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ESTIMATING EFFECTIVENESS OF MONETARY POLICY IN ZAMBIA USING MONETARY RESPONSE FUNCTIONS.

BY

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APPROVAL

The undersigned certify that this dissertation has been examined and approved as meeting the requirements for partial fulfilment of Master of Arts in Economics Degree.

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DECLARATION

I declare that this work presented in this dissertation has not been accepted for any Degree or currently being submitted for any other Degree at this University or any other for the same purpose. The present work submitted is the result of my own investigations except where referenced.

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ACRONYMS

ADF Augmented Dickey Fuller

ARDL Autoregressive Distributed Lag

AIC Akaike Information Criterion

BOP Balance of Payments

BOZ Bank of Zambia

DSGE Dynamic Stochastic General Equilibrium

HQ Hanna-Quinn Criterion

GDP Gross Domestic Production

GMM Generalized Method of Moments

IFEM Interbank Foreign Exchange Market

IMF International Monetary Fund

INERP Interim New Economic Recovery Programme

KPSS Kwiatkowski-Philip-Schmidt-Shin

MPC Monetary Policy Committee

OMO Open Market Operation

PP Phillips-Perron

SAP Structural Adjustment Programme

SIC Schwartz Information Criterion

VAR Vector Autoregressive

VECM Vector Error Correction Mechanism

ZCCM Zambia Consolidated Copper Mines

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DEDICATION

To my family and friends.

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ABSTRACT

This study reviewed the effectiveness of monetary policy in Zambia using monetary response functions. The Zambian monetary policy has consisted of monetary aggregates as policy instrument from 1992 to 2012 and policy rate from 2012 to present. Effectiveness of the monetary policy was therefore estimated by running two monetary response functions, each based on one of the policy instruments. The effectiveness was determined by the policy instrument that is more responsive to macroeconomic changes. A VAR model was employed to estimate both monetary response functions using quarterly data for the period 2000 to 2016.

The conclusions are based solely on the impulse response functions and the variance decomposition functions as it provides a standard deviation of the impacts of the macroeconomic variables on the monetary policy instruments. The results indicate that the policy rate responds positively to inflation gap, output gap, exchange rates and the lagged policy rate. This is in line with Taylor's rule and shows the Central Bank systematic behaviour in monetary policy. The policy rate is seen to be biased towards output stabilization. The other response functions show that money supply responds negatively to inflation gap, output gap, exchange rates and lagged money supply. The money supply is biased towards inflation gap. The exchange rate is also observed to greatly impact money supply as an intermediate instrument. Based on this, we conclude that money supply is more effective in stabilising price, which is the main objective of monetary policy. Exchange rates aid in stabilizing price making the money supply instrument more effective than interest rate.

CHAPTER ONE: INTRODUCTION

1.0 Background of the study

Effectiveness of monetary policy has over the years been measured by generally estimating the sensitivity of macroeconomic variables to monetary policy changes. This basically measures how Central Banks respond to changes in the macro economy using their policy instruments. There have been various approaches to this measure as preferred monetary policy instruments have changed over time. The traditional approach basically relates the major monetary policy to the growth of money supply. This however has been questioned due to the many other non-policy variables affecting growth of monetary aggregates in an economy and the increasing difficulty in measuring it (Bernanke & Mihov, 1998).

As the pool of knowledge continues to grow, other approaches have been developed to improve on the traditional approach. For instance in 1989, Romer and Romer developed the narrative approach where the dates of Central Banks' shift to an anti-inflationary policies where studied. This helped analyse how quickly and effectively the Central Bank responded with policy to counter inflation so as to achieve their monetary goal. Boschen and Mills (1991) improved on this by considering both inflationary and anti-inflationary policy responses but their model suffered from endogeneity problems. In 1992 Bernanke and Blinder suggested the use of the Federal Funds rate as a measure of monetary policy whilst Christiano and Eichebaum (1992) incorporated the Vector Auto regression (VAR) techniques to counter endogeneity.

Measures of monetary policy effectiveness continue to be tested using various methods in search of methods that explain Central Bank behaviour adequately (Bernanke, Biovin & Eliasz, 2005). As observed, building on the existing models was cardinal in these studies. Mutoti (2005) further added that for an effective monetary policy, monetary authorities need to develop a clear view of how major shocks affect the whole economy by looking at the aggregate supply and aggregate demand in the long run. In this case, a general equilibrium model is preferred as opposed to a VAR model.

In 1993, John B Taylor coined the Taylor rule which is basically an interest rate based monetary response function. A monetary response function is a function whose dependent variable is the policy instrument and the explanatory variables, the policy goals. It establishes a rule on how the Central Bank responds to changes in macroeconomic variables. Thus, the function indicates a systematic and consistent system of the Central Bank behaviour which helps analyse its effectiveness of achieving its goals (Setlhare, 2004).

Taylor's rule measures the change in interest rates required to adjust deviations of inflation and other macroeconomic variables from their targets. It is basically a rule that determines the appropriate monetary policy instrument by measuring which policy instrument is most responsive to the changes (Kelikume, Alabi, & Ike-Anikwe, 2016). According to Taylor (1999), the degree to which actual inflation fluctuates around its target is a measure of the policy instruments' performance. The rule is not exclusive to inflation only but also deviations of other variables such as output, employment, interest rates etc. from their targets.

Taylor's rule has since been used to measure the effectiveness of monetary policy instruments to macroeconomic changes. This analysis particularly became common in developed countries after their transition from the monetary aggregates regime to inflation targeting regime. The use of Taylor's rule as an efficiency measure also rekindled the use of McCallum's rule which is also a monetary response rule based on monetary aggregates as a policy instrument. McCallum's rule has been used in the few studies on estimating monetary response in developing countries (Rasche & Williams, 2005).

Zambia's monetary policy has been based on several policy instruments. Interest rates are the major policy instrument in the country after having used monetary aggregates for over 20 years. The shift to interest rates was made in a bid to modernise monetary policy and anchor inflation more efficiently since interest rates are more easily understood by the public. The use of interest rates also allows the Central Bank to influence pricing of Commercial Bank credit products which were relatively high at the time of the transition (Bank of Zambia, July 2012). According to Taylor (1999), interest rates policy works better in the face of increased volatility in markets; which has been a consequence of financial innovation, whereas monetary aggregates are more effective in situations of high/growing inflation levels.

This study therefore seeks to establish the effectiveness of monetary policy by estimating the monetary policy response functions similar to Taylor's rule and McCallum rule. Since Zambia has had two prominent policy instruments after financial liberalisation in the 1990s, the study estimates two monetary response functions, one with interest rates and the other with monetary aggregates as the dependent variable. The study employs a VAR model as advocated by Bernanke and Blinder (1992) as it provides a simple dynamic analysis that measures monetary policy using only a simple structural model.

1.1 Statement of the Problem

In the 1990s, most developed countries transitioned to the use of interest rates as policy instrument mainly due to loss of stability of broad money brought about by increased financial innovation. In recent years, countries like Ghana, in 2007 and Zambia in 2012, have also adopted interest rates as a policy instrument whilst other developing countries are on route to doing the same. Bahmani-Oskooee & Gelan (2009) argued that financial innovation in developing countries has not been widespread and so liquid money is still a huge and major part of peoples' wealth in many cases. In their research, they found that the money demand functions for most developing countries are still very stable. Subsequently, they suggested that developing countries may be shifting to use of interest rates as policy instrument prematurely as there is no justification for shifting away from monetary aggregates (Duca & Vanhoose, 2004).

After financial liberalisation, the Zambian economy was characterised by high inflation, about 111% in 1990, due to the removal of price controls, liberalisation of exchange and interest rates, removal of subsidies etc. These measures resulted in prices rising as the market forces were allowed to determine prices. The inflation rates were further exacerbated by seignorage activities pursued in 1992 in response to civil servants demand for increased pay (Simutanya, 1996). This necessitated a shift in monetary policy instruments from direct to indirect instruments with monetary aggregates as the major policy instrument. During the monetary aggregates regime, inflation was brought down significantly i.e. 46% in 1995, 30% in 2000 and 6.4% in 2012. In April 2012, there was a shift from use of monetary aggregates as policy instrument to interest rates. Inflation rates have since risen gradually; 7.1% in 2013 7.3% in 2014, 7.7% in 2015 and 21.8% by September, 2016 (Central Statistical Office, 2016). These price level increases have been attributed to the falling world copper price of which Zambia is a major exporter. Since copper is the main forex supplier, a fall in the price of copper results in depreciation of domestic currency and thus an increase in prices due to the country's large import dependency (Ministry of National Planning, 2017).

However, given the ability of Zambia's inflation rate to remain relatively stable in the period when monetary aggregates were the nominal anchor, which included the 2008 global financial crisis, it raises the question of how effective the new monetary policy instrument is towards responding to economic changes particularly inflation. Could the use of interest rates as a nominal anchor have been too soon given the low level of financial inclusion[1] and consequently a weak transmission channel? Could the economy still be too unstable so that monetary aggregates are more effective in price stabilisation than interest rates?

The few researches done on the appropriate nominal anchor have shown contradicting results. A study by Ng'andwe (1980) found that reserve and broad money have no significant effect on inflation hence recommend shift away from monetary aggregates instrument. Pamu (2005) also observed that all measures of money did not explain inflation dynamics in Zambia. Similarly, Hangoma (2010) using Svensson's model of inflation targeting found that the Treasury bill rate and inflation rate have a significant relationship though the transmission was not smooth and thus recommended the use of interest rates. However, Chileshe and Zgambo (2014) who estimated the money demand function and the monetary policy transmission mechanisms observed that a strong inverse relationship exists between monetary aggregates and inflation. They also found that the interest rate channel in the transmission mechanism had no significant effect on output or inflation and thus recommended continued use of money aggregates in monetary policy. These findings were also consistent with Chileshe et al (2014).

The advantages of interest rates instruments are clear and thus the reason for most countries adopting them over monetary aggregates. However, discrepancies in the empirical results on the appropriate policy instrument and the little empirical evidence on the performance of interest rates as policy instrument necessitate a study on the effectiveness of interest rates as policy instrument in the Zambian economy as opposed to monetary aggregates. This study uses monetary response rules to estimate effectiveness of each policy instrument, an approach that has not been used so far in the Zambian context.

[1] Financial Inclusion was at 38% in 2015 (Finscope,2015)

1.2 General Objective

- The general objective of this study is to estimate the efficiency of interest rates and money aggregates in responding to macroeconomic changes.

1.2.1 The specific objectives are to:

- Determine the effect of inflation gap on the interest rates and money supply.
- Determine the effect of output gap on the interest rates and money supply.
- Determine the effect of exchange rate on the interest rates and money supply.

1.3 Hypothesis Testing

- Increased inflation gap (actual minus target) will increase interest rates and reduce money supply.
- Increased output gap (actual minus target) will increase interest rates and reduce money supply.
- Exchange rates have a positive effect interest rates and negative impact on money supply.

