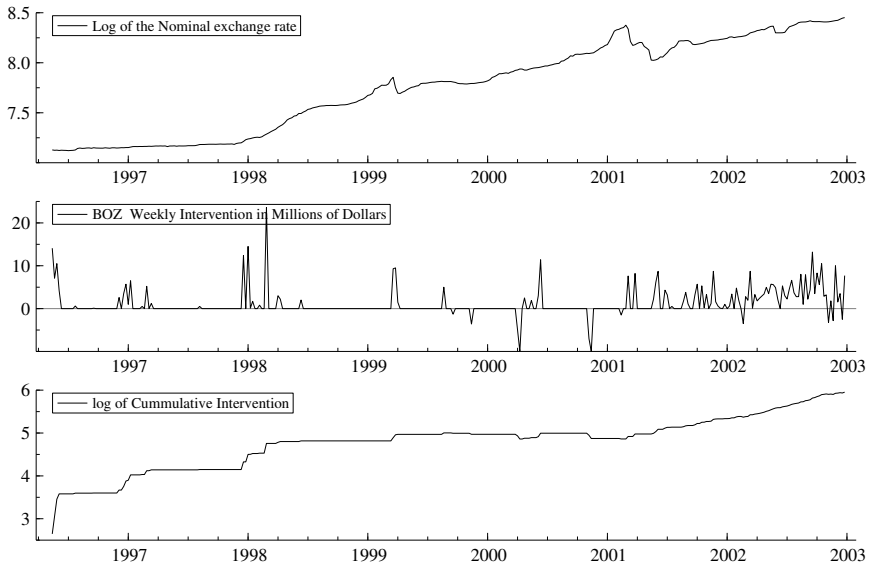


Fig. 4.1: **Weekly Intervention and the Exchange Rate**

political pressure towards the end of 2000 and in 2001 with the run up to the elections and the 'third term' debate when the incumbent president wanted to run for a third term of office. This led to much speculation and pressure from many sectors, and this may have been the reason for the rapid depreciation and the ensuing increased BOZ interventions.

4.4 Methodology

The general formulation of the exchange rate follows Dominguez (1998) and models exchange rates as a forward looking process conditional on public information. We write the spot rate as in the equation below.

$$s_t = \sum_{k=0}^{\infty} \Delta^k E_t(z_{t+k}|\Omega_t) \tag{4.2}$$

Where S_t is the nominal spot exchange rate in logs, Δ is the discount factor, Z_t a vector of exogenous variables, Ω_t is the public information set at time t.

in the case of the portfolio balance approach, foreign exchange interventions lead people to re-balance their portfolio as a result of changes in their relative portfolio compositions so that the effect of intervention can enter as an exogenous variable in the vector Z. Under signalling on the other hand, intervention provides additional information to the market so that $\Omega < \Omega + I_t$ where I_t is foreign exchange intervention. This new information will change market agents' expectations translating ultimately into changes in the spot rate S_t.

Inherent in the equation above is the assumption that exchange rates are efficient aggregators of information and market expectations are rational so that any hypothesis test based on this equation involves a joint hypothesis that the foreign exchange market is economically efficient (Dominguez (1998)). Implicit also in the signalling interpretation above is the hypothesis that intervention signals are credible and unambiguous. In both cases, reality may be otherwise. In Zambia actions of the monetary policy authority may be conflicting. For example, it is not clear to a market agent when the BOZ buys foreign exchange whether this is signalling future monetary policy or foreign reserves accumulation. In this case a market purchase of the dollar is an ambiguous signal.

Empirical work on the effect of exchange rates has used a number of different approaches. A number of early studies regressed the spot exchange rate on intervention variables. Later different methods were used to test the desirability of intervention by checking whether intervention was profitable. More recently, different approaches have been used to test the impact of exchange rates on the volatility of exchange rates. In the estimations, we use the contemporaneous value and one lag of the intervention variable.

We investigate the impact of intervention on both the level and volatility of exchange rates without specific reference to the channel through which this effect may operate. Discriminating between the portfolio balance and signalling channels requires clear maintained hypotheses about conditions on the associated risk factors and their interaction with intervention. Generally,

because of the small size of intervention versus market volumes of currency, intervention effects are often seen as being signalling effects. This is likely to be the more plausible interpretation of our results. Zambian financial asset markets are underdeveloped and investment is often associated with political risk. With this is in mind, exchange rate movements are more likely to be important for local exporters and importers of goods and services. In this case, volatility in exchange rates is likely to result from speculative band wagons and changes in expectations about future market fundamentals.

