AN INVESTIGATION OF THE EFFECTIVENESS OF THE INTEREST RATE
CHANNEL OF MONETARY POLICY TRANSMISSION MECHANISM IN
ZAMBIA

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MARTIN C. FUNDA

200124544

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Main Supervisor: Prof. E. Ziramba

Co-supervisor: Mrs. J. Mumangeni
ABSTRACT

This study investigates the effectiveness of the interest rate channel of monetary policy transmission in Zambia by employing the vector auto-regression (VAR) approach and focuses on the reduced-form relationships between money supply, inflation, real interest rate and real output by utilizing annual data for the period from 1980 to 2011. Using the 4 variable VAR model, the analysis was carried out by examining the dynamic nature of impulse response functions, multivariate Granger causality tests and variance decomposition estimates generated from the model. The main findings from the basic VAR model suggest that a decrease in money supply reduces output in the year following the shock and recovers in the third year but reduces again from the fourth year and the magnitude is small but significant. However, inflation rises first and peaks in the second year following the shock, before declining and rising again after the fifth year but as with output, the magnitude is small and significant. After adding the real interest rate variable to the basic model, money supply still affects output, inflation and real interest rate but the magnitudes are small and insignificant. The main conclusion drawn from the study is that monetary policy affects output and inflation but the interest rate channel is not effective in Zambia.
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DEDICATION

To God Almighty and my beloved parents Charles Martin Funda and Charity Nanyangwe Funda.
DECLARATION

I, Martin Chitupa Funda, declare hereby that this study is a true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education.

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Martin Chitupa Funda  
Date: 18/03/2014
1. INTRODUCTION

This chapter introduces the study by summarizing what the study intends to investigate. This chapter will therefore look at the statement of the problem, the research objectives, the research hypotheses, significance and limitations of the study.

1.1 Introduction

Monetary policy transmission mechanism is defined as the process of how monetary policy decisions are transferred to the real economy and the price level by influencing the investment and consumption decisions of firms, households and financial intermediaries. According to Boivin, Kiley and Mishkin (2010), the monetary transmission mechanism is one of the most studied areas of monetary economics for two reasons.

First, understanding how monetary policy affects the economy is essential to evaluating what the stance of monetary policy is at a particular point in time. Second, in order to decide on how to set policy instruments, monetary policymakers must have an accurate assessment of the timing and effect of their policies on the economy. To make this assessment, they need to understand the mechanisms through which monetary policy impacts real economic activity and inflation.

The monetary transmission mechanism describes how policy-induced changes in nominal money stock or short-term interest rate impact on output and inflation. Unless they know more about the different ways in which monetary policy affects the real economy, monetary policy makers will always be facing uncertainty about
how much or how little to move their policy tools. Accordingly, this uncertainty will lead the monetary policy maker to move these policy tools by too much or too little, to move too early or too late adding uncertainty into the economy (Mishkin, 1996). Hence, the transmission mechanism of monetary policy is of vital importance for macro-financial regulation.

1.2 Statement of the problem

Although monetary policy transmission mechanism has been a subject of empirical studies in Zambia, there is no consensus on how it works. A study by Mutoti (2006) examines the transmission of monetary policy in Zambia, focusing on the role of money and exchange rate. However, the impact of the policy induced changes of the Bank of Zambia (BoZ) on the real economy still remains an open question. A study by Lungu (2008) which investigated the monetary policy transmission in the Southern African Development Community (SADC) produced mixed results.

Mutoti (2006) states that though the monetary transmission mechanism has been a subject of much research over a number of years in developing countries, especially Sub Saharan Africa, very little is known about issues central to underlying monetary policy in Zambia. In particular, how the economy responds to shocks, the relative importance of various transmission channels, the magnitude and timing of monetary policy effects and the effectiveness of various policy instruments are less understood.

According to Alexander, Balino and Enoch (1995), it is widely acknowledged that significant gaps remain with regard to the precise nature of the channels monetary impulses are transmitted through economies. As Bernanke and Gertler (1995) mentioned, the monetary transmission mechanism remains a black box to be
explored. It is against this background that this study seeks to assess the interest rate channel of monetary policy transmission in Zambia from 1980 to 2011.

1.3 Objectives of the study

The main objective of this study is to assess the interest rate channel of monetary policy transmission in Zambia. The specific objectives of the study are to:

(i) Examine the effectiveness of the interest rate channel of monetary policy transmission in Zambia.

(ii) Draw policy implications from the findings.

1.4 Hypotheses of the study

The following hypotheses will be tested in light of the statement of the problem and the outcomes from the hypotheses will be used to obtain a stance on the objectives of this study. The hypotheses to be tested are as follows:

H₁: Money supply (M2) does not Granger cause inflation (CPI) and Output (GDP).

H₂: Money supply (M2) does not Granger cause real interest rates (RIR), inflation (CPI) and Output (GDP).

1.5 Significance of the study

This study, which has never been conducted before in Zambia, will contribute to the literature and academic knowledge by exploring the dynamism within the monetary transmission framework and complexity of monetary policy. This study will evaluate the effectiveness of monetary policy transmission mechanism associated with the
interest rate channel in Zambia and may make suggestions for policies relevant to the economy.

1.6 Limitations of the study

This study is aimed at empirically investigating whether an active monetary transmission mechanism with particular emphasis on the interest rate channel is present in Zambia. This requires extensive research into the workings of the monetary authorities and the economy as a whole in order to have a critical understanding of how they operate. However, as this is a quantitative desk research, no interviews will be conducted with relevant stakeholders such as the Bank of Zambia for the purpose of getting their views on the monetary policy transmission mechanism.

1.7 Structure of the study

The rest of this study is structured as follows. Chapter 2 gives a background of monetary policy in Zambia and Chapter 3 presents a review on monetary transmission literature that is relevant to Zambia with a particular emphasis on the interest rate channel. Chapter 4 explains the data and methodology followed in this study. In Chapter 5 the empirical findings of the research are presented and in Chapter 6 the conclusion, policy implications and recommendations based on the results of the study are presented.
2. EVOLUTION OF MONETARY POLICY FRAMEWORK IN ZAMBIA

This chapter looks at the evolution of the monetary policy framework in Zambia and gives an insight of monetary policy before and after 1992 when Zambia liberalised its economy. It also looks at the financial programming framework and challenges of monetary policy in Zambia. As in most countries, monetary policy framework in Zambia has evolved in response to economic reforms. A major aspect of these reforms was financial reforms and one of the main features of financial reforms was the reform of monetary policy. Therefore, the evolution of monetary policy framework in Zambia can be seen in two distinct phases, the period associated with monetary controls and the period under which monetary policy has been allowed to develop in a setting of a liberalized environment.

2.1 Monetary Policy Before 1992

The Bank of Zambia (BoZ) was established by an Act of Parliament, originally under the Bank of Zambia Act of 1964. Currently the Bank is governed by the Bank of Zambia Act of 1996 and is mandated to formulate and implement monetary policy in Zambia. For twenty seven years after independence, the financial sector in Zambia was highly controlled. In its conduct of monetary policy, the Bank of Zambia used direct instruments from 1964 up until 1991. The objective of monetary policy during this period 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
(Simatele, 2004). 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. According to Kalyalya (2001), the combined effects of the above factors, structural rigidities in the economy, such as heavy dependence on the production and export of copper, an inefficient and hence inappropriate industrial strategy of import substitution, and an inefficient public sector, were to push the economy into a state of stagflation. Clearly, monetary policy and other government policies had failed to deliver.

2.2 Monetary Policy Since 1992

In response to the changing financial environment and global consensus, the Bank of Zambia placed greater emphasis on market-based (indirect) monetary instruments such as open market operations rather than direct instruments (credit and interest controls) in its conduct of monetary policy. This shift from heavy reliance on direct instruments of monetary policy was a central part of the extensive measures taken to liberalise the economy that began in 1992. The idea was to remove the financial repression believed to have come along with the controls and let the market operate more efficiently. According to Simatele (2004), stabilisation policy has increasingly 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 targets 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. Therefore, since January 1993 the Bank of Zambia has employed both direct and indirect instruments, with a greater reliance on the latter. The indirect instruments include government securities which comprise Treasury bills and bonds auctions, daily open market operations (OMO), the discount window and foreign exchange dealings while the direct instruments include the core liquid asset ratio and the statutory reserve ratio.

In accordance with the Financial System Report of Zambia (2011), daily open market operations (OMOs), introduced in March 1995, are conducted through the sale of term deposits of varying maturities and the sale of Treasury bills for outright purchase by the commercial banks when the central bank wants to withdraw liquidity. In addition Repurchase Agreements (Repos) are also used as a liquidity withdrawal instrument. The Treasury bills used in this instance are those on the Bank of Zambia’s trading portfolio. When the central bank intends to inject liquidity into the banking system, it provides secured loans, which are backed by either Treasury bills or Bonds. The Bank of Zambia also adopted the money supply aggregate as the primary monetary policy instrument to play the main role in monetary policy. Reserve money is the operating target of monetary policy while broad money, defined as including foreign exchange deposits of commercial banks, is the intermediate target of monetary policy. Reserve requirements on financial institutions have been a common tool of controlling the monetary aggregates and there are two types of reserve requirements for commercial banks in Zambia. Firstly,
there is the statutory reserve ratio on commercial bank deposits. These are unremunerated reserves that commercial banks must keep with BoZ calculated as a percentage of total deposit liabilities excluding central government deposits. The ratio was adjusted downwards by 6 percentage points in September 2007 to 8 percent from 14 percent on both Kwacha and foreign currency deposits. Secondly, there is the core liquid assets ratio. This is the ratio of eligible liquid assets to total deposit liabilities including bills payable (excluding central government deposits). Eligible assets that can be held by commercial banks as core liquid assets include those that are interest bearing such as Treasury bills, Repurchase Agreement (Repos) and Term deposits. In March 2001 the core liquid asset ratio was raised to 35 per cent from 25 per cent. In July 2006, it was adjusted downwards to 9 per cent. However, due to the still underdeveloped nature of the country’s financial markets, it has not been possible to abolish direct instruments completely. The use of indirect and market based instruments in the conduct of monetary policy brought into focus a new dimension to the way monetary management was designed and implemented and therefore the elements of financial programming was introduced.

2.3 Financial Programming Framework

According to Kalyalya (2001), financial programming refers to the forecasting of major macroeconomic variables over a period of time, and deriving quantitative policy targets from a set of objectives and assumptions. He explains that as in other countries following International Monetary Fund (IMF) programmes, in Zambia financial programming forms the core of the monetary framework. Figure 1 shows a brief outline of the financial programming framework that Zambia currently uses.
Figure 1.1: Bank of Zambia Financial Model (BoZFM)

Source: Bank of Zambia
Where OMO = open market operations; mm = money multiplier; NFAc = net foreign assets of BoZ; NDAc = net domestic assets of BoZ; NCGc = BoZ’s net claims on Government; NCG = total banking net claims on Government; TBs = GRZ Treasury bills; Bs = GRZ Bonds; NFA = total net foreign assets; BoP = balance of payments support; E = exchange rate; M = money demand, V = velocity; P = price level; Y = output; Inf = inflation rate, Ms = money supply; NDA = total net domestic assets; VA = value added.

The financial programming framework presented in Figure 1 is a typical exercise countries following IMF supported programmes engage in. Given this framework, Simatele (2004) explains that 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 output/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 each of them are also set. Discretionary monetary policy is estimated by subtracting net domestic assets from estimated operating target levels for reserve money.

In terms of the implementation of monetary policy, Kalyalya (2001) states that reserve money or liquidity programming has been the main guide since 1992. This approach takes reserve money as the operating target of monetary policy, based on a given money multiplier. Broad money is treated as the intermediate target, while low and stable consumer price inflation serves as the ultimate target of monetary policy. To forecast reserve money, he explains that the Bank of Zambia assesses on a daily
basis the liquidity position of all deposit money at banks, which reflects the central bank’s net foreign asset and net domestic asset position. The other component of the reserve money supply is the net claims on Government. He states that this is forecast on the basis of Government revenue to be collected and deposited at the Bank and the anticipated Government expenditures. Treasury bills and bond transactions and Treasury bill rediscounts are also considered. Claims on commercial banks are predicted through open market operations and overdraft facility, with the commercial banks overall current account position projecting the overdrafts to commercial banks.