1.4 Justification of the Study

Estimating the monetary response function for an economy is vital in analysing its monetary policy performance. In the case of Zambia, it provides a clearer picture of the performance of interest rates as a policy instrument as opposed to monetary aggregates. This will allow for use of a more appropriate instrument for more effective policy implementation or maintenance of an effective policy. As Chipili & Zgambo (2014) in their study were able to recommend the continued use of monetary aggregates in monetary policy, this study will either confirm or refute this based on the empirical evidence available thus far. The response function also provides a rule for Central Bank behaviour useful for macro-modelling. Deeper understanding of Central Bank behaviour also increases its credibility to the public (Rasche & Williams, 2005).

The private sector may also benefit from knowledge of the Central Banks response function as it allows them to adjust their wealth portfolios according to the expected changes in economic conditions as they will be able to correctly predict Central Banks reaction. The private sector response will also help the Central Bank implement policy since the private sector will react as the Banks expect making their policy more effective.

1.5 Organisation of the Study

The purpose of this study is to estimate effectiveness of Zambian monetary policy instruments using monetary response functions. Thus the study proceeds by first reviewing the Zambian macro economy and monetary policy detailing how it has evolved since independence. The study will then review both theoretical and empirical data on monetary response functions. The methodology and the analytical framework will then be presented. Finally the study will conclude with a summary of the results, policy recommendations, limitations and suggestions on areas of further research.

CHAPTER TWO : Overview of the Zambian Economy

2.0 Introduction

This chapter contextualises the study by outlining the Zambian economy and its' monetary policy since attaining independence in 1964. The first section looks at the macroeconomic environment whilst the second looks at the evolution of the monetary policy and concludes with an outline of the current Zambian monetary policy framework.

2.1 Macro-economic Environment since 1964

The Zambian economy has undergone various changes since attaining independence from her British colonialists in 1964. At the time, the economy was characterised by strong macroeconomic variables as the country benefited vastly from the countries consistent receipts from copper exports (Saasa, 1996). The mining sector provided at least 95% of foreign exchange in the Zambian economy. This translated into high domestic savings and huge public infrastructure attracting some private investment. Most earnings from copper were used to provide other public goods and services and sustain other less profitable businesses that were run by the government. The economy was at the time characterised by financial repressive policies such as fixed interest and exchange rates, price controls, controlled credit allocation etc. Government did not only interfere in the market by setting prices but also owned most the companies supplying both goods and services. Despite the existing policies the economy grew steady at about 4% in the late 1960s (Simutanya, 1996).

In the 1970s, earnings from copper fell by over 23% as oil prices plummeted and copper prices fell. This resulted in increased borrowing to sustain not only the copper mines but also other public resources previously run by proceeds from copper sales. This led to deterioration of the economy with the GDP growth rate falling to 1% in the 1980s. In most cases, the GDP growth rate was negative whilst GDP per capita fell by 18.1% between 1981 and 1985 (Mutale, 1991). This put pressure on the public budget and the financial repressive policies allowed the government to redirect credit to the fiscal deficit and carry out seigniorage activities to sustain public expenditure. External debt rose from 49% of GDP to 119% of GDP while inflation reached an average of 76.9% from an average 7% prior to the 1980s. Interest rates were consistently negative leading to the bank losing its intermediation role and consequently the credit provided to the private sector relative to GDP declined (Chileshe & Zgambo, 2014).

Owing to increased domestic and international pressure, the government adopted the International Monetary Funds' (IMF) Structural Adjustment Programmes (SAPs) in 1983. Since the government was in dire need of external funding, the programme came as a prerequisite to any bailout. This programme required devaluation of the domestic currency and eventually led to adoption of a flexible exchange rate auction system in 1985. The programme also called for the removal of subsidies, limiting wage increases to 5%, decontrol of prices of essential commodities, liberalisation of agricultural sector and international trade, public sector reforms and a reduction in civil service employment. The reforms were however rejected by the locals due to the increased cost of living. Thus, in 1987 the programme was cancelled. A short-lived economic recovery occurred in 1988 with the growth rate going up to 6.8% due to bumper harvest recorded in the previous season. The Interim New Economic Recovery Program (INERP) was adopted in 1989 reintroducing controls that existed prior to the SAPs. However, the economic crises worsened thereafter and with the IMF having withdrawn their support, the government was forced to renegotiate resulting in the formation of the Policy Framework Paper (PFP) in 1990. This reintroduced most SAP measures and nationwide discontent lead to election of a new Government in 1991 (Simutanya, 1996).

The new government, now under a democratic environment, fully embraced the SAPs. The economy was completely liberalised and wide-spread privatisation was pursued. This process lead to massive job losses and increase in prices as market forces were allowed to determine prices. The exchange rate was liberalised, trade restrictions where removed, public funding was removed in most sectors to reduce budget deficit and contractionary fiscal policy was pursued to stabilize the economy. The financial market was also liberalised so that the private sector[2] was allowed to participate in the market most of which were previously government dominated. Liberalisation of exchange rates led to the depreciation of domestic currency by over 200% in the 1990s (McPherson, 1995).

The economy was however not stabilized immediately after the SAPs where restored. The increase in prices and job losses caused another public outcry and the government consented by increasing civil servants wages via seigniorage as the existing fiscal deficit couldn't allow other forms of financing. This further exacerbated the inflation rates; 111% in 1991 and

[2] These were mostly foreign owned companies.

191% in 1992 (Simutanya, 1996). To tackle the problem, a limit was put on wage increases, government was put on a cash budget, the exchange rate was unified by allowing the Zambia Consolidated Copper Mines (ZCCM) to sell at the market rate, import and export licences were removed etc. Despite the cash budget, government continued to use Bank of Zambia (BOZ) to supply forex for ZAMOIL, a local Oil corporation and so high inflation rates persisted. At the end of 1993, the BOZ funding was cut and the macroeconomic variables began to stabilize (McPherson, 1995). Macroeconomic stability has since been restored over the years with inflation averaging 10% in the 2000s and GDP growth rates increasing over 4 times from the 1990s rate as can be observed in Table 1 below.

Table 1: Financial Sector Statistics

Indicator	1960-1961	1970-1971	1980-1981	1990-1991	2000-2001	2011	2012
Real Per Capita GDP Growth (annual % growth)	0.8	-1.9	-1.8	-1.7	2.8	3.6	4.0
Real GDP Growth (annual % growth)	3.9	1.5	1.1	0.8	5.6	6.8	7.3
Average Annual Inflation Rate-	-	11.1	76.9	68.1	15.5	6.4	6.6
External Debt Stocks (% of GNI)-	-	75.3	206.1	214.3	89.9	27.4	27.6
External Debt(% of GDP)-	-	48.7	118.3	147.3	67.9	18.1	19.0
Total Debt Service (% of exports)	2.9	26.2	25.1	25.0	12.9	2.2	2.2
Total Reserves (% of total external debt)-	-	10.1	2.8	2.8	23.1	47.0	56.5
Total Reserves (% of GDP)	18.6	7.1	4.5	5.0	9.1	12.1	14.7
Broad Money (% of GDP)	19.3	29.0	30.9	18.2	21.3	23.4	24.1
Broad Money Growth (annual % growth)	27.2	10.5	41.5	49.9	22.7	21.7	17.9
Real Interest Rate (%)-	-	0.8	15.5	3.1	11.3	5.6	5.6
Domestic Credit (% of GDP)-	0.3	41.9	63.9	59.6	28.2	18.1	18.5
Domestic Credit to Private Sector (% of GDP)	8.5	17.1	14.0	7.5	9.6	12.3	14.8
External Balance (% of GDP)	15.1	0.9	-1.7	6.9	2.4	9.0	-

Source: World Bank Indicators (online)

2.2 History of Monetary Policy

2.2.1 Phase 1- 1992 to 2012

The period prior to 1992 was characterised by a multiple objective monetary policy. The main objective was to provide credit to government and promote economic growth through direct instruments. The major policy instrument included fixed interest rates, sectoral credit allocations, core liquid assets and statutory reserves requirements. With these policies, the Central Bank had little control over monetary policy (Chileshe & Zgambo, 2014). The government dictated most monetary policy actions as the Central Bank had little independence. The government budget deficit was mainly financed by Central Bank borrowing as monetary policy targets were not well defined. These instruments resulted in broad macroeconomic instability characterised by negative interest rates, consistent Balance of Payment (BOP) deficits, widening savings and investment gap, etc (Kalyalya, 2001).

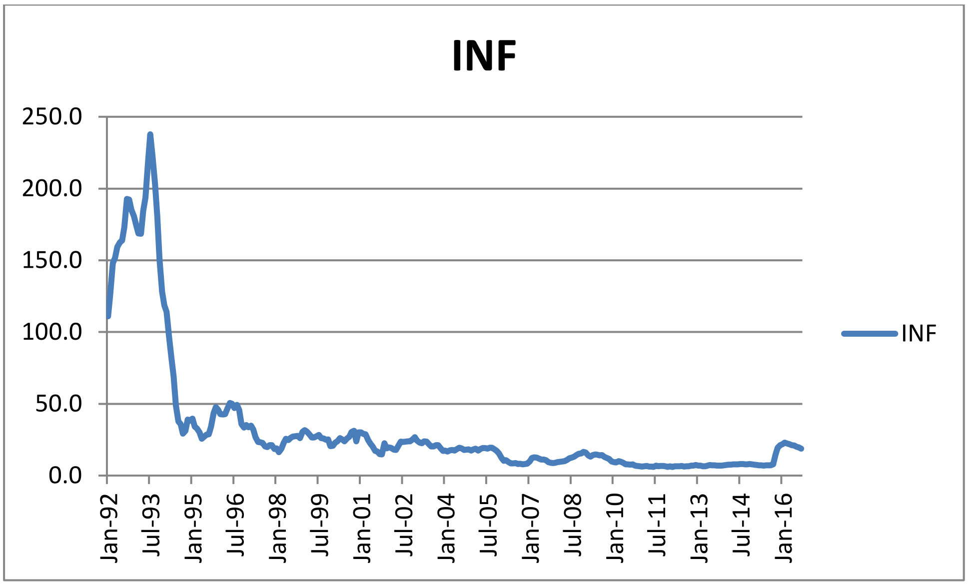
Liberalisation of the financial sector in 1992 allowed for some reforms in monetary policy. Market based instruments such as Treasury bill auctions and Open Market Operations (OMO) supplemented by foreign exchange auctions where introduced as the main policy instruments. The foreign exchange market was also eventually liberalised replacing the auctions together with interest rates and the Balance of Payment accounts in 1994. Monetary policy was aimed at stabilizing prices with reserve money as the operating target and broad money as the intermediate target (Fundanga, 2008). The Central Bank could also use management of foreign exchange as a tool of monetary policy. The exchange rate is an indirect tool of monetary policy since exchange rates are allowed to float. The Central Bank however continued to use some direct instruments such as reserve ratios sparingly to regulate money supply and financial institutions (BOZ, 2004).

The Bank of Zambia (BOZ) Act was amended in 1996, narrowing the Central Bank‘s objectives to stability of the general price level and the financial sector. The Act also gave the Central Bank autonomy over monetary policy implementation increasing its independence. Monetary policy was then concentrated on creating a stable macroeconomic environment to support sustainable economic growth with the inflation targets being set by the Ministry of Finance (MOF) in consultation with the BOZ.

All the indirect instruments introduced where at the control of the BOZ thus making autonomy possible. With these indirect instruments, the BOZ tried to influence the behaviour of financial institutions and other market players to control inflation. This promoted efficient allocation of credit to the public and generally encouraged financial development. Since the country was under the IMF fund programme, the monetary framework was solely based on the IMF Financing Programme as conditionality to the fund (Kalyalya, 2001).