4.4.1 Data

We use two sets of data in the study. The first set of data is a monthly series and includes base money, the retail mid exchange rate, intervention, aid and the consumer price index.[7] This data set is used to investigate whether intervention in Zambia is sterilised. It was not possible to get price and base money data at the weekly frequency. The second data set consists of intervention, aid flows and exchange rates at a weekly frequency. This data set is used to investigate the effect of central bank intervention on the level and variance of the exchange rate. All data are from the Bank of Zambia annual reports and statistics fortnightly.

Intervention and Donor Aid

Intervention is measured as open market dealing in the foreign exchange market by the BOZ. These interventions are done for the purpose of smoothing exchange rate movements. Official statistics distinguish between such foreign exchange intervention and interventions meant for other purposes such as accumulation of reserves and debt servicing. It is known that central banks are reluctant to release high frequency intervention data and when released is usually with a lag (Gosh 2002, Dominguez (1998). With this high level of secrecy in intervention operations, it is probable that the statistics

[7] The mid rate is defined at the mean between the retail buying and selling rates.

may not accurately distinguish between the various types of interventions in which the central bank is involved. Unfortunately, we are unable to get a similar frequency of data for the other interventions covering the whole sample period to enable us to test if including all the variables in the intervention measure makes a difference to the results obtained in this study. We are also unable to distinguish between announced and secret interventions due to the lack of consistent announced data.

Aid is measured as donor inflows as shown in BOZ official statistics. The original intervention and aid data are shown in millions of dollars. We use the central bank mid rate to convert these into kwacha values. Cumulative series for these variables are used in preference to actual intervention and aid series because it allows us to capture cumulated effects of these variables over time. This approach has been used in other studies.[8]

Base Money and Output

Base money is measured as the sum of kwacha currency in circulation plus commercial bank reserves at the central bank. The output series is interpolated from an annual series using the Denton method.[9]. The series is filtered using Hodrick-Prescott method to extract the output growth component and this is used in the estimation.

Below, we describe the characteristics of the data used in the analysis. We start by looking at the monthly data set and then proceed to look at the weekly one.

Table 4.1 shows summary statistics of the series and figure two their graphs. The series includes the base money, cumulative intervention, output and cumulative aid. All variables are expressed in natural logs. From a casual

[8] See Dominguez and Frankel (1993) and Sweeney (2003)

[9] The Denton Method for interpolating data uses an 'associated series' imposing the constraint that the interpolated series must obey the annual totals. The indicator series contributes its pattern to the series and adds more information especially where such movements in such a series are closely related to the series to be interpolated. See Renka (1988) and Baum (2001)

Tab. 4.1: Descriptive Statistics Monthly Series

	$UnitRoot^a$		Normality	Mean	Std Dev.	Min	max
Variable	level	1st diff					
Base money	-2.15	-11.04**	4.29	12.63	0.46	11.92	13.59
CI	-1.68	-8.16**	5.32	12.49	0.74	11.19	13.63
CAID	3.05	-9.16	4.25	13.57	0.91	11.73	14.93
S	-3.04	-6.2**	4.18	7.73	0.39	7.15	8.34
Y	-3.54**		1.23	5.77	0.24	5.26	6.28

[a] These are Phillips- Perron tests. All the log level tests were conducted with a constant and a trend in them. These proved to be more appropriate after preliminary examination.

Correlation matrix

Variable	Base money	CI	CAID	CPI
Base money		1.00	0.94126	0.85385
CI		0.94126	1.00	0.86053
CAID		0.85385	0.86053	1.00

inspection, three of the series exhibit some non-stationarity. Unit root test were run using the Phillips-Perron method.[10]