2.4 Challenges of Monetary Policy

An effective implementation of monetary policy needs an assessment of how the monetary policy changes transmit through the financial markets and the broader economy. Simatele (2004) states that in the literature there is general agreement that monetary policy gets transmitted to final objectives of inflation and growth through two stages. In the first stage, policy changes transmit through the financial system by altering financial prices and quantities. In the second stage, financial prices and quantities influence the real economy by altering aggregate spending decisions of households and firms, and hence the aggregate demand and inflation. Nonetheless, whether monetary policy actions influence the spectrum of market interest rates would depend upon the level of development of various segments of financial markets. To this end, there are several challenges that monetary policy in Zambia faces. According to Kalyalya (2001), the weak and undeveloped nature of the financial system poses a serious challenge to the effectiveness of monetary policy. The Zambian financial system, like that of most developing countries, remains
shallow as reflected by the domination of the operations of commercial banks despite the reform effort. Among the banks, four of the five largest banks are branches of foreign banks. The remainder of the financial sector can be classified as non-bank financial institutions that include a development bank, a discount house, a savings bank, mortgage and leasing finance companies, and insurance companies. In addition, the growing stock exchange needs to be developed further while commercial banks have continued to provide traditional banking services, but customers complain these services are very narrow and costly. Kalyalya (2001) further explains that the undeveloped nature of the secondary market for Government debt has also retarded the efficient functioning of the primary market, as most investors are not prepared to invest in new bond issues unless these bonds can be sold at short notice and at as little expense as possible. The lack of an active secondary market means that there is some inflexibility in using Government securities to regulate the money supply.

Money market imperfections can also be cited as a challenge to monetary policy in Zambia. Kalyalya (2001) says the volatility of interest rates for overnight interbank lending, high and sticky interest rates for market lending and a segmented money market all contribute to money market imperfections. Financial distress in the Zambian financial system is another problem. A number of commercial banks that mushroomed following financial liberalization found it difficult to compete, resulting in more than eight banks being liquidated or placed in receivership. This development has largely been responsible for interbank market segmentation, as many participants are averse to risking their funds by lending to other banks
In addition, the bank failures pose challenges for confidence building in the financial system. Weaknesses in fiscal policy will also continue to undermine the effectiveness of monetary policy in Zambia. There are expenditure control problems as evidenced by the accumulation of arrears. Tax collection has largely been rigid mainly due to a narrow tax base that requires broadening. In addition, the fear of increasing the domestic debt to unsustainable levels poses a dilemma in using Government securities for controlling growth in the money supply. Therefore, without efficient and well-developed money and capital markets, the scope for implementing effective monetary policy will continue to be severely limited and this might have implications for monetary transmission.

2.5 Summary
As earlier mentioned, it is imperative and very important for the monetary authorities to have knowledge of how monetary policy affects the real sector and the economy as a whole. In other words, understanding the path that policy changes take to impact the macro economy is important. There are many channels of monetary policy transmission in the available literature but this study will focus particularly on the interest rate channel of monetary policy transmission mechanism and will seek to establish whether the interest rate channel has been effective in Zambia from 1980 to 2011.
3. LITERATURE REVIEW

3.1 Introduction

This chapter takes a look at the available literature, theoretical and empirical, on the monetary policy transmission mechanism with particular emphasis on the interest rate channel.

According to Meltzer (1995), monetary policy is aimed at influencing interest rate and availability of loanable funds for investment through central bank’s control of money supply. The process through which monetary policy decisions affect aggregate demand, gross domestic product (GDP) in real terms, and inflation is described as monetary transmission.

Monetary transmission mechanism therefore refers to the general conceptual framework, while the channel of monetary influences refers to the route through which the monetary disturbances influence the goal variables (Pierce & Tysome, 1985). Mishkin (1996) states that traditionally, six key channels of monetary policy transmission have been identified in literature. These are the interest rate channel, the money supply channel, the credit channel, the balance sheet channel, the asset price channel, the exchange rate channel and the expectations channel.

3.2 Theoretical Framework

Robinson and Robinson (1997) note that the monetary transmission mechanism is one of the least understood economic processes but yet the successful conduct of monetary policy requires a clear understanding of the process by which changes in monetary policy affect the economy. Further its precise definition varies according to
the structure of the economy and across business cycles. They explain that monetary policy transmission mechanism describes the channels through which changes in monetary policy affect the objective target. It describes how private sector agents respond to the policy actions of the monetary authorities. They state that the channels through which monetary policy are transmitted are varied and complex, depending on the financial structure, expectations, openness of the economy and production functions. In the long run they say that the price level is determined solely by the actions of the monetary authorities. They explain that this stems from the fact that the central bank alone creates the ultimate means of payments, base money, on which a monetary economy depends. By altering the terms at which this means of payment is provided, the authorities are able to determine the nominal value of transactions in the economy and hence the price level in the long run.

The analysis of the monetary transmission mechanism involves a coherent theory of the demand for money and the supply of money and how they relate to aggregate demand and output. Practically, the transmission itself and hence the conduct of monetary policy, depends on a stable money demand function (Robinson & Robinson, 1997). Theories of the demand for money had their origins in the traditional quantity theory. The Cambridge version states that the amount of money that a society holds is identical to a fraction, k, of the value of total transactions planned. This yields the famous Cambridge equation $M = kPT$. Fisher replaced k by its reciprocal, the velocity of circulation of a unit of money, to obtain the equation of exchange $MV = PT$. Building on the Cambridge approach, Keynes analysed the demand for money in terms of the transaction, speculative and precautionary
motives. His analysis however identified only two assets, money and bonds, which are perfect substitutes. Given the assumption of a two asset economy, price rigidities and a stable money demand function, interest rates in the Keynesian system, provides the conduit through which monetary impulses are transmitted to the real sector. As Pierce and Tysome (1985) note, if savings equals investment implying a goods market equilibrium, but money demand is not equal to money supply, then the rate of interest will adjust to equate the two directly by influencing the demand for idle balances and indirectly by altering investment and consumption and hence the demand for active cash balances.

However, the monetarists according to Meltzer (1995) argue that the Keynesian treatment of the demand for money is simplistic and prescribes the incorporation of a wider range of assets which are not necessarily perfect substitutes. He explains that money is therefore only one asset amongst a range of assets, which include other financial assets, physical and human capital and consumer goods. The demand for money will therefore depend on wealth, the relative return on money versus all other assets and desired expenditure. More importantly he says the monetarists believe that the relation between the quantity of money demanded, other assets and desired expenditure is stable. Given this stable relation and the fact that all markets clear, the monetarist analysis leads to the important conclusion that in the long run the change in the price level is directly proportional to the change in the money supply. As Friedman (1956) states, there is perhaps no other empirical relation in economics that has been observed to recur so uniformly as the relation between substantial changes
over short periods in the stock of money and prices. One is invariably linked with the other and in the same direction.

According to Boivin, Kiley, and Mishkin (2010), literature also makes a distinction of monetary transmission through two sets of channels; the neoclassical channels and the non neoclassical channels. They argue that the neoclassical channels focus on how interest rate changes operating through investment, consumption and trade impact the ultimate objectives while the non neoclassical channels operate primarily through change in credit supply and impact on the behaviour of banks and their balance sheets. They further argue that how these channels function in a given economy depends on the stage of development of the economy and the structure of its financial system.

Mishkin (1996) states that the channels of monetary transmission are often referred to as a black box implying that we know that monetary policy influences output and inflation but we do not know for certain how precisely it does so. He says that this is because not only different channels of monetary transmission tend to operate at the same time but also they change over time. As Bernanke and Gertler (1995) observed, the empirical analysis of the effects of monetary policy has treated monetary transmission mechanism itself as a black box. Consequently, the questions remain; does monetary policy affect the real economy? If so, what is the transmission mechanism by which these effects take place? Mohanty (2012) points out that monetary policy changes affect market interest rates such as bank lending and bank deposit rates in varying degrees over time. He explains that changes in interest rates by the monetary authorities could also induce movements in asset prices to generate
wealth effects in terms of market valuations of financial assets and liabilities. Higher interest rates can induce an appreciation of the domestic currency, which in turn, can influence net exports and, hence, aggregate demand and output. At the same time, he states that policy actions and announcements affect expectations about the future course of the economy and the degree of confidence with which these expectations are held.

Mohanty (2012) argues that regarding inflation, the level of demand relative to domestic supply capacity in the labour market and elsewhere is a key influence on domestic inflationary pressure. He explains that if demand for labour exceeds the supply, there will be upward pressure on wages, which some firms will be able to pass into higher prices charged to consumers. He further argues that exchange rate movements have a direct effect on the domestic prices of imported goods and services, and an indirect effect on the prices of those goods and services that compete with imports or use imported inputs, and thus on the component of overall inflation. Mohanty (2012) further points out that these changes affect the spending, saving and investment behaviour of individuals and firms in the economy in reference to output. Other things being the same, he argues that higher interest rates tend to encourage saving rather than spending. Equally, he explains that a higher value of currency in the foreign exchange market encourages spending by making foreign goods less expensive relative to goods produced at home. Therefore, changes in the interest rate and exchange rate affect the demand for goods and services produced.

Transmission mechanism in general is largely conditioned by the monetary policy framework, structure and depth of the financial system in which the central bank
operates and the state of real economy (Bernank & Blinder, 1988). In other words, the scheme of the transmission process in any economy begins with the discretionary actions of the monetary authorities and the response of financial aggregates (money and interest rates). The second stage involves the link between changes in financial variables, aggregate demand and prices and is the core of the transmission mechanism, which has been explained from different angles. Robinson and Robinson (1997) explain that monetary policy changes are first transmitted to the financial markets, which as the monetarists explain, arises from the fact that information and transaction costs are lower. Therefore changes in the Central Bank’s indicative short term rate (repo rate) will affect a wide spectrum of interest rates, altering the whole term structure of interest rates within the financial market. However, they note that effect of monetary policy on financial markets and hence the economy depends on economic agents’ perception of the nature of the central bank’s action and expectations about future economic developments. If agents perceive the central bank’s action as being permanent, then one can expect longer term rates to be most responsive.

According to Boivin, Kiley, and Mishkin (2010), the theoretical explanations on monetary policy transmission have evolved over the years, with major episodes of crises playing an important role in prompting revaluations of earlier tenets. They explain that Keynes in his general theory of output and employment described the importance of interest rate channel of monetary policy transmission. According to the Keynesian interest rate channel, a policy induced increase in the short term nominal interest rate leads first to an increase in longer term nominal interest rates, as
investors act to arbitrage away differences in risk adjusted expected returns on debt instruments of various maturities as described by the expectations hypothesis of the term structure. They further state that when nominal prices are slow to adjust, these movements in nominal interest rates translate into movements in real interest rates as well. Firms, finding that their real cost of borrowing over all horizons has increased, cut back on their investment expenditures. Likewise, households facing higher real borrowing costs scale back on their purchases of homes, automobiles, and other durable goods. Aggregate output and employment fall.

Boivin, Kiley, and Mishkin (2010) explain that in open economies, additional real effects of a policy-induced increase in the short-term interest rate come about through the exchange rate channel. They argue that when the domestic nominal interest rate rises above its foreign counterpart, equilibrium in the foreign exchange market requires that the domestic currency gradually depreciate at a rate that, again, serves to equate the risk-adjusted returns on various debt instruments, in this case debt instruments denominated in each of the two currencies. Furthermore, they assert that this expected future depreciation requires an initial appreciation of the domestic currency that, when prices are slow to adjust, makes domestically produced goods more expensive than foreign produced goods. Net exports fall, domestic output and employment fall as well.

Mishkin (2001) points out that asset price channels are highlighted by Tobin’s (1969) q-theory of investment and Ando and Modigliani’s (1963) life cycle theory of consumption. According to him, Tobin (1969) highlighted the importance of the cost of capital and portfolio choice in the transmission of monetary policy. He explains
that Tobin’s q measures the ratio of the stock market value of a firm to the replacement cost of the physical capital that is owned by that firm. All else equal, a policy induced increase in the short term nominal interest rate makes debt instruments more attractive than equities in the eyes of investors. Hence, following a monetary tightening, equilibrium across securities markets must be re-established in part through a fall in equity prices. With a lower value of q, firms find it less desirable to issue new shares of stock to finance new investment projects and hence, investment, output, and employment fall. The life cycle hypothesis by Ando and Modigliani (1963) emphasised the wealth effect. Mishkin (2001) explains that Ando and Modigliani’s life-cycle theory of consumption assigns a role to wealth as well as income as key determinants of consumer spending. He claims that this theory also identifies a channel of monetary transmission. If stock prices fall after a monetary tightening, household financial wealth declines as well, leading to a fall in consumption, output, and employment.

Monetarist portrayal of transmission mechanism by Friedman and Schwartz (1963) emphasised the role of money supply besides other assets. According to Meltzer (1995), asset price movements beyond those reflected in interest rates alone also play a central role in monetarist descriptions of the transmission mechanism. Boivin, Kiley, and Mishkin (2010) argue that monetarist critiques of the traditional Keynesian model often start by questioning the view that the full thrust of monetary policy actions is completely summarized by movements in the short-term nominal interest rate. They state that monetarists argue instead that monetary policy actions impact simultaneously on prices across a wide variety of markets for financial assets
and durable goods, but especially in the markets for equities and real estate, and that those asset price movements are all capable of generating important wealth effects that impact, through spending, on output and employment.