The country has since recorded tremendous improvements in the price stability as shown in Figure 1 below.

Figure 1: Inflation Trend



Source: Bank of Zambia

From the figure above, it can be observed that the inflation rate has generally stabilized after 1992. A huge spike is noted in 1993 due to the seigniorage activities pursued in a quest to improve civil servants salaries. The exchange rate also depreciated by over 200% due to liberalisation of the rate and unification of the parallel rate. After 1993, the price level was stabilised due to the strict budget controls and other incentives to control the exchange rate, budget deficit, wage increases etc. introduced (McPherson, 1995). The inflation rate continued to stabilise generally due to the Central Bank policy instruments introduced in 1992 and the increased autonomy in monetary policy implementation obtained in 1996.

2.2.2 Phase 2- 2012 to date

Zambia's monetary policy has since liberalisation been based solely on monetary aggregates; reserve money and broad money. Success of such instruments requires a stable and predictable relationship between money and price level as postulated by Friedman. Despite the indirect instruments having successfully stabilised the price level and financial sector, the inflation rates remained relatively high. This was attributed to the weak and undeveloped financial systems and market imperfections among other things (Kalyalya, 2001).

Empirical evidence that was done on money demand function suggested a weak relationship between broad money and inflation and unstable money multiplier, which are prerequisites for an effective monetary aggregates policy instrument. Analytical studies found that this relationship was relatively volatile and weak in most instances (Hangoma, 2010). The use of monetary aggregates also did not promote much financial market participation which increases Central Bank influence in the market. Thus, in April 2012, the policy rate was introduced as the major policy instrument replacing money supply. The use of interest rates as a policy instrument was intended to help usher the economy into an inflation targeting regime which is the ultimate goal (Chileshe & Zgambo, 2014).

The BOZ introduced the monetary policy committee rate (MPC rate) as the operating instrument effective on the assumption of a strong relationship between interest rates and inflation among others (Chileshe & Zgambo, 2014). This rate is usually revised after 3 months or in cases of discretionary policy requirements.

The use of interest rate based instruments has been on the rise as it is known to anchor inflation in a more efficient and transparent manner. The policy rate is set up to maintain inflation within a certain target and reviewed monthly to ensure consistency (Bank of Zambia, December 2012) This policy uses the overnight interbank rate as an operating target as opposed to reserve money, and it is usually maintained around the policy rate (Bank of Zambia, July 2012).

Interest rates are generally more easily understood by economic agents compared to monetary aggregates. Thus the use of interest rates helps implementation of monetary policy since agents will immediately understand and respond appropriately increasing efficiency of policy actions. For instance, if the Central Bank wants to reduce inflation, they increase the interest rate. Upon hearing of a proposed increase in interest rates, the public would understand that the economy is being tightened and that the cost of investment has risen. They also realise the opportunity cost of holding money has increased thus they immediately reduce money held or demanded which consequently reduces inflation. Interest rate and inflation expectations are thus anchored. This also improves transparency on the Central Banks part (Chileshe & Zgambo, 2014).

The exchange rate has remained flexible since financial liberalisation in 1992. It is completely market determined by demand and supply forces through the Interbank Foreign Exchange system (IFEM). This system was introduced to address the Central Bank shortcomings in foreign exchange purchases and sales whilst avoiding parallel markets as observed in the early 1990s. The public can thus access forex not only at the Central Bank but in Commercial Banks and bureau de charge institutions. This system also reduced volatility of the exchange rate observed prior to its introduction. The Central Banks' role is only to manage foreign exchange reserves for the country and in some cases smoothen swings in the exchange rate. There is however no control on the forex transactions in the Capital and Current account (Bank of Zambia, 2004).

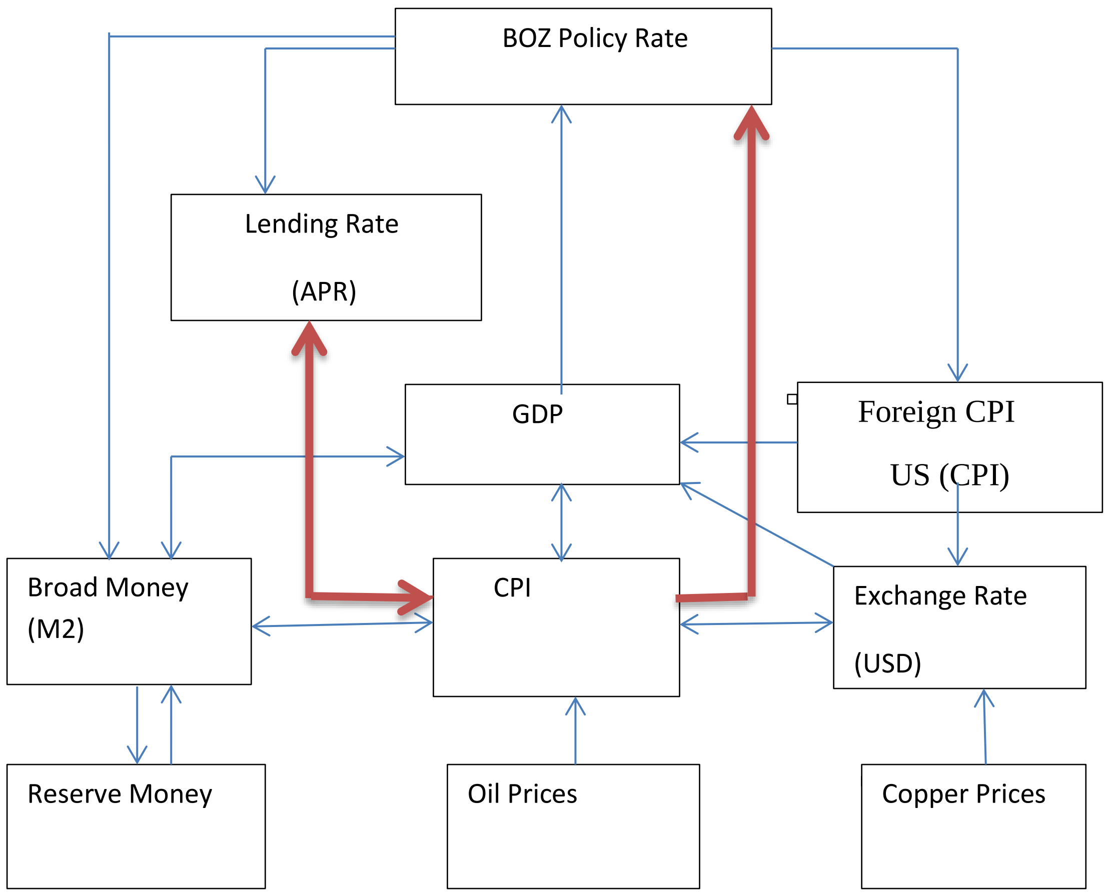
2.3 Monetary Policy Framework

The primary objective of the Bank of Zambia's monetary policy is price stability. The price level is to be kept low and stable to promote investment and hamper economic growth. The inflation rate is generally to be maintained in a range of 6% - 8% in the medium term. The mandate of the Central Bank is to formulate and implement monetary and supervisory policies that achieve and maintain price stability and promote financial stability.

As stated above, the Bank of Zambia uses the policy rate as an instrument for anchoring price level. The policy rate is determined by the Monetary Policy Committee (MPC) which sits quarterly to revise the rate depending on long term goals and the prevailing economic environment. The policy rate determines the fluctuations of the overnight interbank rate, which is usually in the interval of ±2% of the interbank rate corresponding to the policy rate unless circumstances require otherwise. The MPC thus set the rate and the Central Bank maintains the overnight interbank rate within the acceptable range through OMOs, Statutory reserve requirements and the overnight lending facility. If the interbank rate is too high, the Central Bank can carry out an Open Market purchase to increase money supply and thus reduce the interbank rate. This interbank rate thus determines the market interest rates and consequently, the inflation rate (Bank of Zambia, 2016).

In summary, the policy rate is the primary instrument, the interbank rate the operating target and inflation the policy goal. The policy rate also affects other variables like money supply indirectly influencing inflation. Exchange rates are also influenced by policy rates since the change in interest rates will cause an increase or decrease in demand of domestic currency so that the currency appreciates or depreciates respectively. Thus assuming substitutability between domestic and foreign capital assets, a change in interest rates will affect exchange rates. This consequently affects price of traded goods affecting inflation rates. The impact of policy rate through to inflation rate can be shown on the Zambian Quarterly Model (ZQM) below reflecting the monetary policy transmission mechanism (ibid).

Figure 2: Zambia Quarterly Model



Source: Bank of Zambia Website.

The highlighted arrows show the major monetary policy transmission mechanism. From the model above we can see that copper remains the major foreign currency supplier and so monetary variables through exchange rates are affected by changes in world copper prices. As in most non-oil producing countries, the oil prices directly affect inflation as oil is vital for production of most goods and services. Consequently, it affects the general price level and results in cost push inflation. Since Zambia is not an oil producing country, all oil is imported and so external oil pricing affects the macroeconomic variables triggering a response from monetary variables.

CHAPTER THREE: LITERATURE REVIEW

3.0 Introduction

This chapter reviews the theoretical and empirical literature on monetary response functions and their various applications in economic research. The first section looks at the theoretical literature detailing the two prominent monetary response functions i.e. Taylor's Rule and McCallum's Rule. The second section reviews the empirical literature beginning with various efficiency measures carried out in the Zambian context then proceeds to review some of the studies on monetary response functions done in both developing and developed countries.

3.1 Theoretical Review

A Monetary Response Function is a function relating a monetary policy instrument to a monetary policy goal. It is an equation that details which monetary policy goal has actually been influenced by actions of the Central Bank through available policy instruments (Setlhare, 2004). Bernanke and Frank (2009) define it as a model of Central Banks behaviour relating the Banks interest rates and the inflation rate. The expectation is that the Central Banks' behaviour will be anti-inflationary. Therefore, the Bank will increase interest rates if the inflation rate in above the inflation target. Similarly, if the output is below the potential output, the Bank will respond by reducing the interest rates as this will increase investment and consequently output.

Several rules such as Taylor's rule, McCallum rule and other hybrid rules have been constructed to elaborate on these functions. These functions generally differ in their monetary policy instruments and goals. The two prominent rules are detailed below.

3.1.1 Taylor Rule

Taylor rule is a monetary policy rule developed by John Taylor in 1993 on his research concerning monetary policy rules versus discretion. Based on the Barron and Gordon (1982) model, which critics discretion based on the time-inconsistency theory, Taylor advocated for a monetary policy rule that not only responded to monetary base or interest rates mechanically but systematically. Given the nature of an economy, a mechanical rule may prove to be unrealistic. However, evidence from the multicounty model he examined showed that monetary policy reacts systematically to not only price changes but also output changes. Thus instead of having a trade-off between the inflation and output or a price only rule, Taylor's rule assigns weighs to the two variables allowing for some discretion on the part of Central Bank in targeting the both macroeconomic variables (Taylor, 1993).