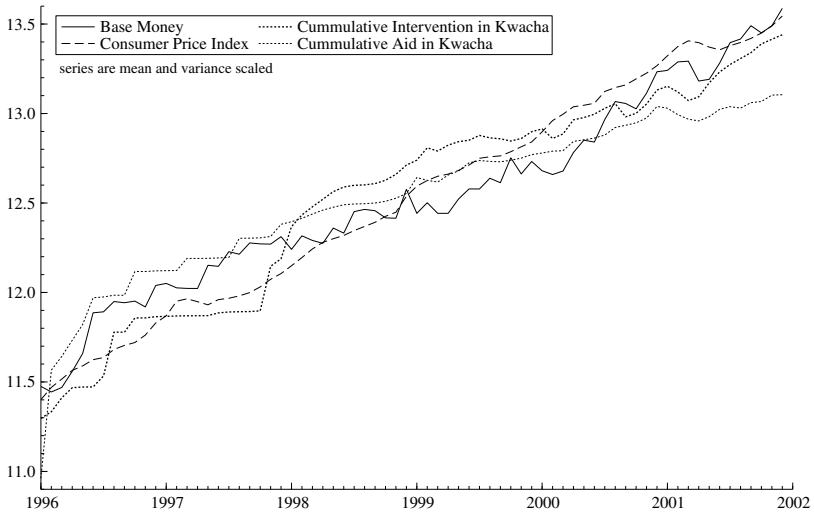


Fig. 4.2: **Monthly Series in Logs**

The statistics suggest that all the variables are integrated of order one and all are stationary in first differences. Figures 4.2 and 4.3 show the same series in logs and first differences respectively. From figure 4.3, we identify some outliers especially in the cumulative aid and intervention series. For the aid series, this occurs in early 1996 when Zambia had just completed the Rights Accumulation Programme (RAP) under the IMF restructuring programme and was therefore receiving large amounts of aid. We also observe unusually high values for growth in cumulative intervention reflecting periods of high levels of intervention in the foreign exchange market. This is observed in July

[10] This is a method developed by Phillips and Perron (1988) and is a generalisation of the Augmented Dickey-Fuller (ADF) test. The assumptions about error properties are less stringent than in the ADF method. The unit root tests the hypothesis that $\rho = 1$ in the equation $\Delta y = \mu + \rho y_{t-1} + \varepsilon$.The cumulative aid series shows a huge jump in the early part of the series as explained below.we therefore conduct the unit root tests from September 1996.

and August 1996 and November 1997 to January 1998.

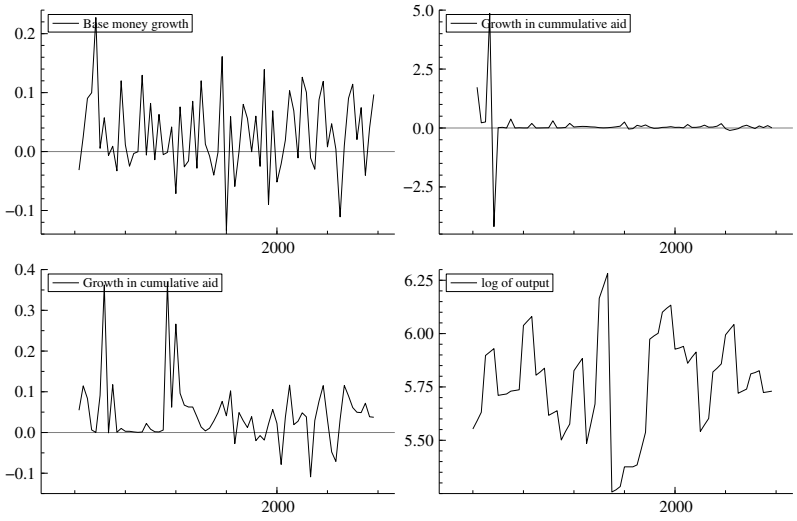


Fig. 4.3: **Growth in the Monthly Series**

In the table 4.2 we show the summary statistics for the two weekly data series. Unit roots are also tested using the Philips-Perron method. both series are integrated of order 1 and stationary in first differences. Both series exhibit clustering as evidenced in the kurtosis.

Tab. 4.2: Descriptive Statistics Weekly Series

	Unit Root[a]		Normality	Mean	Variance	Skewness[b]	Kurtosis[b]
	levels	1st diff					
CINT	-1.1	16.25**	11.47**	4.8	0.57	-0.45	2.88
S	-2.6	-10.96**	28.21**	7.77	0.44	-0.14	1.62

[a] Normality is tested using the Jarque-Bera test statistic which is χ^2 distributed with 2 degrees of freedom.
[b] Skewness and kurtosis are standardised to a normal distribution so that skewness should be equal to zero and kurtosis equal to 3.