According to Bernanke and Gertler (1995), the two distinct credit channels, the bank lending channel and the balance sheet channel, allow the effects of monetary policy actions to propagate through the real economy. With regard to the bank lending channel, they state that banks play a special role in the economy not just by issuing liabilities such as bank deposits that contribute to the broad monetary aggregates, but also by holding assets such as bank loans for which few close substitutes exist. More specifically, theories and models of the bank lending channel emphasize that for many banks, particularly small banks, deposits represent the principal source of funds for lending and that for many firms, particularly small firms, bank loans represent the principal source of funds for investment. Furthermore they explain that an open market operation that leads first to a contraction in the supply of bank reserves and then to a contraction in bank deposits requires banks that are especially dependent on deposits to cut back on their lending and firms that are especially dependent on bank loans to cut back on their investment spending. In addition they state that financial market imperfections confronting individual banks and firms thereby contribute, in the aggregate, to the decline in output and employment that follows a monetary tightening.

Bernanke and Gertler (1995) describe a broader credit channel, the balance sheet channel, where financial market imperfections also play a key role. They emphasize that in the presence of financial market imperfections, a firm’s cost of credit, whether
from banks or any other external source, rises when the strength of its balance sheet deteriorates. They argue that a direct effect of monetary policy on the firm’s balance sheet comes about when an increase in interest rates works to increase the payments that the firm must make to service its floating rate debt. Additionally they say that an indirect effect arises, too, when the same increase in interest rates works to reduce the capitalized value of the firm’s long lived assets. They therefore conclude that a policy-induced increase in the short term interest rate not only acts immediately to depress spending through the interest rate channel, it also acts, possibly with a lag, to raise each firm’s cost of capital through the balance sheet channel, deepening and extending the initial decline in output and employment.

Bernanke and Gertler (1995) contested the effectiveness of interest rate channel. They argued that monetary policy affects short term interest rates but has little impact on long term interest rates which can only have large effects on purchases of durable assets, implying monetary policy ineffectiveness. They argued that the puzzle could be resolved through the credit channel of transmission. Edwards and Mishkin (1995), however, doubted the effectiveness of the bank lending channel arguing that with financial innovations, banks were becoming increasingly less important in credit markets.

Ritter, Silber and Udell (2004) argue that the Keynesians were concerned with the short run while Classical economists were concerned with the long run. Not only did they differ in the timing concept, but also their views on what caused changes in gross domestic product (GDP). According to them, the monetarists give primacy to money in explaining changes in GDP, whereas the Keynesians emphasize the role of
government expenditure to explain changes in GDP. Additionally, they state that in terms of the monetary transmission mechanism, the two groups have different ideas. They argue that the Keynesian analysis is specific about the channels through which the money supply affects economic activity. Furthermore, they explain that the Keynesians typically examine the effect of money on economic activity by building a structural model, a description of how the economy operates using a collection of equations that describe the behaviour of firms and consumers in many sectors of the economy. These equations then show the channels through which monetary and fiscal policy affect aggregate spending.

Bernanke and Gertler (1995) assert that monetarists do not describe the ways in which the money supply affects aggregate spending. They claim that monetarists examine the effect of money supply on economic activity by looking at whether movements in aggregate spending are tightly linked with movements in money supply. For that reason, they say that by using reduced-form evidence, monetarists analyze the effect of money supply on aggregate spending as if the economy were a black box whose workings cannot be seen. According to Mishkin (1996), no clear cut evidence can be made that the reduced-form evidence is preferable to structural model evidence or vice-versa. He explains that the structural model approach, used primarily by Keynesians, offers an understanding on how the economy works. If the structure is correct, it predicts the effects of monetary effects more accurately, allows predictions of the effect of monetary policy when institutions change, and provides more confidence in the direction of causation between money supply and aggregate
spending. If the structure of the model is not correctly specified because it leaves out important transmission mechanisms of monetary policy, it could be very misleading.

3.3 Empirical Literature

In the literature, there is a general recognition that monetary policy affects the real economy at least in the short run. However, there is no general agreement on the channel through which monetary policy influences the behaviour of output and prices. Lungu (2008) states that in the recent years, monetary policy transmission has been an issue of extensive research particularly since Bernanke’s seminal article in 1986 which provided alternative explanations of real and nominal sources of prices for explaining money-income relationship. However, the findings on the effectiveness of various channels of transmission remain an unresolved issue. For example Al-Mashat and Billmeier (2007) point out the importance of credit channel of monetary policy transmission in Egypt. However, Moursi, Mossallamy and Zakareya (2007) did not find support for credit channel of monetary transmission in Egypt.

This empirical literature review focuses on evidence of monetary policy transmission from studies in low income countries which are similar to the Zambian economy and focuses on recent studies as most countries liberalised their economies and this can have an impact on monetary transmission. Due to the relatively large number of low income countries, the studies are ranked according to geographic regions namely Sub-Saharan Africa, Middle East and North Africa, Asia and the Pacific and Latin America and the Caribbean. Studies from Sub-Saharan Africa will be reviewed first as this is the region Zambia hails from followed by evidence from the other regions.
Mutoti (2006) examine the transmission of monetary policy in Zambia using a cointegrated structural vector auto-regression (SVAR) model using monthly data over the sample period 1992 to 2003. This period corresponds to monetary targeting and the post liberalization era. The monthly data in this study is obtained by interpolation by means of the Chow-Lin distribution interpolation procedure. The study defines domestic output (Y) as real gross domestic product (GDP). The domestic price is Zambia’s consumer price index (CPI), whereas the measure of money stock (M2) is broad money. Domestic interest rate (R) is the 3 month Zambian Treasury bill rate and the nominal exchange rate (S) is between Zambian Kwacha and South African Rand. Accordingly, foreign price (P*) is South African CPI and the 3 month South African Treasury bill rate captures foreign interest rate (R_t^f). He adopts the Mundell-Fleming-Dornbusch model which is a well known macroeconomic model for a small open economy under flexible exchange rates. The empirical results of the study found monetary policy to have generally served to dampen inflationary pressures induced by exchange rate shocks and support is given to an exchange rate channel of transmission. This study however only concentrated on the exchange rate channel of monetary policy transmission and did not investigate the interest channel. Therefore, using a similar VAR framework there remains a need to examine the interest rate channel of monetary policy transmission.

Uanguta and Ikhide (2002) examine the transmission mechanism in Namibia using the Narrative Approach and a VAR with Cholesky ordering. They use monthly data for the period 1990 to 1999 obtained from the Bank of Namibia (BoN) and the South African Reserve Bank (SARB). They focus on the SARB’s main instrument, the repo
rate and its corresponding BoN’s bank rate. Due to the fact that Namibia maintains a currency board pegged to the South African rand, they use a recursive identification in a six variable VAR ordered (IP, CPI, L, RL, R²S, M2), where IP is private investment, CPI is the domestic price level, L is credit to the private sector, RL is the bank lending rate, R²S is the South African Reserve Bank policy rate and M2 is broad money. Structural innovations are identified using a Cholesky decomposition based on the ordering just described, relying on assumptions regarding the speed with which each variable responds to shocks. The results are deduced from two methods applied in the study, the Cumulative Forecast Error and vector auto regression Impulse Response Analysis (IRA). The empirical findings of the study show that shocks to South African Reserve Bank repo rate are transmitted to lending rates and private investment in Namibia indicating that both the interest rates and credit channels are effective.

Abradu-Otoo, Amoah and Bawumia (2003) examine the monetary policy transmission in Ghana. The main aim of this study is to have some level of understanding of how monetary policy decisions and actions affect inflation and output. They use a six variable VAR, with recursive identification ordered (P, Y, L, M2, RTB, RER), where P is inflation, Y is real output, L is credit to the private sector, M2 is money supply, RTB is the Treasury bill rate and RER is the real exchange rate. The policy variables used in the study are the Treasury bill rate and money supply. The sample period covered is from 1969 to 2002. The time series properties of the variables are assessed using the Augmented Dickey Fuller test (ADF) and the Philips-Perron (PP) test. The essence of these tests is primarily aimed at determining
whether the variables are stationary or not. The unit root test results suggest that stationarity in the variables can be induced in all the variables by differencing the data once. They compute impulse response functions (IRFs) using generalized impulse responses and are unable to identify statistically significant effects of monetary policy shocks either in the form of shocks to M2 or to the Treasury bill rate, except in the short run on the monetary policy variable itself. However, the empirical results of the study found strong evidence of monetary policy instruments affecting inflation and output in the Ghanaian economy in the long run and that the exchange rate channel remains the main medium through which monetary policy acts.

Cheng (2006) uses a five variable VAR ordered (Y, P, M3, RS, S) with a recursive and structural identification scheme to examine monetary transmission in Kenya. From the model Y is real output, P is the domestic price level, M3 is broad money, RS is the central bank policy rate and S is the nominal effective exchange rate. The study uses monthly data from January 1997 to January 2005. By estimating the VAR in levels, implicit cointegrating relationships are allowed in the data. All variables are seasonally adjusted and expressed in logarithms, except interest rates, which are in percentage terms. Standard information criteria are used to select the lag lengths of the VARs and a sequential Chow test suggests that there is no evidence of structural breaks at the 5 percent confidence level. Using the structural scheme based on Sims and Zha (1998) real output does not respond contemporaneously to any other variables in the system, the price level responds only to real GDP, the money stock responds to all variables but the exchange rate, the central bank policy rate responds
only to the money stock and the exchange rate, and the exchange rate responds to all
the other variables in the system. Under both schemes, recursive and structural, he
finds that policy driven interest rates have a considerable impact on the price level
and the foreign exchange value of the Shilling, but not on real output.

Saxegaard (2006) examines the pattern of excess liquidity in Sub-Saharan Africa and
its consequences for the effectiveness of monetary policy using non linear structural
or threshold vector autoregressive (SVAR) model. The sample of countries includes
the Central African Economic and Monetary Community (CEMAC) region, Nigeria,
and Uganda. The study employs quarterly data from the IMF’s International
Financial Statistics (IFS) over the period 1990 to 2004. He estimates four variable
threshold VARs (SVARs) ordered (Y, P, S, M0), where Y is real output, P is
inflation, S is the nominal exchange rate and M0 is base money used as the
instrument of monetary policy. The threshold variable was the existence of excess
reserves over an estimated desired level of precautionary reserves. Identification is
achieved for the policy variables by assuming that non policy variables do not react
to the policy variables, but the latter do react to the non policy variables. Tests for
non stationary behaviour using the Augmented Dickey Fuller (ADF) test indicate that
several of the variables contain a unit root. However, testing for the presence of unit
roots using the KPSS test, which has a null hypothesis of stationarity, failed to reject
the null hypothesis. Hence, the study proceeds under the assumption that the data is
stationary. The empirical results of the study indicate a money supply shock has
weaker effects on real output and inflation when bank liquidity is high in Nigeria and
Uganda with no effect in CEMAC thereby suggesting that excess liquidity weakens
the monetary policy transmission mechanism.

Lungu (2008) uses vector auto-regressions (VAR) with Cholesky ordering to assess
the process of monetary transmission mechanism in the Southern African
Development Community (SADC). The study uses monthly data in an eight variable
VAR, with recursive identification ordered \((Y, M2, M0, P, R_S, L, R_L, R_D)\), where \(Y\)
real output, \(M2\) is broad money, \(M0\) is base money, \(P\) is the domestic price level, \(R_S\)
is the bank rate \((R_S)\) controlled by the central bank as the policy variable, \(L\) is the
bank lending rate to the private sector, \(R_L\) is the bank lending rate and \(R_D\) is the
deposit rate. The main sources of data are the International Monetary Fund’s
International Financial Statistics (IFS) database and various central banks’ monthly
and quarterly reports. The study is from 1990 to 2006. All variables are expressed in
natural logarithms except for interest rates which are expressed in decimals. The
findings of the study suggest the results are mixed but generally report the existence
of a bank lending channel in all SADC countries in the sample. In the case of
Zambia, according to the findings, a change in the policy rate also leads to significant
positive changes in the monetary base. In Zambia loan supply is insensitive to policy
rate changes throughout the period of the study. The relationship between policy rate
and loan supply is positive but insignificant. Furthermore, the policy rate change
does not significantly affect output, prices and money supply variables throughout
the period of the study. For the SADC region in general, while the bank lending rate
and deposit rate respond to innovations in central bank policy rate, the impact on the
domestic price level, real output and the bank lending rate to the private sector is limited.

Buigut (2009) employs the vector auto-regression (VAR) model with Cholesky ordering to conduct a study to assess the importance and similarity of the interest rate channel for the East African Community (EAC) countries. The sample of countries includes Kenya, Tanzania and Uganda. The data used is annual time series data sourced from the International Financial Statistics (IFS CD Rom). He uses a three variable recursive VAR of the form \((Y, CPI, R_S)\), where \(Y\) is real output, CPI is inflation and \(R_S\) is a short term interest rate. The series cover the period from 1984 to 2006 for Kenya, 1985 to 2005 for Uganda and 1984 to 2005 for Tanzania. To test for the presence of unit roots, the data is examined using the Augmented Dickey Fuller (ADF) test. The ADF test failed to reject the null hypothesis of a unit root at 1% level of significance in the log level of all the variables. However the test statistics reject the null hypothesis of a unit root after differencing the variables once. Therefore all variables included in the model are integrated of order one. The findings of the study show that the effect of a monetary policy shock on output and inflation are not significant. The main implication to be drawn from the study is that the interest rate channel may not be so important for this region at this stage due to the underdeveloped nature of the money markets which restricts the importance of this channel.