This rule provides recommendations for how the Central Bank sets the policy rate as economic conditions change in an effort to achieve stability. It shows the Federal funds rate (Central Bank interest rate) as a function of the real interest rate at zero inflation, past inflation, deviation of inflation rate from its target and output deviation from its desired level as show below;

$$i_t = \pi_{t-1} + \bar{r} + 0.5(\pi_{t-1} - \pi^T) + 0.5Y_t \qquad (3.1)$$

Where,

i_t = Federal Funds rate (policy rate)

π_{t-1} =average inflation rate over the last four quarters

$\bar{r}$ = real interest rate

π^T = target inflation

Y_t = output gap.

The output gap was computed as a percentage difference i.e. $Y_t = 100(y - y^*)/y^*$ where y is actual output and y^* is potential output. The potential output is obtained by estimating a linear trend of the log of real output (ibid).

The rule implies that a percentage increase in the inflation rate over its target will cause the federal funds rate to increase by 0.5 percent. Similarly, a percent fall of output below its target will result in federal funds rate increasing by 0.5 percent (Mankiw, 2000). The coefficients (0.5) are representative of the United States economy and thus cannot be generalized. Taylor also recommended the rule to be useful in measuring the performance of the Central Bank by measuring the degree to which the inflation rate fluctuates around the interest rate. He added that other measures such as fluctuations in real output, employment, the lagged interest rate for interest rate smoothing, and expected inflation could also be used to measure performance (Taylor, 1999).

Taylor (1993) observed that the above model is expected in both a flexible and fixed exchange rate system. However, when exchange rates are fixed, the interest rate changes would cause domestic currency changes and thus require readjustment of the interest rest to counter the appreciation or depreciation of the domestic currency. This is because the Central

Bank intervenes in foreign exchange (forex) market by purchasing domestic currency with foreign reserves. This causes loss of control on monetary base as it is dependent on the behaviour of the forex market. Thus monetary base can only be affected when domestic and foreign assets are not perfect substitutes (Emir, Karasoy, & Kutner, 2000). He therefore found the flexible exchange rate regimes to be superior in price stabilization to the fixed exchange rates regime since fixing the exchange rates implies an exchange rate rule. Similarly, output fluctuations were also observed to be larger when exchange rates are fixed relative to when they are flexible in most developing countries (Taylor, 1993).

Taylor's rule is famous because it is considered to be more realistic as most Central Banks use interest rates as a policy instrument and have inflation and/or output as their policy goal/s. Furthermore, research done after Taylor using his rule reveals coefficients similar to those reported by Taylor more often than not (McCallum Bennet & Edwards, 1999).

3.1.2 McCallum Monetary Response

McCallum developed a monetary policy rule that is basically a nominal feedback rule in 1988. This response function unlike Taylor's, considers monetary aggregates as policy rule and a nominal growth rate target. Thus it is a proportional feedback rule of the change in the monetary aggregates due to a change in the nominal output gap. The nominal growth rate can be considered inflation and output gap such that targets in the Taylor rule and McCallum rule are not fundamentally different (McCallum, 2000). Both recognised the importance of flexibility in monetary policy rule setting. This made it in essence vaguely similar to Taylor's rule differing mainly in policy instrument only.

The rule is expressed as follows;

$$\Delta b_t = \Delta x^* - \Delta v_{at} + 0.5(\Delta x^* - \Delta x_{t-1}) \tag{3.2}$$

Where;

Δbt = change in the log of the adjusted monetary base

Δx* =target growth rate for nominal GDP

Δxt =change in the log of nominal GDP

Δv i=average growth of base velocity over the previous 16 quarters or 4 years

The target growth rate is specified as $p^* + \Delta y^*$, where Δy^* is the long-run average rate of growth of *real* GDP and p^* is target inflation (McCallum, 2000). All the variables are in logarithmic form.

Other monetary policy functions have been developed that incorporate the McCallum rule. Some of them include the hybrid Taylor-McCallum rule where interest rates respond to nominal output gap and the McCallum-Hall-Mankiw rule where monetary base growth responds to inflation and output gap. Application of these rules depends on an economy and its characteristics (Patra & Kapur, 2012).

3.1.3 Review of Theoretical Literature

The expected signs of these monetary response function relationships' are based on the general New Keynesian Theory. According to monetarists, interest rates and money supply have a negative relationship so that the two variables have opposing effects on macroeconomic variables. Similarly, Irving Fisher suggested that inflation and money supply have a directly proportional relationship so that an increase in one variable immediately results into the other increases. Therefore, we expect that an increase in inflation above its target will be responded to by a decrease in money supply or an increase in interest rates. This implies a negative relationship between inflation gap and a money supply instrument but positive relationship with regards to an interest rate instrument (Mankiw, 2000).

The Mundell-Fleming model of IS-LM which explained the relationship between nominal exchange rates, interest rates and output, expects that an expansionary monetary policy will cause an increase in output. This is because expansionary monetary policy, which can be carried out by increasing money supply or reducing interest rates, will increase money available in the economy directly causing increased spending and output consequently. This will also increase investment when interest rates fall due to the low cost of borrowing also increasing output. Increased money supply also increases spending and thus aggregate demand increasing output. The fall in output below its target will therefore induce an increase in money supply or a fall in interest rates (Mishkin, 2004).

Mundell-Fleming-Dornbusch model (IS-LM-BOP) which included the BOP account also assumes a priori, that expansionary monetary policy will reduce interest rates and it will be required to correct an appreciation of exchange rate under a flexible exchange rate regime. Exchange rates are based on the supply and demand of domestic or foreign currency. Assuming the exchange rate is the domestic currency per unit of foreign currency, depreciation will respond to by a fall in money supply or an increase in interest rates as this will reduce supply of domestic currency. This is because fall in money supply will reduce domestic currency available causing the exchange rate to appreciate. Similarly, an increase in interest rates will make domestic capital relatively more profitable so that there will be increased demand for domestic capital assets resulting in an influx of foreign currency or increased demand for domestic currency causing the exchange rate to depreciate (Rafiq & Mallick, 2008).

3.2 Empirical Review

3.2.1 Monetary policy efficiency measures

Measures of monetary policy effectiveness are many and continue to be criticized and/or developed upon. Most effectiveness studies' have focused on developed countries and not developing ones as developing countries may have in past years focused on stability rather than sustainability of their macro economy. However, with most developing countries having stabilised their economies, the issue of sustainability is now of growing interest.

In the Zambian context, only three significant studies are available on the effectiveness of monetary policy. One study compared the pre liberalization and post liberalisation monetary policy instruments which are direct and indirect instruments respectively. The study revealed that indirect instruments where more efficient than the direct ones in controlling inflation based on the success recorded in bringing down and stabilizing inflation. This study, done by Abraham Mwenda in 1999, used an Autoregressive model to model money supply (M2) and the Chow test to measure stability of money supply. The Z-test was then used to test money supply control in the 2 periods (Mwenda, 1999). This study was synonymous with the traditional approach in which money growth rate is used to measure effectiveness of instruments.

A more recent study on the measure of effectiveness of monetary policy was done by Chipili & Zgambo (2014). This study estimated the stability of the money demand function and analysed the monetary policy transmission mechanism using ARDL. The period of study focused on the monetary aggregates regime and the results indicated the continued importance of monetary aggregates in monetary policy. This was based on an insignificant relationship between interest rates and inflation and a stable money demand function. Similar results were obtained by Chileshe *et.al* (2014) using VAR techniques. They concluded that there has been, up until 2014, a strong link between monetary aggregates, inflation and output whilst interest rates link remains weak. These studies were a good improvement on effectiveness study but did not adequately incorporate the role of interest rates as policy instruments. Focus was on money supply instruments as opposed to interest rates.

In developed countries, estimation of effectiveness of monetary policy has incorporated the use of monetary response functions. A study of the United States (US) economy by Clarida, Gali & Gertler in 2000 estimated the effectiveness of monetary policy using a policy reaction function run by a Generalized Method of Moments (GMM) model. The objective was to determine whether monetary policy was more effective in the United States in the pre-Volcker era compared to the post–Volcker era. The study compared the standard error of inflation gap and output gap in the 2 periods. Stability tests of the reaction functions, using Hansen J-statistic, were also estimated in the two periods. The study concluded that the response to inflation gaps has been more systematic in the post-war era and thus monetary policy can be said to be more effective (Clarida, Gali, & Gertler, 2000).

Similarly, Pancrazi & Vukotic (2015) aimed at determining if monetary policy had maintained its effectiveness using Taylor's rule. The objective was to determine if the policy instruments used in the pre-war era could still be effective in today's era. Using Taylor's rule, effectiveness of monetary policy was measured using the elasticity of the inflation and output gap with respect to the marginal change in the policy instrument. The results showed a decline in the policy instrument responsiveness as the post-war era efficiency measures is lower than the pre-war era. This analysis, unlike that of Clarida, Gali & Gertler (2000), used a dynamic stochastic general equilibrium (DSGE) approach which is better for policy analysis and forecasting whilst still using a linear model as the Taylor rule is specified (Pancrazi & Vukotic, 2015).

Another study on the United States economy to measure effectiveness of monetary policy was done by Boivin & Giannoni (2006). The objective was to establish if monetary policy had become more effective over time thus the period prior to 1980 and after 1980 were examined. This study used the VAR model to obtain policy reaction functions. Thus the reduced form of the structural model gave a policy reaction function similar to that of Taylor's rule. The impulse response functions were used to observe the reaction of policy instrument to inflation and output gaps. Based on reduced volatility in output and inflation and stronger responses of monetary policy instruments (federal funds rate) to inflation gap after 1980, the study concludes that monetary policy has become more effective in the US (Boivin & Giannoni, 2006).

3.2.2 Monetary response functions in developing countries.

A number of developing countries have estimated the monetary response function without particular attention to implications on efficiency. Other objectives have been pursued particularly macro-modelling so as to understand the behaviour of Central Banks. Most response functions were tailored to that of Taylor's whilst a few were tailored to that of McCallum's Rule. The studies have also used various estimation techniques to obtain these response functions. The first section looks at Taylor rule based functions and the second at McCallum rule based functions.

a) Models following Taylors Rule

Iklagi (2009) estimated Nigeria's response function for the macro-modelling purposes using a small open macroeconomic model. Analysis was done using baseline forecasts and indicated that the Central Bank followed some rule and that policy was biased towards price stabilization. Agu (2011) also did a study in Nigeria estimating an interest rate (Minimum Rediscount rate) based monetary response function using Taylor's rule. The extended Taylor rule included the conventional inflation and output gap and credit to private sector, public credit growth and exchange rates with the objective of modelling Central Bank behaviour. The study found that only inflation and output gap and private credit significantly affect the interest rate and like Iklagi (2009) concluded that the Central Bank follows some rule. A more recent study by Kelikume et. al (2016) used ARDL to estimate Nigeria's response function. The analysis showed that monetary policy moves along decreasing inflation whilst output deviations are not significant. Based on the three studies, it can be concluded that monetary policy is biased towards price stability.