Correlation matrix

	S	*CINT*
S	1.000	0.883(0.0756)
CINT[c]	0.883(0.0756)	1.000

[c] The value in the brackets shows correlation between cumulative intervention and depreciation
**(*) denotes significance at the 1%(5 %) level

4.5 Estimation and Results

In this section, we estimate our model in equations 4.3 to 4.6 and discuss the results. We start by conducting a simple test to determine whether intervention in Zambia is sterilised or not. After that we estimate an OLS equation of the growth rate of the exchange rate and thereafter a GARCH (1,1) model due to the presence of ARCH effects in the data.

4.5.1 Is Intervention Sterilised?

In this section, we check whether foreign exchange intervention in Zambia is sterilised. Following the outline in section 2, it follows that to determine whether foreign exchange intervention is indeed sterilised, we must check if it has an effect on the growth of base money. In the estimation, we treat the outliers identified in the data in two ways. In the first case, we create dummies for outliers in both the cumulative intervention and aid series. For the aid variable, we call this dummy 'dumaid' which takes the value of one for the first six months of 1996 and zero for the rest of the estimation period. We also have

a dummy for periods of large interventions and call this dummy 'dumcint'. This dummy has value one for July and August 1996 and November 1997 to January 1998 and zero for the rest of the estimation period. We then regressed the growth of the base rate on cumulative aid, monthly inflation, cumulative intervention and the two dummies. In the second case, we leave out of the sample the first six months of the earlier sample and begin the estimation in July 1996 but include the intervention dummy.

Equation 4.3 is estimated by ordinary least squares. The equation is a standard way of checking for sterilisation with a measure for the income gap (Kearney and Macdonald (1985), Von Hagen (1989) and Sarno and Taylor (2001)). Most of the early studies that investigated issues of sterilisation used net foreign assets as a measure of intervention in the absence of actual intervention data. We have the advantage of having actual intervention data and we use this variable instead.

$$\Delta m = \beta_0 + \beta_1 \Delta cint + \beta_2 \Delta caid + \beta_3 \Delta Ytrend + \beta_4 dumcint + \beta_5 dumaid + \varepsilon \quad (4.3)$$

The variables *cint* and *caid* are the cumulative intervention and aid variables in logs. *Ytrend* is output growth trend and ε is the error term. Preliminary estimations showed significant first order autocorrelation in the residuals. We then included one lag of the dependent variable as one of the explanatory variables. The results from both equations are very similar and we show the results for the model with the two dummies in table 4.3. The diagnostics of the models show that the equation is well specified. We find that neither the intervention nor the aid variables are significant. The proxy for the income gap, $Ytrend$ is marginally significant at 7%. Since the intervention variable is not significant, we conclude that there is full sterilisation of foreign exchange intervention in Zambia.

In our analysis, we have concentrated on the short run effects of intervention on the monetary base. Some observers have argued that although full sterilisation can be achieved in the short run, there may not be full sterilisation in the long run. Inability to achieve full long run sterilisation may

Tab. 4.3: OLS Regression of Base Money

variable	coefficient	Std error	t-value	t-prob
C	-3.04	-1.655	-1.84	0.07*
Δmt_{-1}	-0.43	0.12	-5.55	0.000***
$\Delta cint$	0.09	0.09	0.95	0.345
$\Delta caid$	0.02	0.08	0.244	0.81
Ytrend	0.054	0.0.28	1.88	0.066*
dumcint	-0.031	0.035	-0.896	0.374
R2	0.52			
F(12,45)	3.994			0.000**
AR(1) F(5,40)[a]	1.98			0.103
ARCH F(5,35)[b]	0.764			0.582
Normality[c]	0.734			0.693
Hetero test F(16,28)[d]	0.76			0.712
Reset F(1,44)[e]	0.128			0.723
Instability	2.63			

(***)**(*) denotes significance at the (one) five, and (ten) percent level

[a] The AR(1-5) test is an LM test for 5th order residual autocorrelation calculated according to Harvey (1981)

[b] ARCH tests the presence of autoregressive conditional heteroskedasticity Engel (1982)

[c] Normality test based on Doornik and Hansen (1994)with a small sample correction

[d] Based on White (1980), the test checks for unconditional heteroskedasticity

[e] The RESET test due to Ramsey (1969), tests the null of correct model specification

[f] The instability test is a joint parameter test for instability based on Hansen (1992).

reflect institutional deficiencies or in the case of monetary targeting monetary policy, the authority's willingness to give in on its monetary target to lend more weight to exchange rate considerations. In a study of sterilisation in Germany, Von Hagen (1989) finds that the Bundesbank sterilises in the short run but not in the long run. Indeed being a monetary targeting bank as well, it may well be that BOZ is not able to fully sterilise its interventions in the long run. This is even more likely in the case for Zambia since political

interference in preference for stable exchange rates over achieving monetary goals is sometimes very significant. The focus on short-term sterilisation in the paper is sufficient for analysing the effect of intervention on the short-term fluctuations in the exchange rate.