Ngalawa (2009) investigates the process through which monetary policy affects economic activity in Malawi using a seven variable VAR ordered \((Y, P, M0, M3, L, RS, S)\) with a recursive and structural identification scheme. \(Y\) is real output, \(P\) is the
domestic price level measured by the all items national composite consumer price index with base year 2000, M0 is base money measured as total cash reserves held by the central bank, vault cash in commercial banks and currency held by the non-bank public, M3 is broad money measured by the currency in circulation, demand deposits and time deposits, L is bank lending to the private sector which captures commercial bank loans, RS is the bank rate, also known as the policy variable, defined as the rate at which the central bank provides short term loans to commercial banks and discount houses in its function as a lender of last resort and S is the nominal exchange rate of the Malawi Kwacha to the United States Dollar (USD) is used as a proxy for exchange rate. The study employs monthly time series data for the period 1988 to 2005. The time series properties of the data are assessed using the Augmented Dickey Fuller (ADF) unit root test. The unit root test results indicate that all the variables contain a unit root and are therefore not stationary. However, after differencing the data once, the null hypothesis of a unit root is rejected and the variables become stationary. Ngalawa conducted his estimations using several restricted models in addition to the seven variable model and found that real output does not respond to any other variables in the system, the price level responds only to real GDP, bank loans respond to all the other variables in the system, the exchange rate responds contemporaneously only to real output and the price level, broad money responds to real output, the price level and the bank rate, the bank rate responds only to the exchange rate, and reserve money responds to all variables except real GDP and the price level. The overall results of the study indicate that shocks to bank rate affect bank lending to the private sector, real output, and the
domestic price level in the theoretically expected direction, but none of the impulse response functions (IRF) are statistically significant.

In the Middle Eastern and North African (MENA) developing countries, we focus on a study by Al-Mashat and Billmeier (2007) who examined the monetary transmission mechanism in Egypt using a vector auto-regression (VAR) model. They built on the Moursi, Mossallamy, and Zakareya (2007), also known as MMZ, analysis for Egypt by using their measure of the intermediate target of monetary policy in a VAR with the form \((\text{OIL}, \text{FF}, \text{Y}, \text{P}, \text{R}, \text{ER})\), where \(\text{OIL}\) is the international oil price and \(\text{FF}\) is the US Federal Funds rate. These variables are both treated as exogenous in the VAR, and \(\text{R}\) is the monetary policy indicator constructed by MMZ. They achieve identification through the recursive ordering \((\text{Y}, \text{P}, \text{R}, \text{ER})\) among the endogenous variables where \(\text{Y}\) is a measure of economic activity, \(\text{P}\) is the price level and \(\text{ER}\) is the exchange rate. The study uses monthly observations running from January 1996 to June 2005.

The time series properties of the data are assessed using the Augmented Dickey Fuller (ADF) test. The null hypothesis of a unit root cannot be rejected for the four variables in the VAR model in levels but become stationary after differencing them once. Therefore, the variables are integrated of order one. The study also uses Granger-causality tests to examine the causal links between monetary policy and economic outcomes (prices and output). The evidence suggests a significant effect of the nominal effective exchange rate on both output and prices. The main findings of the study suggest that the responses of prices and output to a monetary policy shock are in the right direction, but neither effect is statistically significant over any
horizon. In other words, the interest rate channel is underdeveloped while the exchange rate channel plays a strong role in propagating monetary shocks to output and prices. In addition, the bank lending and asset price channels are relatively weak.

Various studies have also examined transition economies for monetary policy transmission in Asia, Pacific, Latin America and the Caribbean. We include them in this literature review due to their focus on low income developing countries and small open economies that are similar to the economy of Zambia.

Isakova (2008) examines monetary policy efficiency in Central Asia by investigating the monetary transmission mechanism in the region’s economies. She looks at the reduced form effects of policy changes on indicators of aggregate demand in Kazakhstan, the Kyrgyz Republic, and Tajikistan using a five variable vector autoregression (VAR) with Cholesky ordering of the form \((Y, P, M, R, S)\) and a recursive identification following this ordering. \(Y\) represents real income, \(P\) is price indices (CPI), \(M\) is the monetary aggregates, \(R\) is the policy rate and \(S\) is the nominal exchange rate to the U.S dollar. The sample uses monthly data and the period covered varies from 1995 to 2006 for Kazakhstan, 1995 to 2006 for Kyrgyz Republic and from 2001 to 2006 for Tajikistan. All variables are transformed into natural logarithms except interest rates. The time series properties of the data are assessed using the Augmented Dickey Fuller (ADF) unit root test. The ADF test results show that all variables are non-stationary and are integrated of order one to make them stationary except for interest rates which are not transformed. Therefore, first differences of these series are used in the VAR estimation. The results of the study found that even though changes in policy rates are effectively passed through to
market interest rates, weak responses of prices and output to innovations in the policy rate suggested that the bank lending channel has been weak and unimportant. The interest rate channel is however a relatively important and effective channel of monetary policy transmission in these countries.

Dabla-Norris and Floerkemeier (2006) examine monetary policy transmission in Armenia. They examine the relationships between monetary policy variables and both output and prices in Armenia by using a five variable vector auto-regression (VAR) model with Cholesky ordering of the form (Y, P, R, M, S), where Y is real output, P is the domestic price level, R is the repo rate or the short term interest rate used by the Central Bank of Armenia to signal its monetary policy stance, M is narrow money which is the measure of money supply and S is the nominal effective exchange rate to examine the effects of exchange rate changes on output and prices. The vector of exogenous variables is given by world oil prices and the US Federal Funds rate. They use monthly data from May 2000 to December 2005. The time series properties of the data are assessed using the Augmented Dickey Fuller (ADF) unit root tests. The ADF test results suggest that the null hypothesis of a unit root cannot to be rejected. The variables are then differenced once in order to make them stationary and are therefore said to be integrated of order one. The study also uses multivariate and bivariate block Granger causality tests to examine the causal links between monetary policy and economic outcomes. Overall, the results suggest the joint significance of all three policy variables for output and prices. The bivariate tests indicate that monetary aggregates have a significant Granger effect on output but not on prices. In other words monetary aggregates affect output, but not prices.
and repo rates affect prices, but not output. After examining the interest rate channel, the results indicate that the lending rate responds immediately and significantly to an unexpected change in the repo rate. However, output and prices do not respond significantly to lending rate shocks. These results highlight the weakness of the interest rate channel in Armenia, as changes in bank lending rates do not affect economic activity and prices.

Samkharadze (2008) employs a vector auto-regression (VAR) approach with Cholesky ordering to investigate the role of the different channels of the monetary transmission mechanism in Georgia. A five variable recursive VAR of the form \((Y, P, RL, M, S)\) is estimated where \(Y\) is real domestic output, \(P\) is the domestic consumer prices index, \(RL\) is the domestic lending rate, \(M\) is the monetary aggregate used as the measure of money supply and is also the policy variable and \(S\) is the nominal effective exchange rate. The vector of exogenous variables is given by the total remittances of Georgian migrants and the consumer price indices of Turkey and Russia. The study uses monthly data for the period from June 2002 to May 2007. To test the stationarity of the macroeconomic variables the Augmented Dickey Fuller (ADF) test is conducted, followed by Durbin's alternative test for serial correlation. The latter ensures precision of the ADF test. The results showed that the null hypothesis of a unit root cannot be rejected and therefore the variables were differenced once. Particularly the variables were found to be integrated of order one. The main findings suggest that there are significant effects of monetary aggregates on inflation and real GDP, but no coherent effects of bank lending rates or loan supply on these variables. The lending rate was found to have a negative and
significant effect on the price level. This result implies that the interest rate channel is significant in Georgia.

Agha, Ahmed, Mubarik and Shah (2005) use vector auto-regressions (VAR) with Cholesky ordering to examine the monetary transmission mechanism in Pakistan covering the period from July 1996 to March 2004. They use a six variable recursive VAR ordered (IPI, P, L, REER, KSEI, TB6), where IPI is the Industrial Production Index used to as a proxy for real output, P is the domestic price level, L represents private sector loans, REER is the real effective exchange rate, KSEI is the Karachi Stock Exchange 100 Index and TB6 is the 6 month Treasury bill rate which is the measure of the stance of monetary policy. All the variables are seasonally adjusted and are in log form except the 6 month Treasury bill rate. Their empirical results provide evidence that suggest a positive shock to the Treasury bill rate reduces real output but increase the price level which indicate that the interest channel is an important transmission channel for monetary policy. In addition to the interest rate channel, the results point to a transmission mechanism in which banks play an important role. They also found an active asset price channel. The exchange rate channel has been less significant by comparison.

Mohanty (2012) uses a standard structural vector auto-regression (SVAR) approach to empirically examine the interest rate channel of monetary policy transmission in India. The study was undertaken using quarterly data from 1996 to 2011. He uses a four variable VAR ordered (Y, P, M, RS), with a structural identification scheme where Y is real output, P is the domestic price level, is money supply and RS is the repo rate which is the policy variable. The time series properties of the variables are
assessed using the Augmented Dickey Fuller (ADF) unit root test and the Zivot Andrews (ZA) test which allows for structural breaks in the series. The results of the tests show that all variables were found to be non stationary in levels and became stationary after being differenced once. With the exception of the interest rate variable, all other variables are seasonally adjusted and enter the model in log-first differenced form. He also carries out Granger-causality tests and the results generally suggest significant unidirectional causality running from changes in policy rate to output, inflation and a quantity variable such as money or credit indicating that changes in policy rates does impact overall economic activity. The empirical results from the SVAR model indicate that policy rate increases have a negative effect on output growth. These findings underline the importance of the interest rate channel in the transmission of monetary policy in India.

Disyatat and Vongsinsirikul (2003) study the monetary transmission mechanism in Thailand using the vector auto-regression (VAR) approach with Cholesky ordering. They use quarterly data from 1993 to 2001. In their basic model they used a three variable recursive VAR of the form (Y, P, RP14), where Y is real output, P is the domestic price level and RP14 is the fourteen day repurchase rate which they assumed to be the measure of monetary policy. The exchange rate is used as the exogenous variable. The basic model was then extended to construct a single VAR that summarized the key aspects of the monetary transmission mechanism in Thailand. The summary VAR thus contains investment, consumption, prices, RP14, and bank credit in that order. The time series properties of the data are assessed using the Augmented Dickey Fuller (ADF) test and the null hypothesis of a unit root could
not be rejected in levels. Therefore, the variables were differenced once suggesting that stationarity was induced by differencing the data once. The main results of the study found that in addition to the interest rate channel, banks play an important role in monetary policy transmission mechanism, while exchange rate and asset price channels were relatively less significant.

Jayaraman and Choong (2008) carry out an empirical study of transmission mechanism of monetary policy in Fiji using quarterly data from 1990 to 2006. They employ a six variable vector auto-regression recursive (VAR) ordered (PIR, M2, CRE, P, RGDP), where PIR is the short term interest rate which represents the monetary stance of the central bank, M2 is broad money, CRE is private credit, E is the nominal exchange rate, P is the price level and RGDP is real output. To investigate the time series properties of each of the variables in the study, they employ the Augmented Dickey Fuller (ADF) test and Ng-Perron MZ test, which are based on the null hypothesis that a unit root exists in the auto-regressive representation of the time series. The results of the unit root test indicate that variables are non stationary in levels. However, both Augmented Dickey Fuller (ADF) and Ng and Perron unit root tests indicate that RGDP, M2, CRE, E, PIR and CPI are integrated of order one and are therefore stationary. The findings of the study indicate that from the transmission channels investigated, the interest rate channel is not the principal conduit of monetary policy shocks and that the money supply channel is the most dominant channel in Fiji.

Hung (2008) analyzes the monetary transmission mechanism in Vietnam using the vector auto-regression (VAR) approach with Cholesky ordering. He uses quarterly
data from 1996 to 2005. The basic model includes a recursive three variable VAR ordered (Y, CPI, M2), where Y is real output proxied by real industrial output, CPI is the domestic price level and M2 is broad money which he took as a proxy for monetary policy shocks. The vector of exogenous variables included oil, rice, and the Federal Funds Rate. In order to analyze the effect of the interest rate channel, he adds the variable real lending rate (RIR) to the basic model and the ordering becomes (Y, CPI, RIR, M2) while that of the vector of exogenous variables does not change. The same procedure was followed when analysing the exchange rate channel and the credit channel by adding the variables real effective exchange rate and domestic credit to the basic model respectively. The Augmented Dickey Fuller (ADF) test, which was the unit root test used to analyse the time series properties of the data, showed that all the variables are non stationary. Therefore, the variables were transformed to eliminate non stationarity by taking differences of the natural logarithm of the variables and multiplying by 100 which is equivalent to running VAR in percentage changes of the variables. After transformation, all the variables were stationary. The results of the study suggest that monetary policy can affect output and price level and that the effect of monetary policy on output was strongest after four quarters but it took longer for monetary policy to have effects on the price level. Although the significance of each channel was weak, the exchange rate and credit channels were most significant.