Setlhare (2004) modelled Botswana's monetary policy by estimating its monetary response functions so as to establish if the Central Bank had a systematic policy. Two models were estimated, one based on a proportional rule and the other on an integral rule where inflation enters in difference form and in growth form respectively. Using Ordinary Least Squares (OLS), several response functions were estimated based on various information variables and over various time periods. The results showed inflation to be a significant variable implying that price stability could be the Central Banks priority as stated in its policy mandate. Output was found to be insignificant whilst real exchange rate was significant reemphasizing Central Bank priority of price stability over output stability. Private credit was found to be a key intermediate variable due to its strong relationship with the bank rate. Finally, the integral rule was found to outperform the proportional rule since the latter responds to growth of inflation over four quarters whilst the former responds to immediate past inflation (Setlhare, 2004).

Various estimation techniques have also been used in these Taylor-rule based studies. Some studies like that of Hashmi et.al (2011) for Pakistan, Korea, Phillipines and Japan used OLS to analyse the response functions. In this study, foreign capital inflows where included which were observed to be generally insignificant in the short run (Hashmi, Xu, Khan, Bashir, & Ghazanfar, 2011). Another study in India by Inoue & Hamori (2009) used the Dynamic OLS model to estimate India's response function. They found that inflation gap had a wrong sign and was insignificant in models including and excluding exchange rates. Thus they recommended the continued use of monetary aggregates as nominal anchor and not pursue interest rates as they did not effectively respond to inflation but only output and exchange rates (Inoue & Hamori, 2009).

Studies that were done by Hsing & Lee (2004) for Korea, Hsing (2004) for Japan and Chang (2005) in Taiwan used the VAR model to estimate response functions. Hsing & Lee estimated an extended Taylor-rule type function and found that the call rate responded positively to a shock in inflation gap, output gap, exchange rate gap, stock price gap and the lagged call rate. Inflation gap and exchange rate gap were more influential in short run whilst output and stock price gap were more prevalent in the long run. Hsing (2004) estimated the same model in Japan and obtained similar results. Additionally, the inflation gap and exchange rate were more influential than output and stock price gap in explaining the call rate. Chang (2005) also used the same model except 2 policy instruments, the discount rate and collateral loan rate, were employed. The results were similar for instruments, all positive responses, but output and exchange rate gaps had no significant impact on the instruments. The results reflected that monetary policy prioritised price stability. The Impulse Response and Variance Decomposition Functions were used to obtain the results from the VAR model in these studies.

b) Models following McCallum's Rule

In a bid to analyse monetary policy in India, Patra & Kapur (2012) estimated four monetary response functions. The response functions where based on McCallum's rule, Taylor's rule, Hybrid Taylor-McCallum's rule and Hybrid McCallum-Ham-Mankiw rule. The McCallum's rule estimated an extended monetary response function with various measures of income[3] and exchange rates. This analysis was done using the GMM. The results are in line with theory as all the coefficients are positive. Since inflation and output gap were measured as target minus actual, an increase in the gap implies either inflation has fallen below target or income is below its potential output. The appropriate response to this would then be expansionary monetary policy, thus the positive coefficients. Exchange rates were also significant emphasizing their importance in monetary policy of emerging economies. Exchange rate gap is defined as real effective exchange rate minus nominal exchange rate. Thus an increase in this gap requires expansionary monetary policy, an increase in monetary base. The results showed that the rules combining inflation and output describe the monetary policy better (Patra & Kapur, 2012).

A similar study was done by Mehrotra & Sanchez-Fung (2009) to estimate Taylor's, McCallum and the hybrid rules in 20 emerging nations. GMM and OLS methods were also used to estimate the response functions. The McCallum rule also included the lagged monetary base and exchange rates. The results showed that all countries have correct signs with countries like Uruguay having coefficients similar to McCallum (2003) for USA and

[3] Agricultural and non-agricultural income

Japan. Exchange rates have an expected negative sign but did not play a significant role compared to the hybrid models. For Tunisia, the inflation gap and exchange rate had a negative coefficient so that the Central Bank tightens monetary policy when inflation is above target or when the exchange rate depreciates. The study concludes inflation targeting economies were better characterised by hybrid Taylor-McCallum rule whilst other economies have their instruments responding to domestic targets i.e. output gap, inflation gap and exchange rates (Mehrotra & Sánchez-Fung, 2009).

Rotich, Kathanje & Maana (2007) did a study in Kenya to model the Central Bank rule based behaviour. In this study, both Taylor's rule and McCallum's response function were estimated. GMM was applied to analyse both response functions. The results showed that inflation and money supply (M3) have a negative relationship as a percentage annual increase in inflation lead to 4% increase in M3. Exchange rates also had a negative and significant impact on M3. With regards to interest rates, inflation gap had a positive impact whilst output gap had a negative one. The wrong sign on output was attributed to poor proxy variables for GDP. When exchange rates were added, the coefficient of output gap became positive whilst exchange rates were also positive as expected. The study concluded that the Central Bank followed a rule that is biased towards stabilizing inflation gap with some allowance of output stabilization with exchange rates playing a significant role (Rotich, Kathanje, & Maana, 2007).

Another study that was done by Sanchez-Fung (2000) estimated the reaction function for Dominican Republic during the period 1970-98. This is done for two periods i.e. prior to 1985 and post 1985. Taylor's rule was estimated but with monetary aggregates run against output gap and exchange rate gap[4]. Both variables were significant after 1985 but prior to 1985 only exchange rate gap was significant. This showed that monetary policy had become more systematic shifting away from exchange rate bias. Sanchez-Fung (2002) did another study for the period 1969-2000 and included inflation gap. The response function was based on McCallum (2000), an equation with monetary base as policy instrument. Using the same method, the results showed that the inflation and output gap were insignificant whilst exchange rates had a positive impact on money supply. These studies showed that monetary policy in Dominican Republic is biased towards stabilising exchange rate gap.

[4]Foreign exchange market rate minus official rate.

3.2.3 Synthesis

As stated earlier, no study in Zambia has been done to measure effectiveness of monetary policy using monetary response functions. The literature reviewed from developed countries shows monetary response functions can be used to measuring efficiency with the elasticity of the macroeconomic variables to policy instruments or the standard deviation of the instruments coefficients in response to macroeconomic changes

Mehrotra & Sanchez-Fung (2009) helps in selection of an appropriate theoretical framework for the monetary response functions as it advocates for the use a rule where policy instruments target output gap, inflation gap or nominal income and exchange rates for non-inflation targeting economies. Thus an extended Taylor's rule and McCallum rule is estimated in this study. All the variables areincluded in the model since most literature in developing countries found inflation gap and exchange rates to be significant. The results concerning output gap were contradicting and so the variable will still be included in the model. The literature from the developing countries also gives a clear picture of the expected results. The VAR model will be used since standard deviation of the coefficients can be obtained from the impulse response function whilst providing a simple alternative to the more complex structural equations like DSGE.

CHAPTER FOUR: METHODOLOGY

4.0 Introduction

This section looks at the methodological framework used to estimate the monetary response functions for Zambia. The section begins with the theoretical framework upon which the response functions are based. From the theory, the econometric model that will be used for estimation is specified. The third section elaborates on how each of the variables included in the model are defined. Lastly but not the least, the estimation procedure of the chosen model will be outlined and finally the type and sources of the data stated.

4.1 Theoretical Framework

Several monetary response functions have been coined in the last two decades. Prominent amongst these are Taylor's rule and McCallum's rule. These rules both advocate for a rule rather than discretion based on the time-inconsistency critic. However, they still allow for some flexibility given the nature of economies. Thus, contrary to monetary response functions prior to Taylor's, that only considered inflation as target, these response functions include not only inflation but also output. Both rules, along with other more recent policy rules like the Hybrid Taylor-McCallum rule and the Hybrid McCallum-Hall-Mankiw rule incorporate discretion in their monetary response rule. Taylor's rule extends further by allowing for other variables such as stock prices, exchange rates, fiscal deficit, employment, private credit etc. (Patra & Kapur, 2012).

Taylor's rule is generally a monetary policy rule that looks at how the Central Bank base interest rate responds to changes in inflation and output gap. It describes how the interest rate reacts to inflation and other macroeconomic variables in a systematic manner (Taylor, 1993). The general formulation of Taylor's rule is given below;

$$i_t = f(\Delta\pi_t, \Delta y_t) \qquad (4.1.1)$$

Where;

i_t = Central Bank interest rate

$\Delta\pi_t$ =inflation gap (actual inflation- target inflation)

Δy_t = output gap (actual inflation - target inflation)

This rule has a linear specification as shown below;

$$i_t = \pi_{t-1} + \bar{r} + \alpha(\pi_t - \pi^T) + \beta(Y_t - Y^T) \qquad (4.1.2)$$

Where;

π_{t-1} = average inflation rate over the last four quarters

$\bar{r}$ = real interest rate

π^T = target inflation

Y^T= target output

Generally, the nominal interest rate is the real interest plus inflation in that period. Thus the first two terms correspond to interest rate in the previous period. This term is added for interest rate smoothing so that Taylor's rule can be specified as;

$$i_t = i_{t-1} + \alpha(\pi_t - \pi^T) + \beta(Y_t - Y^T) \qquad (4.1.3)$$

According to Taylor (1993), the coefficients α and β are expected to be positive. This implies when actual inflation exceeds the targeted inflation, the interest rate is increased. Thus an overshooting of inflation rate above its target is responded to by the Central Bank contractionary monetary policy. Similarly, an increase in actual output over the targeted will result in increase in interest rate. This is because when the output exceeds the targeted output then a contractionary monetary policy will be required to reduce output and bring it towards the target output (Younus, 2017).

The second monetary policy rule, McCallum's rule specified monetary base as the monetary policy instrument. In this proportional rule, there is a feedback from changes in the nominal income growth rate onto the monetary base. The model is generalised as;

$$b_t = f(\Delta x) \qquad (4.1.4)$$

Where

b_t = monetary base

Δx = nominal income growth rate gap (actual nominal income growth rate - target nominal income growth rate)

The function is specified as the linear function shown below;

$$\Delta b_t = \Delta x^* - \Delta v_{at} + 0.5(\Delta x^* - \Delta x_{t-1}) \qquad (4.1.5)$$

Where;
Δbt = change in the log of the adjusted monetary base
Δx* = target growth rate for nominal GDP
Δxt = change in the log of nominal GDP
Δv = average growth of base velocity over the previous 16 quarters or 4 years

Change in nominal GDP is generally considered change in price level plus change in real income. The average growth of base velocity was introduced as it represents a long lasting trend unlike average growth in velocity. Based on Fishers equation, we expect the nominal growth rate less average growth of base velocity to be the growth in monetary base. Thus the first two variables reflect long lasting changes that may affect monetary base. This term is however not considered vital and can thus be left out (Patra & Kapur, 2012). McCallum's rule can then be simplified to;

$$\Delta b_t = \Delta b_{t-1} + \alpha[(\Delta p + \Delta y)^* - (\Delta p + \Delta y)] \quad (4.1.6)$$

Where;

Δp = change in price level

Δy = change in income

Simplified as;

$$\Delta b_t = \Delta b_{t-1} + \alpha(\Delta p - \Delta p^*) + \beta(\Delta y - \Delta y^*) \quad (4.1.7)$$

The coefficients α and β are expected to be negative. This is because an increase in inflation over its target will be responded to by a decrease in monetary base, a contractionary monetary policy. An increase in output over its target will also require a contractionary monetary policy action to bring output down to its target, thus a decrease in the monetary base is required. According to Patra & Kapur (2012) exchange rate smoothing is vital in these rules for emerging economies since the Central Bank has to intervene frequently as small economics are more often exposed to exchange rate volatility. Thus exchange rates are added to both response functions.