4.5.2 Does Intervention Affect the Exchange Rates?

In this section, we address the question of whether central bank intervention in foreign exchange rate markets in Zambia affects the exchange rate. Three outliers were identified in the exchange rate series. They fall in the fourth week of March 1999, the second week of March and the third week of May 2001 and last week of may 2002. We introduce a dummy variable dumrate, which takes the value of 1 for each of these points and zero for the rest of the estimation period. As an alternate formulation, we introduce single dummies for each of these points i.e. dum99, dum20011, dum20012 and dum2002.
We start by running a preliminary OLS equation of the depreciation of the exchange rate on a constant, the growth in cumulative intervention and dumrate and as an alternative with the single dummies. The results are presented in table 4.4.
In both cases, the intervention variable is not significant. All the dummy variables in either formulation are highly significant. These preliminary results suggest that central bank intervention may not have an effect on the depreciation rate. Intervention however may affect the exchange rate by affecting its volatility rather than just the level of depreciation. From the ARCH tests, we cannot reject that there are ARCH effects in both equations. We then proceed to estimate a GARCH(1,1) model and simultaneously estimate the effect of intervention on both the mean and volatility of the exchange rate.
Exchange rate volatility has been modelled mainly through implied volatility measured by option prices (Bonser-Neal and Tanner (1996) Bonser-Neal (1996)) and GARCH methods (Dominguez (1992), Baillie and

Tab. 4.4: OLS Regression of the Exchange Rate

	Single Dummy			Multiple Dummies		
	coeff.	t-value	prob	coeff.	t-value	t-prob.
C	0.005	-8.83	0.00	0.005	-8.98	0.00
$\Delta cint_{t-1}$	-0.011	-0.756	0.449	0.-01	-0.63	0.528
Dumrate	-0.103	-19.51	0.00			
Dum99				-0.11	-10.33	0.00
Dum20011				-0.13	-12.55	0.00
Dum20012				-0.011	-10.24	0.00
Dum2002				-0.07	-6.90	0.00
ARCH(1)[a]	16.82		0.000**	9.17		0.0.003**
ARCH(1-3)	7.57		0.000**	6.09		0.00**
ARCH(1-5)	5.36		0.000**	4.17		0.001**

**(*) denotes significance at the 1%(5%) level

[a] *ARCH* tests the presence of autoregressive conditional heteroskedasticity Engel (1982).

Humpage(1994), Dominguez (1998)).[11] In the study, we use the later approach to model the heteroscedastic errors in our exchange rate equation. Apart from the fact that data allows this approach, it is advantageous because it allows us to simultaneously test the effect of intervention on both the mean and conditional volatility of exchange rates.

Figure 1 suggests that we may have some asymmetry in the intervention series and to some extent in the depreciation series (see figure 4). To take account of this behaviour, we use the exponential GARCH (EGARCH) approach to account for asymmetric effects. Such an approach is important where say downward movements in the market are followed by higher volatilities than upward movements of the same magnitude as seems to be evident in our data.

[11] Implied volatility can be defined as the volatility that equates the theoretical and observed market prices of a foreign exchange option. It reflects the average expected volatility over the life of the option

Diagnostics however show that a simple GARCH(1,1) model is superior to the EGARCH. Our model is shown in equations 4.4 to 4.6 below.

$$\Delta lnS_t = \alpha + \Delta lnCINT_{t-1} + \lambda g(h_t) + \gamma dumrate + \varepsilon_t \tag{4.4}$$

$$\varepsilon_t \mid \Omega_t \ D(0, h_t) \tag{4.5}$$

$$h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} + \varphi lnCINT_{t-1} \tag{4.6}$$

The first equation is the conditional mean equation and tests the effect of intervention on the depreciation of the exchange rate. We also introduce the variance in this equation as a regressor through g, a suitable function entering the equation as either the variance itself or its square root. This is called the ARCH-M Model (Engle et al. (1987)). It is used to asses whether the mean explicitly depends on the variance.