Acosta-Ormaechea and Coble (2011) empirically study the monetary policy transmission in Chile, New Zealand, Peru and Uruguay. In the case of Chile, the sample starts from September 1999 to November 2010. For New Zealand, it starts
from April 1999 to September 2010. For Peru, the sample starts in September 2003 going through November 2010. Finally, for Uruguay it starts in January 2006 going through November 2010. The study uses a three variable vector auto-regression (VAR) model to analyse the interest channel. The benchmark model takes the following form \((R_t, IP_t, CPI_t)\), where \(R_t\) is the money market rate also known as the policy variable, \(IP_t\) is the year on year change of an index of economic activity and \(CPI_t\) represents the annual inflation rate. The vector of exogenous variables is in turn given by \((FF_t, WCPI_t, IP_t)\), where \(FF_t\) is the Federal Funds rate, \(WCPI_t\) is the year on year change of the world commodity price index, and \(IP_t\) is the U.S. industrial production index gap. In order to analyze the effect of the exchange rate channel, a slightly different version of the VAR model is estimated. It is now ordered \((NEER_t, IP_t, CPI_t, R_t)\), where \(NEER\) is the nominal effective exchange rate. The vector of exogenous variables does not change. All the variables are transformed into natural logarithms except for the money market rate. The main findings of the study suggest that the interest rate channel was found to be more important in Chile and New Zealand while the exchange rate channel played a more substantial role in controlling inflationary pressures in Peru and Uruguay.

Robinson and Robinson (1997) explore the channels through which monetary policy is transmitted in Jamaica using an eight variable recursive VAR of the form \((RS, R_{TB}, M0, L, M3, S, P, Y)\), where \(RS\) is the repo rate, \(M0\) is the monetary base, and \(M3\) is broad money. The other variables included are the Treasury bill rate \(R_{TB}\), bank lending to the private sector \(L\), nominal exchange rate \(S\), \(P\) is the domestic price level and \(Y\) is real output. The study uses monthly observations on each
variable from 1991 to 1996. The time series properties of the data are assessed using the Phillips Peron (PP) unit root test. The unit root test results indicate that only real GDP over the period was stationary. The other variables are integrated of order one. Consequently, the variables with the exception of real output, enter the model in first differences. Their empirical results provide evidence through impulse responses which suggest a positive short run response of real activity to monetary tightening in the form of an increase in the repo rate, as well as a sustained price puzzle. They did not report confidence intervals for these impulse response functions (IRF). Hence, the analysis points to a process where monetary policy impulses are transmitted by both the interest rate channel and the credit channel.

3.4 Summary

Although there is evidence of the interest rate channel of monetary policy transmission in the various studies reviewed in this study, literature on monetary transmission in Zambia is still in a growing stage, though in recent times, quite a few studies using traditional vector auto-regression (VAR) and structural vector auto-regression (SVAR) approaches have been conducted. However, these studies revealed evidence of the existence of the exchange rate channel and bank lending channel of monetary policy transmission as they heavily focussed on these channels of transmission. Against this background, there is a need to critically investigate the interest rate channel of monetary policy transmission in Zambia to establish its effectiveness. Therefore, this study investigates the effectiveness of the interest rate channel of monetary policy transmission in Zambia based on a vector auto-regression (VAR) framework.
4. METHODOLOGY

The aim of this chapter is to present the research methodology used in this study. It discusses the sources, description and how the time series properties of the data will be determined, the lag selection criteria, the stability and Granger causality tests. Lastly, it explains and discusses the analysis that will be conducted in the VAR model.

4.1 Introduction

According to Cheng (2006), it has become customary to investigate the effects of monetary policy using a VAR methodology. This is based on a set of macroeconomic variables that include an indicator of aggregate demand and the assumed intermediate target of monetary policy. Lungu (2008) explains that the choice of the vector auto-regression (VAR) approach is inspired by the existence of empirical literature using VARs to examine the monetary transmission in Africa, Europe and Asia focusing on reduced-form relationships between monetary policy and macroeconomic variables. Morsink and Bayoumi (1999) observe that the VAR approach allows us to place minimal restrictions on how monetary shocks affect the economy, which given the lack of consensus about the workings of the monetary transmission mechanism is a distinct advantage.

In addition, this approach recognizes explicitly the simultaneity between monetary policy and macroeconomic developments, the dependence of monetary policy on economic variables as well as the dependence of economic variables on monetary policy. This study examines the interest rate channel of the monetary transmission using the vector autoregressive model following Buigut (2009), Dabla-Norris and
Floerkemeier (2006), Hung (2008) and Samkharadze (2008) who investigate the interest rate channel of monetary policy transmission in the East African Community (EAC) Monetary Union, Armenia, Vietnam, and Georgia, respectively, in a similar framework using annual, monthly and quarterly data.

4.2 Data Sources and Description

The research to be carried out is a quantitative desk research as it will employ secondary numerical time series data. The study will use annual data from the year 1980 to 2011, obtained from World Bank Development Indicators (WDI), the International Monetary Fund World Economic Outlook Database (WEO), and Bank of Zambia (BoZ) publications which were the main sources of data. The variables that will be used in this study include real output (GDP), inflation (CPI), real interest rate (RIR) and money supply (M2).

4.2.1 Policy Variable

The study considers the effects of broad money (M2) as the policy instrument which is the policy variable used by the Bank of Zambia to signal its monetary policy stance. As suggested by Sims and Zha (1998), the quantity of money can be used as a measure of monetary policy when the official rate has been relatively constant, as has been the case in Zambia. More importantly, Simatele (2004) states that 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. Evidently, this variable has previously been used as a measure of monetary policy in a similar study in Ghana by Abradu-Otoo, Amoah, and Bawumia (2003) among others.
4.2.2 Macroeconomic Variables

The main macroeconomic variables that reflect the effects of monetary policy are real Gross Domestic Product (GDP) and inflation as measured by the Consumer Price Index (CPI). Output or real GDP is measured by taking GDP in billions of Zambian Kwacha (ZMK) at constant 1994 prices. Output levels are included in order to estimate the impact of monetary policy on output. The choice to use GDP as one of our variables is based on Christiano, Eichenbaum and Evans (2004) who argue that the final goal for monetary policy is to achieve optimum output and employment. Therefore, to estimate the impact of monetary policy on output, output levels are included. This variable has indeed been used in similar studies by Morsink and Bayoumi (2001), Cheng (2006), Jayaraman and Choong (2008) and Isakova (2008) among others.

The second macroeconomic variable is inflation measured by the end of period (annual) Consumer Price Index with 1994 as the base year. This variable is included based on the fact that central banks aim at guaranteeing price stability by controlling the money supply. Similar studies by Uanguta and Ikhide (2002), Agha, Ahmed, Mubarik and Shah (2005), Buigut (2009) and Acosta-Ormaechea and Coble (2011) have used this variable.

The third macroeconomic variable is the real interest rate variable measured as the bank lending rate minus inflation rate in the same period. This variable is included based on Dabla-Norris and Floerkemeier (2006) who explain that it is used in modelling the interest rate channel of monetary policy transmission. Buigut (2009), Hung (2008) and Samkharadze (2008) have all used this variable in similar studies.
4.3 Stationarity Tests

To test the time series properties of the data, stationarity tests will be done using the Augmented Dickey-Fuller (ADF) test and the Dickey-Fuller test with GLS detrending (DFGLS). A time series variable is stationary when it has a finite mean, variance and auto-covariance function that are all independent of time. Stationarity is essential for standard econometric theory. Without it we cannot obtain consistent estimators which in turn give doubtful or spurious regression results.

4.3.1 Augmented Dickey-Fuller (ADF) Test

Examining the ADF test, Gujarati (2003) explains that the ADF test consists of estimating the following equation:

\[ \Delta Y_t = \alpha_0 + \alpha_2 t + \delta Y_{t-1} + \sum \beta_i \Delta Y_{t-i} + \epsilon_t \]  

(1)

Where \( \alpha_0 \) is the intercept, \( t \) is trend, \( \epsilon_t \) is a pure white noise error term and where \( \Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3}), \) etc. The number of lagged difference terms to be included is often determined empirically, the idea being to include enough terms so that the error term in equation (1) is serially uncorrelated. The null hypothesis is that \( \delta = 0 \); that is, there is a unit root and therefore the time series is non stationary. The alternative hypothesis is that \( \delta \) is less than zero; that is, the time series is stationary. If the null hypothesis is rejected, it means that \( Y_t \) is a stationary time series.
4.3.2 Dickey-Fuller Test with GLS Detrending (DFGLS)

Elliott, Rothenberg and Stock (1996) modified the ADF test to come up with the DFGLS test. According to Sun (2010), the basic idea of the DFGLS test is to detrend data before applying the ADF unit root tests. The only difference is that the DFGLS test substitutes the GLS detrended $y_t^d$ for the original $y_t$. The DFGLS equation is given as:

$$
\Delta y_t^d = \alpha y_{t-1}^d + \beta_1 \Delta y_{t-1}^d + \ldots + \beta_p \Delta y_{t-p}^d + \varepsilon_t
$$

(2)

Where $\varepsilon_t$ is a pure white noise error term. No constant or trend term is included in equation (2) since the $y_t^d$ are detrended. Like the ADF test, we consider the t-ratio for $\alpha$ from equation (2). The null hypothesis is that $\alpha = 0$; that is, there is a unit root and therefore the time series is non stationary. The alternative hypothesis is that $\alpha$ is less than 0; that is, the time series is stationary. If the null hypothesis is rejected, it means that $y_t^d$ is a stationary time series.

4.4 Lag Selection Criteria

The lag length of the VAR estimation will be selected using the Akaike Information Criterion (AIC), Schwartz Bayesian criterion (SBIC), Hannan-Quinn Information Criteria (HQIC) and the Log Likelihood Ratio (LR). In the literature, the importance of lag length determination is demonstrated by Braun and Mittnik (1993) who show that estimates of a VAR whose lag length differs from the true lag length are inconsistent as are the impulse response functions and variance decompositions derived from the estimated VAR.
4.5 Stability Test

According to Phaff (2008), one important characteristic of a VAR model is its stability. He explains that if the VAR model is stable, it generates stationary time series with time invariant means, variances and covariance structure, given sufficient starting values. The stability test of the VAR model will be done using the inverse root of the characteristic autoregressive (AR) polynomial. The estimated model is considered stable if all the roots have modules less than one and lie within the unit circle. If the model is not stable, some roots will lie outside the circle, in which case certain results such as impulse response standard errors are invalid.

4.6 Cointegration Test

Buigit (2009) observes that when testing for cointegration among the variables, the Johansen (1988) procedure is usually used to test the presence and the number of cointegration relations in the system. It considers a model where we have a vector of variables \( [Z_t] \) which are endogenous. The generalized specification of an unrestricted VAR is given as follows:

\[
Z_t = A_k Z_t + \ldots + A_m Z_{t-k} + \partial + \nu_t
\]  

Where \( Z_t \) is a \((n\times 1)\) matrix which means the VAR model has \( n \) variables, \( k \) is the lag length, \( \partial \) is the deterministic term and \( \nu_t \) is the error term. This unrestricted VAR can be used to estimate dynamic relationships among jointly endogenous variables.

In making inferences about the number of cointegrating relations, two statistics known as the trace statistic and the maximum eigen value statistic are used. The trace statistic, \( \lambda_{\text{trace}} \), a likelihood ratio test statistic, tests the null hypothesis that the
number of distinct cointegrating vectors is less than or equal to \( r \) against a general alternative. This value is equal to zero when all \( \lambda_i = 0 \). The further away the estimated roots (eigenvalues) are from zero the more negative is the \( \ln(1 - \lambda_i) \) and the larger the trace statistic. The trace statistic is determined using the following formula:

\[
\lambda_{\text{trace}} = -T \sum_{i=r+1}^{n} \ln (1 - \lambda_i)
\]  

(4)

Where \( T \) is the number of observations and \( \lambda_i \) is the \( i^{\text{th}} \) eigenvalue. The null and alternative hypotheses are given as \( H_0: r = 0 \), \( H_1: r > 0 \); \( H_0: r \leq 1 \), \( H_1: r > 1 \); \( H_0: r \leq 2 \), \( H_1: r > 2 \); etc.

An alternative is the maximum eigenvalue test statistic \( (\lambda_{\text{max}}) \), which tests the null that the number of cointegrating vectors is \( r \) against the alternative of \( r + 1 \) cointegrating vectors. The maximum eigenvalue statistic is determined using the following formula:

\[
\lambda_{\text{max}}(r, r + 1) = -T \ln (1 - \lambda_{r+1})
\]  

(5)

The null and alternative hypotheses are given as \( H_0: r = 0 \), \( H_1: r = 1 \); \( H_0: r = 1 \), \( H_1: r = 2 \); \( H_0: r = 2 \), \( H_1: r = 3 \); etc.