4.2 Model Specification

The main focus of this paper is to determine the effectiveness of monetary policy by estimating the response functions. Since Zambia has had two major policy instruments in the last 20 years, 2 response functions are estimated, one based on Taylor's rule and other on McCallum's rule as done by Rotich et.al (2007). This is because Rotich et.al (2007) studies the Kenyan economy which has undergone structural changes similar to that of Zambias' and also used both monetary aggregates and interest rates as policy instrument over the past 20 years.

According to Taylor (1993), a complete structural model would make it easy to quantify the effects of monetary policy since it will incorporate exogenous effects of aggregate supply and demand. However, Rudebusch (1998) advocated for the VAR model in studying monetary policy as it can identify the effects of a policy without a complete structural model. Thus the VAR approach is used to estimate the response functions as used by Hsing (2004). The VAR also has the advantage of assuming all variables are endogenous which is may be the case for most monetary policy variables.

The VAR equation is as shown below;

$$X_t = A_0 + \sum_{i=1}^{p} A_i X_{t-i} + \gamma_i d_i + V_T \quad (4.2.1)$$

Where X_t denotes a vector of endogenous variables

Thus, $X_t = (i, Y, \pi, Ex, Ms)'$

The variables are defined as

V_T is a vector if disturbance term

A is matrix of coefficients d_i is a vector of dummy variables where d_i=1 when t=2012 to 2016 (representing period on interest rates as policy instrument) and 0 otherwise.

i = Policy rate

Y = Output gap

π = Inflation gap

Ex = Exchange rate

Ms = Money Supply

As stated by Taylor (1993),$Y_t = 100(y - y^*)/y^*$, where y^* is obtained from output trend. If y is regressed against time, the estimated y represents potential y = y*.

That is $y_t = \alpha + \beta time$ then $y^* = \hat{\alpha} + \hat{\beta} time$where y is log of output.

From this VAR (p) the following system of equations are obtained

$$\begin{bmatrix} i_t \\ Y_t \\ \pi_t \\ Ms_t \\ Ex_t \end{bmatrix} = \begin{bmatrix} A_{01} \\ A_{02} \\ A_{03} \\ A_{04} \\ A_{05} \end{bmatrix} + A_{1i} \begin{bmatrix} i_{t-1} \\ Y_{t-1} \\ \pi_{t-1} \\ Ms_{t-1} \\ Ex_{t-1} \end{bmatrix} + \cdots + A_{Pi} \begin{bmatrix} i_{t-p} \\ Y_{t-p} \\ \pi_{t-p} \\ Ms_{t-p} \\ Ex_{t-p} \end{bmatrix} + \gamma_i \begin{bmatrix} d_{1i} \\ d_{2i} \\ d_{3i} \\ d_{4i} \\ d_{5i} \end{bmatrix} + \begin{bmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \\ v_{4t} \\ v_{5t} \end{bmatrix} \quad (4.2.2)$$

Where A_{1i} is a 5*5 matrix of coefficients.

γ_i is also a 5*5 matrix of coefficients where coefficients lie along the diagonal only.

This system of equations will then give an equation similar to Taylors' equation (4.1.3) as shown below.

$$i_t = A_{10} + \sum_{j=1}^{p} A_{1i} i_{t-j} + \sum_{j=1}^{p} A_{2i} Y_{t-j} + \sum_{j=1}^{p} A_{3i} \pi_{t-j} + \sum_{j=1}^{p} A_{4i} Ms_{t-j} + \sum_{j=1}^{p} A_{4i} Ex_{t-j} + \gamma_i d_i \quad (4.2.3)$$

Similarly, the VAR (p) is run to obtain the McCallum response functions (4.1.7) for monetary aggregates from the system as below;

$$Ms_t = A_{10} + \sum_{j=1}^{p} A_{1i} b_{t-j} + \sum_{j=1}^{p} A_{2i} Y_{t-j} + \sum_{j=1}^{p} A_{3i} \pi_{t-j} + \sum_{j=1}^{p} A_{4i} i_{t-j} + \sum_{j=1}^{p} A_{4i} Ex_{t-j} + \gamma_i d_i \quad (4.2.4)$$

Thus the VAR (p) system of equations gives both monetary response functions.
Impulse response functions will then be used to determine the response of interest rates when a macroeconomic shock introduced to the system.
Similarly the response of the monetary aggregates instrument to shocks in output gap, inflation gap and exchange rate is obtained from the impulse response functions.

Exchange rates are included due to the fact that stabilization of the rate from external shocks is a huge part of monetary policy in Zambia as in most developing countries. Empirical evidence in most developing countries estimating the response function includes exchange rates and found it to be significant. Due to high import dependence and the sensitivity of the exchange rates to external shocks, it is vital for policy makers to ensure the exchange rate is stable. Thus it plays a huge role in monetary policy regardless of the exchange rate system at play.

4.3 Choice and Measurement of Variables

The table below gives a clear outline of how each variable used in the above model was measured or constructed.

Variable	Measurement
Interest Rates (i)	Policy rate
Real Money Balances (Ms)	M2 is basically a broad form of money comprising of savings, time deposits, money market mutual funds, money market deposit accounts and overnight repurchasement agreements.
Output Gap (Y)	Difference between actual output and potential output. Since potential output does not vary much overtime it is measured by trend in output as done by Taylor (1993).
Inflation gap(π)	Difference between actual inflation and target inflation. Inflation is computed using Consumer Price Index (CPI). Inflation targets are based annual targets set by the Ministry of Finance.
Exchange Rates (EX)	The Zambian Kwacha per US dollars exchange rates are used to derive explicit exchange rates. According to XE currency website, the USD/ZMW is the most popular exchange rate in Zambia (XE, 2017).

4.4 Estimation Techniques

The estimation procedure first required testing for stationarity of all the variables. This is because time series variables can be nonstationary and regressing nonstationary variables will lead to spurious regressions. To test for stationarity, the Augmented Dickey Fuller (ADF) the Phillips-Perron (PP) and Kwiatkowski-Philip-Schmidt-Shin (KPSS) Tests are used. If the variable is not stationary at levels, the unit root tests are then run on the differenced variable. If the hypothesis of unit root is rejected, then the variable is stationary (Gujarati, D, & Gunasekar, 2012).

A suitable lag length is then required for a correct VAR specification and to test for cointegration. To obtain the optimal lag length, the Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC) and Hanna-Quinn Criterion (HQ) is used. The lag length which minimises the information criteria is chosen as it is the most optimal. This ensures the model is well specified (Enders, 2015).

For variables that are stationary at first difference, a co-integration test is carried out. Cointegration is basically a linear combination of non-stationary variables that is stationary. If the linear combination is stationary, then a long-run relationship and a spurious relationship do not exist among the nonstationary variables. Cointegration is tested using the Johansen co-integration test. This test is used as it allows for multiple co-integrating relationships unlike the Engle Granger Test. If there is at least one unrestricted co-integrating equation, then a long run relationship exists between these variables. The short run and long-run dynamics could then be estimated using the Vector Error Correction Model (VECM) instead of the VAR Model. The VECM, unlike the VAR, would give an error correction model showing the short-run relationship, long run relationship and the short-run adjustment to the long-run. If the variables are stationary at levels, the Unrestricted VAR Model would be estimated in level form (Gujarati, D, & Gunasekar, 2012).

After estimating the model, diagnostic tests are carried out to ensure consistent estimates and a stable model. Diagnostic procedures included Heteroscedasticity, serial autocorrelation, multi-variate normality and stability tests. Heteroscedasticityias tested using Whites Heteroscedasticity test whilst autocorrelation is tested using the LM autocorrelation test. The normality test is done using Jarque-Bera test and finally model stability is tested using the inverse roots procedure (ibid).

Finally impulse response functions are used to uncover dynamic relationships and the variance decomposition to understand the extent of these interrelationships. The innovations are to be treated as monetary policy shocks so as to establish their responsiveness. Generally effectiveness is measured by the ability to stabilize shocks, success in eliminating sources of fluctuations and extent to which the policy can reduce randomness in its policy setting (Boivin & Giannoni, 2006). Impulse response functions will generate time-dynamic effects of monetary innovations on non-policy variables (Chuku, 2009). Thus these functions help determine efficiency.

4.5 Data Sources and Analysis

Quarterly Data from 2000 to 2016 obtained from the Bank of Zambia (BOZ), Ministry of Finance (MOF) and Central Statistical Office (CSO) is used for analysis. No quarterly data for GDP is available in Zambia hence the Index of Industrial Production was used to proxy a quarterly GDP series as done by Chipili & Zgambo (2014). E-views is used for analysis of results as it has all the analytical procedures required and is familiar to the author.

CHAPTER FIVE: ANALYSIS OF RESULTS

5.0 Introduction

The main purpose of this study is to measure the effectiveness of monetary policy by looking at the responsiveness of monetary policy instruments to macroeconomics changes. This is done using innovation accounting where the macroeconomic changes (e.g. inflation gap) are considered shocks and the response of monetary instrument (e.g. policy rate) is estimated over a period. To obtain these, descriptive statistics are first observed to examine the behaviour of each stochastic process. Unit root tests will then be carried out to determine the stationarity of each process. Thirdly, estimation will be done using either VECM or VAR depending on the presence of a long term relationship or lack thereof. Finally, innovation accounting will be done which includes impulse response functions and variance decomposition functions.

As stated in the previous chapter, five variables are included in the model of analysis. These are the policy rate, money supply, inflation gap, output gap and exchange rates. Inflation gap is computed by obtaining the difference between actual inflation and target inflation. Since only annual targets for inflation are available, the inflation gap in a year depended only on the actual inflation in each quarter. End quarter values were used since our interest is to see how far the actual value is from the target. Output gap is measured by the difference between the actual output and potential output where potential output was proxied by estimating a trend series using the Hendrick-Prescott Filter as done by McCallum (2000). The other variables are taken as given by the Central Bank. The Policy rate, which is the base lending rate, wasprior to the use of interest rate as policy instrument was referred to as the Central Bank rate. Money supply is measured as M2 and entered in logarithmic form for scaling purposes whilst exchange rates is measured as the domestic price of a US dollar as US dollar is the most commonly traded foreign currency in Zambia.

5.1 Descriptive Statistics

These statistics give a general overview of the data at hand focusing mainly on the measures of central tendency and dispersion. Table 2 below gives the descriptive statistics for each variable under study. Skewness for a normally distributed series is expected to be 0 whilst Kurtosis is to be 3. The Jarque-Bera (JB) statistic that tests for normality is based on the Skewness and Kurtosis values. The Null hypothesis for the normality test states that the series is normally distributed thus money supply, exchange rates and output gap are normally distributed since its JB probability is greater than 0.05 so that the null hypothesis is not rejected at 5% significance. The policy rate and inflation gap have a probability value that is less than 0.05 and so we reject the hypothesis of being normally distributed. Only policy rate and inflation gap are not normally distributed.