The second equation shows the distribution of the error term, which is conditional on the information, set Ω period $t-1$. The conditional density D follows a generalised error distribution. The third equation is the conditional variance equation. It is a function of three variables, the mean ω, news about volatility from the previous period, ε_{t-1}^2 and last period forecast variance h_{t-1}. For the model to be well defined and the variance to be positive, the following conditions must hold i.e $\omega > 0$, $\alpha > 0$ and $\beta \geq 0$. Our specification above also includes the intervention variable in the variance equation. This allows us to see the effect of intervention on the exchange rate volatility.

Our model is estimated by quasi-maximum likelihood method. In this method, the likelihood function provides consistent estimates of the parameters even if the assumption of normality is violated (Bollerslev and Wooldgrige (1992) and Runkle(1989)). This offers a good option because our preliminary OLS estimations revealed non-normality in the data. The standard errors are adjusted by the Bollerslev and Wooldridge method. The results are shown in table 4.5.

Tab. 4.5: GARCH Estimation of the Exchange Rate

	Multiple Dummies			Single Dummy			No Dummies		
	Coeff.	t-stat.	Prob.	Coeff.	t-stat.	Prob.	Coeff.	t-stat.	Prob.
				Conditional mean					
C	0.001	-1.58	0.115	-0.001	-1.312	0.19	0.103	0.886	0.376
garchsqr	0.467	4.77	0.00	0.414	4.319	0.00	0.00	0.358	0.721
$\Delta cint_t$	0.011	1.50	0.13	0.012	1.349	0.178	0.001	1.31	0.896
$\Delta cint_{t-1}$	0.02	1.98	0.05*	0.026	1.766	0.078*	0.014	1.577	0.116
Dumrate				-0.09	-5.863	0.00***			
Dum99	-0.078	-2.62	0.00						
Dum20011	- 0.245	-3.89	0.00***						
Dum20012	-0.125	-14.31	0.000***						
Dum2002	-0.86	-4.29	0.000***						
				Conditional variance					
C	2.09E05	2.5	0.01	1.73E06	2.293	0.023	1.70E06	1.513	0.13
α	0.423	3.4	0.001***	0.439	4.979	0.00	0.926	5.523	0.00
β	0.65	11.63	0.000***	0.66	14.643	0.00***	0.538	10.94	0.000
$\Delta cint_{t-1}$	-4.2E05	-1.99	0.047	-4.59E05	-1.784	0.075*	-2.21E05	-1.406	0.161
				Diagnostics					
Q(5)[a]	1.05		0.958	1.623		0.961	0.788		0.978
ARCH(1)[b]	0.144		0.704	0.671		0.79	0.017		0.898
ARCH (1-3)	0.289		0.831	0.325		0.808	0.616		0.997
ARCH(1-5)	0.21		0.959	0.196		0.964	0.057		0.998
Wald[d]	0.681		0.41	2.22		0.137	88.97		0.00

***(**)(*) denotes significance at the one (five)(ten) percent level

[a]Measures autocorrelation in the squared residuals with 5 lags.

[c]Tests the presence of autoregressive conditional heteroskedasticity Engel (1982)

Exclusion tests for the dummy variables:dumrate, F=380(0.00) and multiple dummies, F=103.03(0.00)

[d]Tests the persistence of volatility shocks

We find that the results from the two models with the dummy variables are very similar while those of the model with no dummies vary in some cases. The first lag of the intervention variable is significant in both the mean and variance equations in the two models with dummies and insignificant in the model without dummies. Given that the exclusion of the dummy variables is significantly rejected, the discussion will focus on the two models that include dummies. At the bottom of table 4.5, we show some diagnostic tests. The Q statistics for the square residuals show no autocorrelation in all the specifications. The ARCH tests indicate no ARCH errors in all the equations. The first result we find is that the intervention variable is positive in the mean equation suggesting that net sales of dollars lead to a depreciation of the kwacha. Similar result have been observed in other studies such as Dominguez and Frankel (1993), Almekinders and Eijfinger (1995), Baillie and Osterberg (1997), Dominguez (1998) and Beine et al. (2002) on US data and Aguilar and Nydal (2000) for Sweden. On average BOZ foreign exchange market intervention are net sales of the dollar. Because the country has low levels of foreign reserves, this result suggests that this may not be what the central bank would like to see. The common interpretation in the literature for this result is that of leaning against the wind. This means that the central bank attempts to oppose a depreciation of its currency (Baillie and Osterberg (1997)) or simply tries to resist short run trends in the exchange rate. The coefficients are only significant at the 5 and 8 % levels with an impact of about 2-3 % on weekly depreciation.