To make inferences regarding the number of cointegrating relationships, the trace and maximum eigenvalue statistics are compared with the critical values. If the calculated value is greater than the critical value, the null hypothesis of no cointegration is rejected and equation (3) is reformulated into a Vector Error Correction Mechanism (VECM) as specified in equation (6).
According to Buigut (2009), the VECM considers information about the cointegration by combining both the short run and long run effects as the error correction term. Following Buigut (2009), we define a VECM for Zambia and let $Z$ be the vector of endogenous variables in time period $t$, such that $Z_t = (\text{GDP}_t, \text{CPI}_t, \text{RIR}_t, \text{M2})$, where GDP is real output, CPI represents inflation, RIR is real interest rate and M2 is money supply. The vector error correction is specified as:

$$
\Delta Z_t = \sum \Gamma_i \Delta Z_{t-i} + \Pi Z_{t-k+1} + \delta + \varepsilon_t
$$

Where $\Pi = a\beta$; $a$ is the loading matrix and contains the short run dynamics and $\beta$ is the matrix containing the long run equilibrium relationships. $\delta$ is the deterministic term and $\varepsilon_t$ is the error term.

### 4.7 VAR Analysis

In the approach used in this study, we first estimate the general VAR model. In the event that there is no cointegration, the unrestricted VAR will be estimated. On the other hand, the Vector Error Correction (VEC) model which is a restricted VAR will be estimated if there is cointegration. Secondly, we generate impulse responses. Thirdly, we estimate variance decomposition estimates. The basic VAR model has the following specification:

$$
Y_t = A(L)Y_{t-1} + B(L)X_t + U_t
$$
Where $\mathbf{Y}_t$ is a vector of endogenous variables; $\mathbf{X}_t$ is a vector for exogenous variables; and $A(L)$ and $B(L)$ are polynomials of the lag operator while estimating model (7).

In estimating VAR models the choice of identification is important and most studies reviewed used standard Choleski decomposition. Samkharadze (2008) states that for Choleski identification scheme the order of the variables becomes important, as different ordering may give different results. Christiano, Eichenbaum and Evans (1999) state that under a Choleski decomposition, the relationship among the reduced-form innovations is assumed to be recursive, so that if variables are ordered according to their place in the recursive chain, the reduced-form innovation in the first variable is assumed to be structural, while that in the second is a structural innovation in the second variable combined with a contemporaneous response to the structural innovation in the first variable, that of the third is a structural innovation in the third variable combined with a contemporaneous response to the structural innovations in the first two variables, and so on. They refer to this as the recursiveness assumption.

In choosing the order of the endogenous variables for the basic VAR model, we follow Hung (2008) who proposes the following order for small open economies:

$$\mathbf{Y}_t = (\text{GDP}_t, \text{CPI}_t, \text{M}_2_t)$$

(8)

Where GDP stands for real output, CPI for represents inflation and M2 is the measure of money supply. The ordering of the variables is based on the assumption that a shock to the monetary policy variable M2 would be transmitted to price level
and output. According to Samkharadze (2008), this is done to reflect the likely degree of endogeneity of the policy variable to current economic conditions. Taylor (1995) suggests that in analyzing the monetary transmission mechanism, one should focus on financial market prices; short term interest rates, bond yields, exchange rates, and so on rather than on financial market quantities; money supply, bank credit, the supply of government bonds, foreign denominated assets, and so on. However, the prime interest rate that the Bank of Zambia frequently announces does not reflect the supply of and demand for money in the money market as it serves as a reference rate for commercial banks in setting their own deposit and lending rates. Therefore, broad money (M2) is used as a proxy for monetary policy shocks as interest rates do not seem to be a suitable representative monetary policy stance in Zambia during the time period of this study.

Some studies include a vector of exogenous variables. Peersman and Smets (2001) explain that including the vector of exogenous variables is done in order to control for changes in world demand and inflation.

Following Hung (2008), we add the variable real interest rate (RIR_t) to the basic model in order to analyze the effect of the interest rate channel. The ordering of the VAR now becomes:

\[ Y_t = (GDP_t, CPI_t, RIR_t, M2_t) \]  

(9)

According to traditional Keynesian economics, an increase in real interest rate discourages investment and eventually leads to a decrease in output. Therefore, the ordering in equation (9) reflects the fact that a change in the money supply would
affect the real interest rate which would in turn affect investment. In empirical applications, the main uses of the VAR are Granger causality tests, impulse response analysis and variance decomposition analysis.

4.7.1 Granger Causality Test

To test whether there is any association between, output, inflation, interest rates and money supply, multivariate Granger causality tests will be conducted. Granger causality analysis (GCA) is a method for investigating whether one time series can correctly forecast another (Granger, 1969). The concept of Granger causality relates to whether one variable can help improve the forecast of another. According to Liu and Bahadori (2012), the regression formulation of Granger causality states that a variable X is the cause of another variable Y if the past values of X are helpful in predicting the future values of Y. They explain that a multivariate auto regression is performed to predict the target time series $X_1$ as follows:

$$X_1(t) = \sum_{i=1}^{p} a_i^T X_i^{\text{Lagged}} + e_1$$

(10)

Where $a_i = [a_{i1}, \ldots, a_{iL}]$ is the vector of coefficients modeling the effect of the $i^{th}$ time series on the target time series and $X_i^{\text{Lagged}} = [X_i(t - L), \ldots, X_i(t - 1)]$ is the lagged part of the time series. The coefficients $a_i$ in equation (10) can be obtained by minimizing the squared loss. Performing a statistical significance test on the value of coefficients identifies the Granger causes of the target series. That is, if any of $a_i$ is non zero, then we can say $X_i$ Granger causes $X_1$. 
4.7.2 Impulse Response Analysis

The main results drawn from the VAR are through the impulse response analysis (IRA). According to Uanguta and Ikhide (2002), IRA seeks to answer the question, how do the modeled variables respond to any innovations or shock in the economy? Impulse response indicates how a shock to any one variable filters through the model to affect every other variable and feeds back to the original variable itself. In other words, they explain that impulse response functions (IRFs) trace the effects of a shock to an endogenous variable on the variables in the VAR. IRFs are used to uncover responses of the main macroeconomic variables to a monetary policy shock.

4.7.3 Variance Decomposition Analysis

Lastly, through variance decomposition, our results provide an insight to policymakers on how long and by what magnitude monetary policy takes to affect each variable. In other words, the variance decomposition tells us what percentage of variance of one variable is due to shocks in another variable and how this proportion changes over time. According to Peersman and Smets (2001), variance decomposition provides a different method of depicting the system dynamics. They explain that it decomposes variation in an endogenous variable into the component shocks to the endogenous variables in the VAR. In addition, the variance decomposition gives information about the relative importance of each random innovation to the variables in the VAR and will help to make inferences about monetary policy transmission.
5. INTERPRETATION AND ANALYSIS OF EMPIRICAL RESULTS

This chapter discusses and analyses the findings of this study. All the time series data were first captured in Microsoft Excel and then imported to E-Views. The summary statistics for the variables used in the VAR models are presented in Table 5.1.

Table 5.1: Descriptive Statistics of Variables Used in the VAR Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Obs</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNM2</td>
<td>3.37943</td>
<td>3.367311</td>
<td>0.836409</td>
<td>1.180182</td>
<td>4.620059</td>
<td>32</td>
</tr>
<tr>
<td>LNGDP</td>
<td>9.30803</td>
<td>9.239399</td>
<td>0.198895</td>
<td>9.084426</td>
<td>9.832320</td>
<td>32</td>
</tr>
<tr>
<td>LNCPI</td>
<td>0.88114</td>
<td>2.295041</td>
<td>3.483880</td>
<td>-4.828314</td>
<td>4.765996</td>
<td>32</td>
</tr>
<tr>
<td>RIR</td>
<td>-1.50796</td>
<td>5.323445</td>
<td>18.46423</td>
<td>-41.79024</td>
<td>25.11584</td>
<td>32</td>
</tr>
</tbody>
</table>

Note: M2 is money supply, GDP is real output, inflation is CPI and RIR is real interest rate. All the variables are used in natural logarithms except the real interest rate, which is expressed in percentage form.

5.1 Stationarity Tests

Stationarity is essential for standard econometric theory and without it, we cannot obtain consistent estimators which in turn give doubtful or spurious regression results. In order to test for the presence of unit roots, the data is examined using the Augmented Dickey Fuller (ADF) test and the Dickey-Fuller test with GLS detrending (DFGLS).
5.1.1 Augmented Dickey Fuller (ADF) Test

Table 5.2 shows that the ADF test failed to reject the null of a unit root at 5% level of significance in log levels of all the variables. However, the test statistics reject the null of a unit root in first difference for all the variables except inflation.

Table 5.2: Augmented Dickey Fuller Unit Root Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF (levels)</th>
<th>ADF (first difference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNM2</td>
<td>-1.656439</td>
<td>-6.182219**</td>
</tr>
<tr>
<td>LNGDP</td>
<td>2.288588</td>
<td>-3.712552**</td>
</tr>
<tr>
<td>LNCPI</td>
<td>-2.105625</td>
<td>-1.710701</td>
</tr>
<tr>
<td>RIR</td>
<td>-1.515685</td>
<td>-5.254456**</td>
</tr>
</tbody>
</table>

Note: ** indicates statistical significance at 5% level with a critical value of -2.96. The regressions for testing the stationarity were conducted with only a constant term.

5.1.2 Dickey-Fuller Test with GLS Detrending (DFGLS)

The Dickey-Fuller test with GLS detrending (DFGLS) was also conducted as shown in Table 5.3 to further test for the presence of unit roots. The DFGLS test failed to reject the null of a unit root at 10% level of significance for all the variables except GDP. However, the test statistics reject the null of a unit root in first difference for all the variables. Thus, all the variables included in the VAR models are therefore integrated of order one. This suggests that stationarity in the variables can be induced in all the variables by differencing the series once. The implication of these results is that all variables entering the VAR model will appear as rates of change. This
conclusion can be made because the DFGLS test has substantially higher power than the ADF test. Hence, this test is referred to as an efficient unit root test.

Table 5.3: Dickey-Fuller with GLS Detrending (DFGLS) Unit Root Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>DFGLS (level)</th>
<th>DFGLS (first difference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNM2</td>
<td>-1.169090</td>
<td>-6.029303*</td>
</tr>
<tr>
<td>LNGDP</td>
<td>2.018322*</td>
<td>-3.433472*</td>
</tr>
<tr>
<td>LNCPI</td>
<td>-1.098347</td>
<td>-1.661299*</td>
</tr>
<tr>
<td>RIR</td>
<td>-1.544511</td>
<td>-5.285990*</td>
</tr>
</tbody>
</table>

Note: * indicates statistical significance at 10% level with a critical value of -1.61. The regressions for testing the stationarity were conducted with only a constant term.

5.2 Lag Selection Criteria

According to the Likelihood-Ratio test statistics (LR), final prediction error (FPE), Akaike's information criterion (AIC), Schwarz information criterion (SC) and the Hannan and Quinn information criterion (HQIC), Table 5.4 and Table 5.5 show that the optimal lag length for the basic model and the interest rate channel model is 1.

Table 5.4: Lag Length Selection of the Basic Model

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9.215489</td>
<td>NA</td>
<td>0.000131</td>
<td>-0.428654</td>
<td>-0.287210</td>
<td>-0.384356</td>
</tr>
<tr>
<td>1</td>
<td>35.30688</td>
<td>44.98516*</td>
<td>4.04e-05*</td>
<td>-1.607371*</td>
<td>-1.041594*</td>
<td>-1.430177*</td>
</tr>
<tr>
<td>2</td>
<td>39.68711</td>
<td>6.645868</td>
<td>5.70e-05</td>
<td>-1.288766</td>
<td>-0.298656</td>
<td>-0.978676</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion
Table 5.5: Lag Length Selection of the Interest Rate Channel Model

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-102.3416</td>
<td>NA 0.017998</td>
<td>7.333906</td>
<td>7.522498</td>
<td>7.392971</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-51.53307</td>
<td>84.09693*</td>
<td>0.001654*</td>
<td>4.933315*</td>
<td>5.876278*</td>
<td>5.228639*</td>
</tr>
<tr>
<td>2</td>
<td>-43.69161</td>
<td>10.81581</td>
<td>0.003117</td>
<td>5.495973</td>
<td>7.193306</td>
<td>6.027556</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion

5.3 Stability Test

In order to test the stability of the VAR model, the inverse root of the characteristic autoregressive (AR) polynomial was used. The results of the stability test shown in Figure 5.1 and Figure 5.2 show that no root lies outside the unit circle. Therefore, this indicates that the VAR models satisfy the stability condition for the basic model and interest channel model respectively.