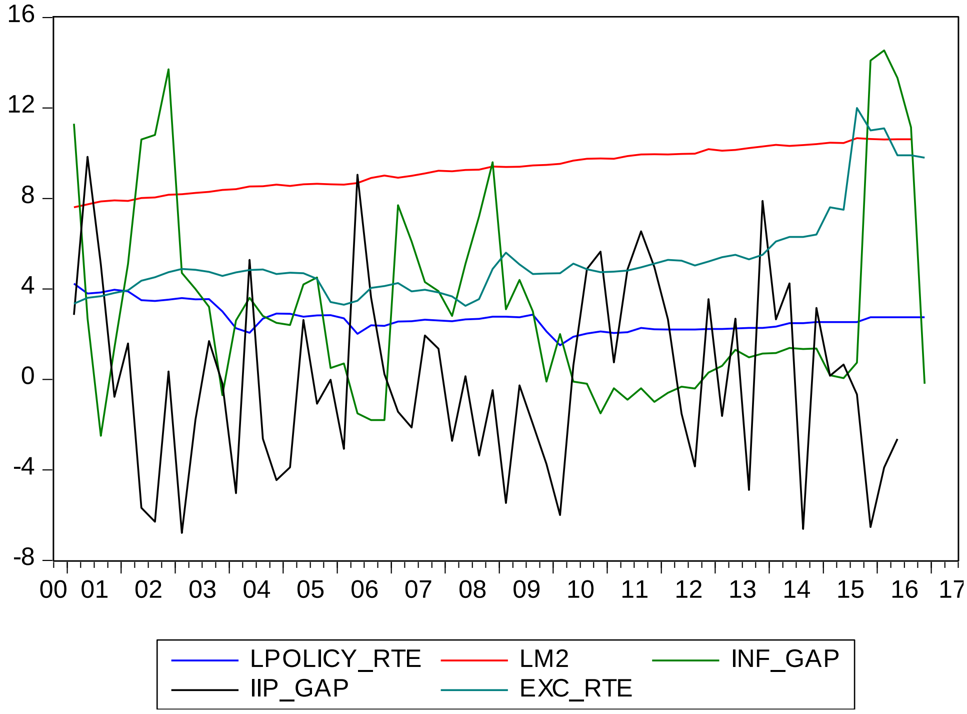
Table 2: Descriptive Statistics

	Money Supply	POLICY RATE	INFLATION GAP	OUTPUT GAP	EXCHANGE RATE
Mean	8.905319	2.855819	3.003696	0.214922	4.435352
Median	8.909364	2.690194	2.750000	0.060240	4.668550
Maximum	10.36889	6.932448	13.70000	9.840682	6.100000
Minimum	7.609737	1.509590	-2.500000	-6.793099	3.249700
Std. Dev.	0.703689	0.882165	3.837745	4.056643	0.646815
Skewness	0.042200	2.233157	0.887633	0.290900	-0.077372

Kurtosis	2.004693	10.98750	3.350100	2.545819	2.630737
Jarque-Bera	1.912371	160.5173	6.275439	1.044144	0.307243
Probability	0.384356	0.000000	0.043382	0.593290	0.857597

Additionally a time plot of each variable is shown below in Figure 3. The time plots in the graph generally shows no trend for most of the series except money supply and exchange rates that seem to have a slight upward trend while policy rate has a slight downward trend. The plots also indicate no visible structural breaks for each of the series thus a time dummy may not be vital for this study. The variables without a trend may also suggest that the variables are stationary.

Figure 3: Time Plots



Where LPOLICY_RTE is the Policy rate

LM2 is the log of Money Supply

INF_GAP is the Inflation gap

IIP_GAP is the Output gap

EXC_RTE is the Exchange rate

5.2 Unit Root Tests

Testing for unit roots implies testing for the stationarity (fluctuations about the mean) nature of a time series. Regressing nonstationary series may result in spurious regressions thus testing for stationarity is important if one is to obtain results with some economic meaning (Enders, 2015). If a variable is not stationary at levels, it can be transformed to be stationary by differencing or detrending (subtracting the mean). Several tests have been used to test for stationarity as each test has its own advantages. Augmented Dickey Fuller (ADF) test adjusts for serial correlation which may be present by adding a differenced lagged dependent variable. The Phillip-Perron (PP) test is a non-parametric test and thus is able to correct for heteroscedasticity and serial correlation of the error resulting in consistent estimates (Greene, 2000). Though the PP test is generally stronger than the ADF test, the Kwiatkowski-Philip-Schmidt-Shin (KPSS) test is also added as it is a more efficient Dickey Fuller test (Enders, 2015). The KPSS compliments the ADF test but is considered more efficient as it tests for stationarity and other unit root tests like ADF and PP (Greene, 2000). Thus in cases of contradicting results, the KPSS test is referred to as the tie breaker. Break point unit root tests are not used as no visible structural breaks were observed on the time plots. The test statistics included will be based on the trended model if the trend is significant and/or if a unit root is not present at levels, otherwise the non-trended model is used. The unit root test results are shown below.

Table 3: Augmented Dickey-Fuller (ADF) Unit Root Tests

H0: Variable has a Unit Root

Variable	Levels		First Difference	
	ADF Test statistic	Prob	ADF Test statistic	Prob
Policy Rate	-2.617	0.0951*	-6.7210	0.000***
Money Supply (M2)	-4.025	0.0127**	-7.5587	0.000***
Inflation Gap	-3.301	0.0013***	-6.3347	0.000***
Output Gap	-6.453	0.0000***	-7.7467	0.000***
Exchange rate	0.8899	0.8981	-8.6839	0.000***

*** significant at 1% ** significant at 5% *significant at 10%

Table 4: Phillips-Perron (PP) Test

H0: Variable has a Unit Root

Variable	Levels		First Difference	
	PP Test statistic	Prob	PP Test statistic	Prob
Policy Rate	-1.5522	0.113	-7.172	0.0001***
Money Supply (M2)	-3.989	0.014**	-20.839	0.000***
Inflation Gap	-3.301	0.001***	-7.106	0.000***
Output Gap	-6.423	0.000***	-23.459	0.000***
Exchange rate	1.4398	0.962	-8.677	0.000***

*** significant at 1% ** significant at 5% *significant at 10%

Table 5: Kwiatkowski-Philip-Schmidt-Shin (KPSS) Test

H0: Variable is Stationary

Variable	Levels		First Difference	
	LM Test statistic	Critical value at 5% significance	LM Test statistic	Critical value at 5% significance
Policy Rate	0.157	0.146**	0.021	0.146
Money Supply (M2)	0.176	0.146**	0.041	0.146
Inflation Gap	0.161	0.463	0.088	0.463
Output Gap	0.074	0.463	0.145	0.463
Exchange rate	0.194	0.146**	0.096	0.146

*** significant at 1% ** significant at 5% *significant at 10%

The above test results are summarised below;

Table 6: Unit Root Tests

Variable	**ADF**	**PP**	**KPSS**
Policy Rate	I(1)	I(0)	I(1)
Money Supply (M2)	I(0)	I(1)	I(1)
Inflation Gap	I(0)	I(0)	I(0)
Output Gap	I(0)	I(0)	I(0)

Exchange rate	I(1)	I(1)	I(1)

I (1) implies stationary at first difference I (0) implies stationary at levels

From the above results we conclude that only inflation gap and output gap are stationary at levels. Money supply, Policy rate and Exchange rate are stationary only at first difference.

5.3 Co Integration Test

Running a VAR model requires that all the variables be stationary. However, entering the variables in first difference may cause loss of important information, particularly if there are co-movements in the long run (Enders, 2015). Thus it was imperative to carry out a cointegration test to determine whether the variables have a long run relationship. In this case, the cointegration test is run on policy rate, exchange rate and money supply as they are nonstationary at levels.

To test for cointegration, the Johansen cointegration test was used. This is a multiple cointegrating test as it can test for the existence of more than one cointegrating relationship/equation. The test is basically a multivariate generalization of the Augmented Dickey –fuller test. The Johansen cointegration test uses two tests to test for cointegration i.e. the Trace test and the Maximum eigenvalue test. To estimate the number of cointegrating relationships, the tests look at the rank of the cointegrating matrix. The Trace statistics tests the hypothesis that the number of cointegrating relationships is less than r where r is from 0 to k-1 and k is number of variables in the model. This is tested against the alternative that the cointegrating relationships are greater than r. Thus the test will test k number of hypotheses where r will change from 0 to k-1.

The Maximum eigenvalue tests the hypothesis that the number of cointegrating relationships is r against the alternative that the relationships are r+1. The Maximum eigenvalue test has a shaper hypothesis making the test stronger so that if results are contradicting, the maximum eigenvalue test was preferred to trace test. Both test statistics are compared with the Osterwald -Lenum critical values.

To run the Johansen Test, the first step is to obtain the optimal lag length. The optimal lag length is selected using minimum information criteria. Looking at the table below, the lag which minimizes information is the first lag. Only the Schwartz Information Criterion (SIC) selected a different lag length thus based on most information criterion, one lag is selected as optimal lag length.

Table 7: Information Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-455.3965	NA	6.416711	16.04815	16.40340*	16.18653
1	-415.1838	70.71876*	3.819453*	15.52358*	16.76695	16.00790*
2	-392.9731	35.23087	4.308888	15.61976	17.75125	16.45002
3	-370.6521	31.55718	5.009337	15.71214	18.73176	16.88834

Therefore, the Johansen test is run using one lag. The results of the Johansen Test are summarized in Table 8 below:

Table 8: Johansen Co integration Test

Hypothesized No.of CE(s)	Trace Statistic	p-value	Max Eigen Statistic	p-value
None	38.7791	0.122	16.983	0.459
At most 1	21.79613	0.148	13.302	0.304
At most 2	8.49439	0.214	8.494	0.214

The results show no co-integrating relationships amongst these variables. Both the Trace and Maximum Eigenvalue tests fail to reject the hypothesis of no cointegrating relationships at 5%. They consequently reject the hypothesis of any number of cointegrating relationships. Thus we conclude that there is no long run relationship amongst these variables and so the VAR is estimated in first difference.

5.4 Estimation

Unrestricted VAR is used for the estimation procedure since no long run relationship exists. The Unrestricted VAR requires that all variables be stationary thus policy rate, money supply and exchange rates are incorporated in differenced form as done by Ronanye (2011) and Chuku (2009). According to Enders (2015), the VAR can be written in first difference if the variables are nonstationary at levels and have no long run relationship.