The more plausible explanation for Zambia is that this may reflect speculation in the foreign exchange market (Beine et al. (2002)) or speculative "bandwagons" (Bonser-Neal (1996)). It is not uncommon in Zambia for the dollar to be scarce on the market even after a central bank sale. The tendency is to purchase as many dollars as possible after a central bank sale and then withhold the dollars until the exchange rate rises again and resell. This kind of speculation may stem from the fact that since the reforms, the nominal exchange rate has been depreciating almost continuously. It may also be

exacerbated if the market participants believe that the central bank's resolve to stabilise the exchange rate is strong. In such a case speculators will buy the dollar until it appreciates again and they will resell. This argument is similar to that offered by Beine et al. (2002) who argue that the positive sign may reflect the market's attack on the currency after an initial successful intervention in order to test the determination of the central bank to defend the currency, which may ultimately result in a depreciation.

As a second result, we find that central bank intervention reduces the variance of the exchange rate. This shows that the central bank actually achieves its objective of smoothing out exchange rate fluctuations. This result is similar to findings in other studies for volatility.[12] However, the change in cumulative intervention has a less than 1 % effect on weekly exchange rate volatility. The data discussed in section 4 suggests increased intervention from periods when the exchange rate began to rise quite rapidly. This supports our leaning against the wind strategy proposed above which is in line with BOZ's main objective for foreign exchange intervention.

A reconciliation between the opposite effects of intervention on the mean and volatility of the exchange rate can be found in the interaction between speculative band wagons and nature of shocks to the foreign exchange markets. When the variability in exchange rates is caused at least in part endogenously, intervention can lower volatility by providing information to traders in the foreign exchange market. According to the signalling hypothesis this causes market participants to revise their expectations given the new information conveyed by central bank intervention. Based on demand and supply of foreign exchange in the market, the central bank is able to manipulate the exchange rate at least at the time that intervention takes place (Hung (1997) and Westerhoff (2001)). When BOZ sells dollars on the market, they succeed in reducing volatility but because of speculation, the exchange rate rises as explained above but with reduced variability.

[12] See for example studies by Ramchander and Sant (2002), Hung (1997) and Rogers and Siklos (2003)

The third result is that both the ARCH and GARCH parameters are significant in the variance equation for all specifications. The β coefficient is just over 0.6 and is highly significance in all cases indicating the persistence of volatility. We find an α coefficient of 0.4 which is also very significant indicating a strong reaction of the conditional variance to shocks. The wald test(shown at the bottom of table 4.5) shows that the sum of the two coefficients is not significantly different from 1, indicating an IGARCH process with persistent volatility.

4.6 Summary and Conclusion

In the paper, we investigate the impact of central bank intervention on the exchange rate in Zambia. We begin by running a standard regression on base money to see if intervention in Zambia is sterilized. The results indicate that indeed there is sterilization as the intervention variable is not significant. Since aid forms significant foreign exchange flows, we also include this variable in the estimation and find that this variable also has no effect on base money.
We then estimate an exchange rate equation using weekly data and cumulative intervention as a regressor. Preliminary OLS regressions show the presence of ARCH effects and non-normality so we proceed to estimate GARCH (1,1) model by quasi-maximum likelihood. We find that cumulative intervention tends to lead to a depreciation but reduces exchange rate volatility. Our explanation of the observed results tends towards 'leaning against the wind' which is in line with BOZ exchange rate objective of smoothing exchange rate fluctuations.
The fact that intervention has a desired effect on the exchange rate at least in part, shows that BOZ interventions in the foreign exchange markets are successful. The question of how to reduce the positive impact on the depreciation rate is important. One issue that could be addressed is that of foreign exchange rate speculation which seems to be rampant in the country. On the research front, the study does not address the issue of long-term

impact of intervention. This is an important issue because of the importance of money supply in stabilization policy in Zambia. Further work could be done to investigate whether intervention is sterilized in the long run and if so whether the effects of intervention on the exchange rate are a short or long run phenomenon. Although markets are still quite underdeveloped in Zambia, the stock market has been operating for almost ten years now and the capital account has been open for almost just as long. This suggests that there may be room for intervention to affect the exchange rate through financial assets as suggested by the portfolio balance model. Testing the hypothesis of portfolio effects is another question of future research interest, which may also offer very useful options for policy makers.

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