Figure 5.1: Stability Test of the Basic VAR Model
Figure 5.2: Stability Test of the Interest Rate Channel Model

5.4 Cointegration Test

The tests for the trace and maximum eigenvalue statistics that show the results of the unrestricted cointegration rank test was carried out using the Johansen cointegration test as summarised in Table 5.6 and Table 5.7. The null of no cointegration \((r = 0)\) can be rejected at the 5% critical values using both the trace \((\lambda_{\text{trace}})\) and maximum eigenvalue \((\lambda_{\text{max}})\) statistics for the basic model and the interest rate channel model. This suggests the variables are cointegrated. For this reason, the cointegration tests indicate that there is one cointegration vector \((r = 1)\) for the basic model and two cointegration vectors \((r = 2)\) for the interest channel model. Given these results, the vector error correction (VEC) model is estimated.
Table 5.6: Test of Cointegration Rank for the Basic VAR Model

<table>
<thead>
<tr>
<th>Rank</th>
<th>Trace Statistic</th>
<th>Critical Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>95%</td>
</tr>
<tr>
<td>0</td>
<td>54.61585</td>
<td>29.79707</td>
</tr>
<tr>
<td>≤1</td>
<td>10.32625</td>
<td>15.49471</td>
</tr>
<tr>
<td>≤2</td>
<td>1.203277</td>
<td>3.841466</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Max Statistic</th>
<th>Critical Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>95%</td>
</tr>
<tr>
<td>0</td>
<td>44.28960</td>
<td>21.13162</td>
</tr>
<tr>
<td>≤1</td>
<td>9.122974</td>
<td>14.26460</td>
</tr>
<tr>
<td>≤2</td>
<td>1.203277</td>
<td>3.841466</td>
</tr>
</tbody>
</table>
Table 5.7: Test of Cointegration Rank for the Interest Rate Channel Model

<table>
<thead>
<tr>
<th>Rank</th>
<th>Trace Statistic</th>
<th>Critical Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>95%</td>
</tr>
<tr>
<td>0</td>
<td>105.9810</td>
<td>47.85613</td>
</tr>
<tr>
<td>≤1</td>
<td>37.63155</td>
<td>29.79707</td>
</tr>
<tr>
<td>≤2</td>
<td>14.52335</td>
<td>15.49471</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Max Statistic</th>
<th>Critical Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>68.34944</td>
<td>27.58434</td>
</tr>
<tr>
<td>≤1</td>
<td>23.10820</td>
<td>21.13162</td>
</tr>
<tr>
<td>≤2</td>
<td>9.694877</td>
<td>14.26460</td>
</tr>
</tbody>
</table>
5.4.1 Vector Error Correction Model (VECM)

A vector error correction (VEC) model is a restricted VAR that has cointegrating restrictions built into the specification, so that it is designed for use with nonstationary series that are known to be cointegrated. The VEC specification restricts the long run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing a wide range of short run dynamics. The cointegrating term is known as the error correction term since the deviation from the long run equilibrium is corrected gradually through a series of partial short run adjustments (Buigut, 2009). As a result, this study uses the restricted VAR or the vector error correction (VEC) model to analyse the monetary policy transmission mechanism. The representation of the vector error correction estimates of the VAR models are shown in Table A.1 and Table A.2 in Appendix A.

Table B.1 and Table B.2 in Appendix B show a summary of the diagnostic tests for the multivariate residual tests of the VEC models and indicate well specified stable models. The Portmanteau Autocorrelation test and the Autocorrelation LM test, which test the assumption of serial correlation in the residuals of the multivariate models, rejected the presence of serial correlation in the models. The assumption of normality is accepted by the VEC models as the null hypothesis of the residuals being multivariate normal could not be rejected. There is no evidence of heteroscedasticity in the VEC models as the null hypothesis that the residuals are homoscedastic at 5% level of significance could not be rejected. Figure C.1 and Figure C.2 in Appendix C show a graphical representation of the residuals in the individual equations in the VEC models.
5.5 Basic VAR Model

5.5.1 Granger Causality Test

The results of the multivariate Granger causality tests in Table 5.8 are presented as preliminary evidence of the causal links between monetary policy and economic outcomes (inflation and output). The evidence suggests that in the basic model, money supply (M2) and output (GDP) are statistically significant and explain inflation (CPI) at 5% level of significance while inflation (CPI) is not statistically significant.

Table 5.8: Granger Causality Test for the Basic Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>DLNGDP</th>
<th>DLNCPI</th>
<th>DLNM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLNGDP</td>
<td></td>
<td>0.8493</td>
<td>0.1935</td>
</tr>
<tr>
<td>DLNCPI</td>
<td>0.0235*</td>
<td></td>
<td>0.0120**</td>
</tr>
<tr>
<td>DLNM2</td>
<td>0.7204</td>
<td>0.8129</td>
<td></td>
</tr>
</tbody>
</table>

Note: Entries show the probabilities of accepting the null hypothesis that the corresponding group of column variables did not Granger-cause the row variable, based on Wald tests’ $\chi^2$ statistics. ** denotes statistical significance at 5% significance level. Diagonal entries have been omitted since they do not reflect causal implications.

5.5.2 Impulse Response Analysis

Given the conclusion that there is cointegration among the variables, Figure 5.3 provides the results of the impulse responses to an exogenous monetary policy shock based on the Cholesky decomposition following the ordering; output, inflation and money supply. This ordering implies that the policy instrument does affect the other variables but with a lag. A thirty year horizon is considered and results are based on a
restricted VAR model that includes one lag. The ordering of the variables is based on the assumption that a shock to the monetary policy, such as a tightening of monetary policy, would be transmitted to inflation and output. In this analysis, the impulse response functions of the basic model are shown below.

**Figure 5.3: Impulse Response Functions of the Basic Model**

![Graph showing impulse response functions](image)

Figure 5.3 shows the responses of GDP and inflation to a monetary policy tightening. Output declines during the year following the shock, and recovers in the third year but reduces again from the fourth year and continues to fluctuate in this manner until the thirtieth year. A one standard deviation (S.D.) innovation on money supply causes inflation to initially rise first and peaks in the second year, before declining and rising again after the fifth year. This pattern continues until the thirtieth year but with the magnitudes reducing. This is opposite to what is expected from a monetary contraction. This phenomenon has, however, been noted in a lot of literature and has been denoted as the price puzzle (Hülsewig, Winker & Worms, 2004).
5.5.3 Variance Decomposition Analysis

The results from variance decompositions are shown in Table 5.9 below.

Table 5.9: Variance Decomposition of the Basic Model

<table>
<thead>
<tr>
<th>Year</th>
<th>DLNGDP</th>
<th>DLNCPI</th>
<th>DLNM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>6</td>
<td>81.4370</td>
<td>18.0541</td>
<td>0.508865</td>
</tr>
<tr>
<td>12</td>
<td>81.3117</td>
<td>18.1019</td>
<td>0.586345</td>
</tr>
<tr>
<td>18</td>
<td>81.6982</td>
<td>17.8076</td>
<td>0.494194</td>
</tr>
<tr>
<td>24</td>
<td>81.8780</td>
<td>17.6757</td>
<td>0.446206</td>
</tr>
<tr>
<td>30</td>
<td>82.0089</td>
<td>17.5870</td>
<td>0.404063</td>
</tr>
</tbody>
</table>

Variance Decomposition for DLNCPI

<table>
<thead>
<tr>
<th>Year</th>
<th>DLNGDP</th>
<th>DLNCPI</th>
<th>DLNM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1651</td>
<td>99.8348</td>
<td>0.0000</td>
</tr>
<tr>
<td>6</td>
<td>1.6224</td>
<td>97.8207</td>
<td>0.556850</td>
</tr>
<tr>
<td>12</td>
<td>1.5417</td>
<td>97.7920</td>
<td>0.666235</td>
</tr>
<tr>
<td>18</td>
<td>1.4984</td>
<td>97.9034</td>
<td>0.598121</td>
</tr>
<tr>
<td>24</td>
<td>1.4625</td>
<td>97.9674</td>
<td>0.570042</td>
</tr>
<tr>
<td>30</td>
<td>1.4462</td>
<td>98.0069</td>
<td>0.546775</td>
</tr>
</tbody>
</table>

Cholesky Ordering: DLNGDP DLNCPI DLNM2

The results reveal that the proportion of variance of inflation due to innovations to money supply is quite small. This value reaches its maximum in the twelfth year and it equals to 0.66% while own shocks accounted for 97.79% and output accounted for
1.54%. Money supply has even less power in explaining the variation in the real GDP. As can be seen from Table 5.9, this number equals to only 0.58% in the equivalent twelfth year and does not exceed 0.58% within the given 30 year period. Own shocks accounted for most of the shocks, 81.31%, while inflation accounted for only 18.1%. Therefore, the hypothesis that money supply (M2) does not Granger cause inflation (CPI) and Output (GDP) should be rejected.

5.6 Interest Rate Channel Model

5.6.1 Granger Causality Test

The Granger causality test results are shown in Table 5.10 below.

**Table 5.10**: Granger Causality Test for the Interest Channel Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>DLNGDP</th>
<th>DLNCPI</th>
<th>RIR</th>
<th>DLNM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLNGDP</td>
<td></td>
<td>0.5161</td>
<td>0.1162</td>
<td>0.3724</td>
</tr>
<tr>
<td>DLNCPI</td>
<td>0.0216**</td>
<td></td>
<td>0.3281</td>
<td>0.0000***</td>
</tr>
<tr>
<td>RIR</td>
<td>0.1556</td>
<td>0.1815</td>
<td></td>
<td>0.0066***</td>
</tr>
<tr>
<td>DLNM2</td>
<td>0.5980</td>
<td>0.9067</td>
<td>0.0750*</td>
<td></td>
</tr>
</tbody>
</table>

Note: Entries show the probabilities of accepting the null hypothesis that the corresponding group of column variables did not Granger-cause the row variable, based on Wald tests’ $\chi^2$ statistics. *;** and *** denote statistical significance at 10%, 5% and 1% significance level respectively. Diagonal entries have been omitted since they do not reflect causal implications.

The results show that when the real interest rate is added to the basic model, money supply (M2) and output (GDP) are still significant and explain inflation (CPI) at 1% and 5% significance level respectively. In addition, money supply explained real
interest rate (RIR) at 1% significance level and RIR explained M2 at 10% level of significance. However, inflation is not significant and does not explain money supply, output or inflation.

The effect of the interest rate channel of monetary policy transmission is analysed by adding the real interest rate variable to the basic model. As earlier mentioned, the ordering of the endogenous variables in the VAR model becomes output, inflation, real interest rates and money supply. This ordering reflects the fact that a change in the money supply would affect the real interest rate, which would, in turn, affect investment according to traditional Keynesian economics.

5.6.2 Impulse Response Analysis

The impulse response functions in Figure 5.4 suggest that a negative one standard deviation (S.D.) innovation (monetary contraction) on money supply to the real interest rate led to a decrease in output from the first to the third year but increased up to the fifth year and decreased until the seventh year. This oscillating pattern continues until the thirtieth year. In other words, a negative one S.D. innovation in money supply (contractionary monetary policy) increased the real interest rate during the year following the shock until the third year and decreased output from the first year through to the third year. Real interest rate then decreased until the fifth year before increasing until the seventh year as output increased and reduced in the same years. This pattern continues up to the thirtieth year. As expected from a monetary contraction, the increased real interest rate caused inflation to fall sharply from the first to the third year and increased slightly until the seventh year before dropping after the eighth year. A similar pattern continues up to the thirtieth year.
**Figure 5.4:** Impulse Response Functions of the Interest Rate Channel

Response to Cholesky One S.D. Innovations

Response of DLNGDP to RIR

Response of DLNCPI to RIR

Response of RIR to DLNM2
5.6.3 Variance Decomposition Analysis

The results from variance decomposition are shown in Table 5.11 below.

Table 4.11: Variance Decomposition of the Interest Rate Channel

<table>
<thead>
<tr>
<th>Year</th>
<th>DLNGDP</th>
<th>DLNCPI</th>
<th>RIR</th>
<th>DLNM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100.00000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>6</td>
<td>69.35079</td>
<td>19.21242</td>
<td>9.955991</td>
<td>1.480797</td>
</tr>
<tr>
<td>12</td>
<td>69.02698</td>
<td>19.15796</td>
<td>9.639318</td>
<td>2.175744</td>
</tr>
<tr>
<td>18</td>
<td>70.00126</td>
<td>18.74617</td>
<td>9.333248</td>
<td>1.919322</td>
</tr>
<tr>
<td>24</td>
<td>70.06504</td>
<td>18.68340</td>
<td>9.375075</td>
<td>1.876490</td>
</tr>
<tr>
<td>30</td>
<td>70.37995</td>
<td>18.58218</td>
<td>9.254483</td>
<td>1.783384</td>
</tr>
</tbody>
</table>

Variance Decomposition for DLNCPI

<table>
<thead>
<tr>
<th>Year</th>
<th>DLNGDP</th>
<th>DLNCPI</th>
<th>RIR</th>
<th>DLNM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>96.71985</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>6</td>
<td>1.044914</td>
<td>72.47156</td>
<td>24.10179</td>
<td>2.381736</td>
</tr>
<tr>
<td>12</td>
<td>0.669673</td>
<td>68.43599</td>
<td>28.01442</td>
<td>2.879925</td>
</tr>
<tr>
<td>18</td>
<td>0.488266</td>
<td>66.75620</td>
<td>29.76106</td>
<td>2.994481</td>
</tr>
<tr>
<td>24</td>
<td>0.376622</td>
<td>65.87211</td>
<td>30.66763</td>
<td>3.083641</td>
</tr>
<tr>
<td>30</td>
<td>0.306212</td>
<td>65.40785</td>
<td>31.17417</td>
<td>3.111768</td>
</tr>
</tbody>
</table>

Cholesky Ordering: DLNGDP DLNCPI RIR DLNM2

The results show that after adding the real interest rate to the basic model, 2.17% of the shocks in output after twelve years were due to shocks in money supply but this value reduced to 1.78% after 30 years. This value is higher than in the basic model
but still remains relatively low. On the other hand, the real interest rate accounted for 9.63% of the shock in output and dropped to 9.25% after thirty years, meaning that the magnitude of the interest rate channel is quite low. In the long run, the real interest rate appeared to be a significant source of the decrease in inflation as it accounted for 31.17% shocks in inflation after thirty years. However, output did not appear to be an important determinant nor have significant forecasting power for inflation as it accounted for only 0.66% of the shocks after twelve years and only 0.3% after thirty years. Therefore, the hypothesis that Money supply (M2) does not Granger cause real interest rates (RIR), inflation (CPI) and Output (GDP) should not be rejected.
6. CONCLUSIONS, POLICY IMPLICATIONS AND RECOMMENDATIONS

This chapter presents the conclusions and policy implications drawn from the findings of the study in line with monetary policy in Zambia. The chapter also provides recommendations for further research regarding the monetary policy transmission mechanism in Zambia.

6.1 Conclusions

This study investigates the effectiveness of the interest rate channel of monetary policy transmission in Zambia by employing the vector autoregression (VAR) approach and focusing on the reduced-form relationships between money supply, inflation, real interest rate and real output. Starting with the basic model which describes the overall mechanism, the monetary transmission was examined using a VAR model with Cholesky decomposition. The hypothesis being tested was to find out whether money supply Granger caused inflation and output. Finally, a similar VAR model examining the interest rate channel of monetary policy transmission was estimated and this captures the main findings of this study. The hypothesis tested was to find out whether money supply Granger caused real interest rates, inflation and output.

The main findings from the basic VAR model suggest that a decrease in money supply reduces output in the year following the shock and recovers in the third year but reduces again from the fourth year and the magnitude is small but significant. However, inflation rises first and peaks in the second year following the shock, before declining and rising again after the fifth year but as with output, the magnitude is small and significant. After adding the real interest rate variable to the basic model, money supply still affects output, inflation and real interest rate but the
magnitudes are small and insignificant. Therefore, the study showed that monetary policy did affect output and inflation but the interest channel is not significant in Zambia.

The main implication to be drawn from these results seems to be that the interest rate channel is not effective in Zambia. In general, these results go in line with the existing empirical findings for other developing countries. A similar study by Buiguit (2009) to assess the importance of the interest rate channel in Kenya, Uganda and Tanzania (East African Community) found that the interest rate channel is not significant and may not be so important for this region. A study by Isakova (2008) which examines monetary policy efficiency in Central Asia by investigating the monetary transmission mechanism in the region’s developing economies, namely Kazakhstan, the Kyrgyz Republic, and Tajikistan, also draws similar results with this study. She found that the interest rate channel is relatively weak and does not prove to be an important monetary transmission channel. A study by Al-Mashat and Billmeier (2007) that examines the monetary transmission mechanism in Egypt draws similar results with this study. They found that the interest rate channel is under developed and therefore not significant. Dabla-Norris and Floerkemeier (2006) conducted a similar study to examine the monetary policy transmission in Armenia and found that the interest rate channel is weak and insignificant as is the case in this study.

A number of factors, as both theoretical and empirical literature suggest, contribute to influence the monetary transmission mechanism. Bernanke and Gertler (1995) have largely attributed the potency of a country’s monetary transmission mechanism
to the development of an economy’s financial sector. Buigut (2009) states that one of the most important factors is the degree of development of the money market and hence the composition of the finance affecting investment decisions. He points out that in countries where the capital market is less than fully developed, it is likely the interest rate channel will play a smaller role since bank credit is likely to constitute the main source of investment finance. As Isakova (2008) explains, the financial sectors in Central Asian economies remain weak and underdeveloped and this is what would be expected of Zambia given the level of development of the money market.

6.2 Policy Implications

The results of this study offer some policy implications as the model used in this study provides a very important tool that economists and researchers can employ in making economic judgements about how macroeconomic variables affect inflation and economic activity. The main policy advice is that the monetary authorities can effectively employ a combination of money supply and short term interest rates in affecting inflation and real economic activity. As Sun (2010) observes, by adopting a short-term money market rate as an operating target, an effective interest rate transmission channel can be established through which financial institutions price their loans with reference to market rates where the market rates move in response to central bank benchmark rate adjustments.

Hence, this would allow the monetary authorities to effectively influence the short-term money market rate through open market operations. If growth of money supply and short term interest rates can be restrained in the medium to long term, then this
information can help monetary authorities design appropriate policies to influence the real interest rate and hence dampen inflation or encourage economic growth within the economy. This would therefore make the interest rate channel a potent channel of monetary policy transmission.

6.3 Recommendations for Further Research

Due to the broadness of the monetary policy transmission mechanism topic, there is need for further research into the monetary policy transmission process by testing other channels of transmission. For example, a study by Lungu (2008) which investigated the monetary transmission mechanism in the Southern African Development Community (SADC) produced mixed results but generally reported the existence of a bank-lending channel in all SADC countries. As Simatele (2004) observes, testing of the bank lending channel may also be important if it is done with more disaggregated output and bank data as this would show a more detailed picture of how monetary policy is transmitted to the macro economy. Therefore, a more detailed study of the bank lending channel of monetary policy transmission in Zambia needs to be conducted.
REFERENCES


APPENDIX A – VECTOR ERROR CORRECTION ESTIMATES

Table A.1: Vector Error Correction Estimates of the Basic Model

<table>
<thead>
<tr>
<th>Error Correction:</th>
<th>D(DLNGDP)</th>
<th>D(DLNCPI)</th>
<th>D(DLNM2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CointEq1</td>
<td>-0.009358</td>
<td>0.125310</td>
<td>-5.585968</td>
</tr>
<tr>
<td></td>
<td>(0.05115)</td>
<td>(0.20644)</td>
<td>(0.79741)</td>
</tr>
<tr>
<td></td>
<td>[-0.18295]</td>
<td>[ 0.60701]</td>
<td>[-7.00514]</td>
</tr>
<tr>
<td>D(DLNGDP(-1))</td>
<td>-0.397296</td>
<td>0.397883</td>
<td>3.211557</td>
</tr>
<tr>
<td></td>
<td>(0.17262)</td>
<td>(0.69671)</td>
<td>(2.69115)</td>
</tr>
<tr>
<td></td>
<td>[-2.30160]</td>
<td>[ 0.57109]</td>
<td>[ 1.19338]</td>
</tr>
<tr>
<td>D(DLNGDP(-2))</td>
<td>-0.366078</td>
<td>0.098938</td>
<td>-2.400792</td>
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<td>0.004005</td>
<td>-0.174099</td>
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<td>(0.05511)</td>
<td>(0.22242)</td>
<td>(0.85913)</td>
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<td>(0.02149)</td>
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<td>(0.33511)</td>
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<td>[ 3.80310]</td>
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<td>D(DLNM2(-2))</td>
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<td>(0.12881)</td>
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<td>R-squared</td>
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<td>0.892135</td>
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<td>Error Correction:</td>
<td>D(DLNGDP)</td>
<td>D(DLNCPI)</td>
<td>D(RIR)</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
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<td>-0.086412</td>
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<td>(0.39400)</td>
<td>(24.5782)</td>
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<td>[-0.32953]</td>
<td>[2.09317]</td>
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<td>D(DLNGDP(-1))</td>
<td>-0.374449</td>
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<tr>
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<td>(0.19539)</td>
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<td>(50.9670)</td>
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<td>[-1.73884]</td>
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<td>-0.230707</td>
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<td>(0.16365)</td>
<td>(0.68433)</td>
<td>(42.6889)</td>
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<td>[-1.40975]</td>
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<td>[-1.54424]</td>
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<td>D(DLNCPI(-1))</td>
<td>-0.053054</td>
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<td>(0.07601)</td>
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<td>(19.8272)</td>
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<td>[-0.69800]</td>
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<td>[ 0.75547]</td>
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<td>D(DLNCPI(-2))</td>
<td>-0.202561</td>
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<td>(0.07340)</td>
<td>(0.30692)</td>
<td>(19.1460)</td>
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<td>[-2.75977]</td>
<td>[-1.50156]</td>
<td>[-1.4198]</td>
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<td>D(RIR(-1))</td>
<td>-0.001062</td>
<td>-0.007022</td>
<td>0.279395</td>
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<td>(0.00116)</td>
<td>(0.00485)</td>
<td>(0.30263)</td>
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<td>[ 0.92321]</td>
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<td>-0.001768</td>
<td>-0.004373</td>
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<td>(0.00115)</td>
<td>(0.00482)</td>
<td>(0.30076)</td>
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<td></td>
<td>[-1.53334]</td>
<td>[-0.90701]</td>
<td>[-0.42709]</td>
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<tr>
<td>D(DLMN2(-1))</td>
<td>0.019056</td>
<td>0.014821</td>
<td>-11.36513</td>
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<td>(0.02117)</td>
<td>(0.08851)</td>
<td>(5.52144)</td>
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<td>[ 0.90027]</td>
<td>[ 0.16745]</td>
<td>[-2.05836]</td>
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<td>(0.04551)</td>
<td>(2.83907)</td>
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<tr>
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<td>[ 1.01303]</td>
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<td>[-1.29995]</td>
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<td>C</td>
<td>0.004786</td>
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<td>(0.00773)</td>
<td>(0.03233)</td>
<td>(2.01676)</td>
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<tr>
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<td>[ 0.61902]</td>
<td>[-0.19800]</td>
<td>[ 0.27078]</td>
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<tr>
<td>R-squared</td>
<td>0.595625</td>
<td>0.289142</td>
<td>0.350242</td>
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</table>
**APPENDIX B - VEC MULTIVARIATE DIAGNOSTIC TESTS**

**Table B.1: VEC Multivariate Diagnostic Tests for the Basic Model**

<table>
<thead>
<tr>
<th>Test</th>
<th>( \chi^2 ) (lag)</th>
<th>Value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portmanteau Autocorrelation Test</td>
<td>( \chi^2 ) (9)</td>
<td>39.60807</td>
<td>[0.0557]</td>
</tr>
<tr>
<td>LM Serial Correlation Test</td>
<td>( \chi^2 ) (9)</td>
<td>6.320950</td>
<td>[0.7074]</td>
</tr>
<tr>
<td>Jarque-Bera Normality Test</td>
<td>( \chi^2 ) (6)</td>
<td>5.829700</td>
<td>[0.4425]</td>
</tr>
<tr>
<td>White Heteroskedasticity Test</td>
<td>HET ( \chi^2 ) (84)</td>
<td>89.69214</td>
<td>[0.3153]</td>
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</tbody>
</table>

**Table B.2: VEC Multivariate Diagnostic Tests for the Interest Rate Channel**

<table>
<thead>
<tr>
<th>Test</th>
<th>( \chi^2 ) (lag)</th>
<th>Value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portmanteau Autocorrelation Test</td>
<td>( \chi^2 ) (16)</td>
<td>64.17994</td>
<td>[0.0592]</td>
</tr>
<tr>
<td>LM Serial Correlation Test</td>
<td>( \chi^2 ) (16)</td>
<td>16.63048</td>
<td>[0.4099]</td>
</tr>
<tr>
<td>Jarque-Bera Normality Test</td>
<td>( \chi^2 ) (8)</td>
<td>15.07524</td>
<td>[0.0577]</td>
</tr>
<tr>
<td>White Heteroskedasticity Test</td>
<td>HET ( \chi^2 ) (180)</td>
<td>188.3819</td>
<td>[0.3191]</td>
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</tbody>
</table>

Note: The Portmanteau Autocorrelation Test computes the multivariate Box Pierce/Ljung-Box Q-statistics for residual serial correlation up to the specified lag order; The Lagrange multiplier (LM) test tests the null hypothesis of no serial correlation; Normality is the Jarque-Bera statistic for testing normality of the residuals and corresponds to testing whether the skewness and kurtosis of the residuals correspond to those of a normal distribution; HET is White's test for heteroscedasticity and excludes cross terms; P-values are in parenthesis.
APPENDIX C - RESIDUAL PLOT OF THE VEC MODELS

Figure C.1: VEC Residual Plot of the Basic Model
Figure C.2: VEC Residual Plot of the Interest Rate Channel