A VAR (1) model output is shown below

Table 9: VAR Estimation Output

Variables	Δ(Policy rate))	Δ(In Money Supply)	Inflation Gap	Output Gap	Δ(Exchange rate)
Δ(Policy rate(-1))	0.131991	-0.003614	0.001116	-0.043637	-0.009777
	(0.10428)	(0.00178)	(0.07331)	(0.09982)	(0.01933)
	[1.26575]	[-2.03137]	[0.01522]	[-0.43715]	[-0.50566]
Δ(In Money Supply(-1))	11.32201	-0.261998	-4.177843	-0.847704	-0.127144
	(8.98909)	(0.15337)	(6.31957)	(8.60482)	(1.66670)
	[1.25953]	[-1.70828]	[-0.66110]	[-0.09852]	[-0.07629]
Inflation Gap (-1)	0.105493	-0.001341	0.659032	-0.401700	-0.015956
	(0.14230)	(0.00243)	(0.10004)	(0.13621)	(0.02638)
	[0.74135]	[-0.55253]	[6.58774]	[-2.94902]	[-0.60478]
Output Gap(-1)	0.129878	0.000528	-0.210068	-0.004303	0.013829
	(0.14525)	(0.00248)	(0.10212)	(0.13904)	(0.02693)
	[0.89416]	[0.21295]	[-2.05716]	[-0.03095]	[0.51349]
Δ(Exchange rate (-1))	0.379497	-0.003485	2.018308	-1.006242	-0.191439
	(0.84721)	(0.01445)	(0.59561)	(0.81099)	(0.15708)
	[0.44794]	[-0.24107]	[3.38864]	[-1.24075]	[-1.21871]
C	-1.583197	0.064544	1.079160	1.080556	0.086572
	(0.86331)	(0.01473)	(0.60693)	(0.82641)	(0.16007)
	[-1.83386]	[4.38189]	[1.77806]	[1.30753]	[0.54084]
DUMMY	1.120584	-0.009340	-0.074794	-0.209196	0.298241
	(1.17823)	(0.02010)	(0.82833)	(1.12786)	(0.21846)
	[0.95108]	[-0.46460]	[-0.09029]	[-0.18548]	[1.36520]
R-squared	0.117192	0.134917	0.619879	0.189969	0.077603
Adj. R-squared	0.017251	0.036983	0.576847	0.098267	-0.026819
Sum sq. resids	794.0594	0.231153	392.4617	727.6216	27.29827
S.E. equation	3.870691	0.066041	2.721201	3.705227	0.717678
F-statistic	1.172617	1.377635	14.40489	2.071593	0.743163
Log likelihood	-162.6207	81.63431	-141.4791	-159.9994	-61.51068

Akaike AIC	5.654024	-2.487810	4.949305	5.566647	2.283689
Schwarz SC	5.898364	-2.243470	5.193645	5.810987	2.528029
Mean dependent	-0.479876	0.047886	2.912833	-0.211440	0.104917
S.D. dependent	3.904517	0.067297	4.183230	3.901897	0.708243

The coefficients in a VAR model are however not directly interpretable. Sims (1980) argued that the goal of a VAR analysis is to determine the interrelationships among the variables and not to determine the parameter estimates. A VAR model unlike a Structural Vector Autoregression (SVAR) is usually over parameterized making its coefficients unreliable for interpretation. Thus the interpretations are based only on interrelationships obtained from innovation accounting.

However, it can be noted that the dummy is not significant for any of the equations in this system of equations. Based on this and the time plots, we consider the two time periods, 2000-2012 and 2012-2016, to be the same structurally. Money supply has a significant and negative relationship with policy rate. This is in line with the Monetarists' view since interest rates are the price of money thus when money supply increases, the price (interest rate) falls. Money supply also has a significant lag showing autoregressive behaviour. This is expected as money supply may not change drastically over a quarter, it will likely depend on previous amount.

Inflation gap also has a positive significant lag which could be due to expectations. As suppliers see prices going up, their cost of doing business rises and they also increase their product prices. This may however take a while due to money illusion. Output gap and exchange rates also have a significant effect on the inflation gap. The effect of output gap is negative which implies when output exceeds its target, the inflation rate will fall. This is because when productivity increases, competition increases so that prices do not rise as quickly as when productivity is low. Similarly a rise in the exchange rate will lead to an increase in prices since Zambia is an import dependent country. This will lead to increase in inflation rate from its target.

5.4.1 Diagnostic Tests

Despite the coefficients of VAR not being of much importance, diagnostic tests are still carried out on the model to ensure a stable model from which reliable impulse response and variance decomposition function can be drawn. Nonstationary variables may cause expansionary response to shocks overtime thus ensuring stability is vital.

All diagnostic test results are shown in Appendix 5. The results indicate the absence of multivariate normality, autocorrelation and heteroscedasticity. To test for normality of residuals, the Cholesky Normality test is run. The results show that the Jarque-Bera statistic obtained has a probability value that is less than 0.05. Therefore the null hypothesis that the residuals are multivariate normal is rejected. However, the Central Limit Theorem provides a justification for the assumption of normality of residuals if the observations are more than 30 (Gujarati, D, & Gunasekar, 2012). Since we have 68 observations, it can be assumed that residuals are asymptotically normally distributed.

The serial correlation LM test is used to test the residuals for serial correlation. The results in Apendix 5.2 indicate that the hypothesis of no serial correlation is not rejected at 5% for the first 2 lags. To test for Heteroscedasticity, the Whites Heteroscedasticity Test (with no cross terms) is used. The results show that the residuals were homoscedastic as the null hypothesis of homoscedastic residuals was not rejected at 5%. If the model has serial correlation and/or heteroscedasticity, the variance will not be efficient thus the impulse response functions which are based on the standard errors may not be reliable.

The overall stability of the model is checked using the Inverse roots. If the model is stable, the inverse roots are all less than one. The inverse roots graph in Appendix 5.4 show all points lie within the unit circle implying the model is stable. Given the results above, reliable impulse response and variance decomposition functions can be obtained with correct standard errors and confidence intervals.

5.5 Impulse Response Functions

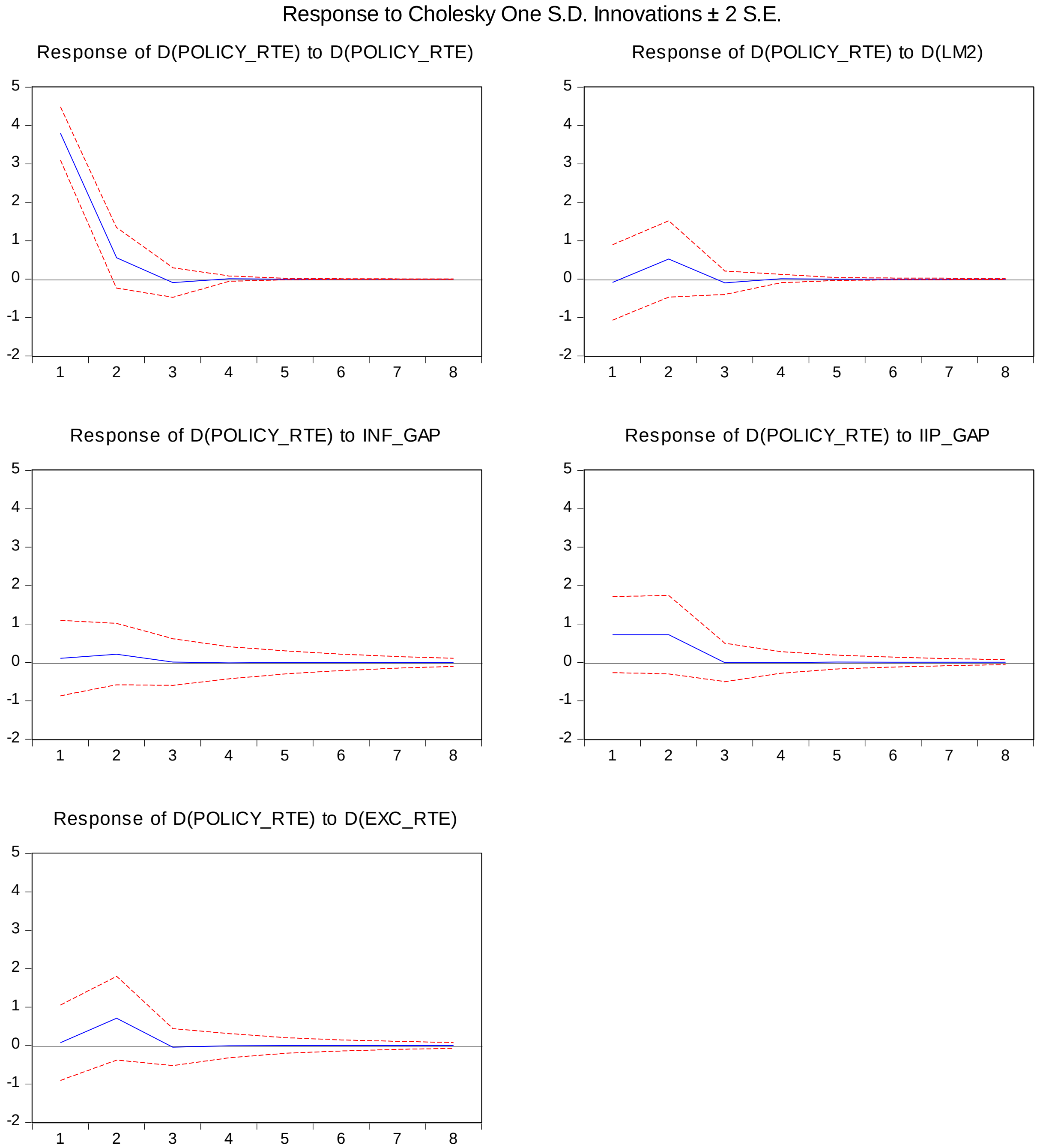
Impulse response functions, also referred to as dynamic multipliers, have been widely used for establishing interrelationships amongst variables in a VAR model. According to Rudebusch (1998), the impulse responses are asymptotically equivalent to the summation of coefficients of regression on the lagged exogenous variable. Impulse functions basically trace the effect of a one standard deviation shock to one of the innovation through to current and future values of the endogenous variable. In this study, the endogenous variables are considered the interest rate (giving an extended Taylor rule) and money supply (giving an extended McCallum rule). Therefore, the response of these endogenous variables when there is a shock to any of the other variable is of primary interest. Cholesky decomposition is required as a restriction that ensures exact identification (Enders, 2015).

These functions have been employed by various researchers and/or Central Banks to measure monetary policy by either analysing the response of monetary instruments to inflation gap, expected inflation, actual inflation, output changes, exchange rate changes, supply factors, demand factors or the impact of these factors on policy instruments. Thus by extension, the policy instruments effects on the macro economy can also be observed.

The ordering of the variables is also vital as it can adversely affect the results. The ordering should generally be that the first variable be the one with potential immediate impact on all the other variables. The order will be based on decreasing impact on the remaining variables. Thus in this model the order used is inflation gap, output gap, Exchange rate, money supply and policy rate as done by Hsing (2004).

5.5.1 Impulse Response Functions for Policy rates

Figure 4: Impulse Response for Policy Rates



The red lines represent 95% confidence interval

Table 10: Impulse Response for Policy Rates

Period	D(POLICY_RT	D(LM2)	INF_GAP	IIP_GAP	D(EXC_RTE)
1	3.797999	-0.005918	0.115632	0.737140	-0.025962

2	0.501303	0.629156	0.233965	0.736753	0.597516
3	-0.124416	-0.115034	0.033795	-0.050759	-0.044748
4	0.010363	0.006797	0.008505	-0.024356	0.007416
5	0.000691	-0.000543	0.013647	-0.003969	0.009437
6	-0.000227	-0.001023	0.008738	-0.005712	0.005240
7	8.21E-05	-0.000545	0.006388	-0.003881	0.004003
8	3.12E-05	-0.000415	0.004629	-0.002799	0.002886

Where D(POLICY_RTE) = Policy rate in first difference

D(LM2) = log of Money Supply(M2) in first difference

INF_GAP = Inflation Gap (Actual Inflation - Target Inflation)

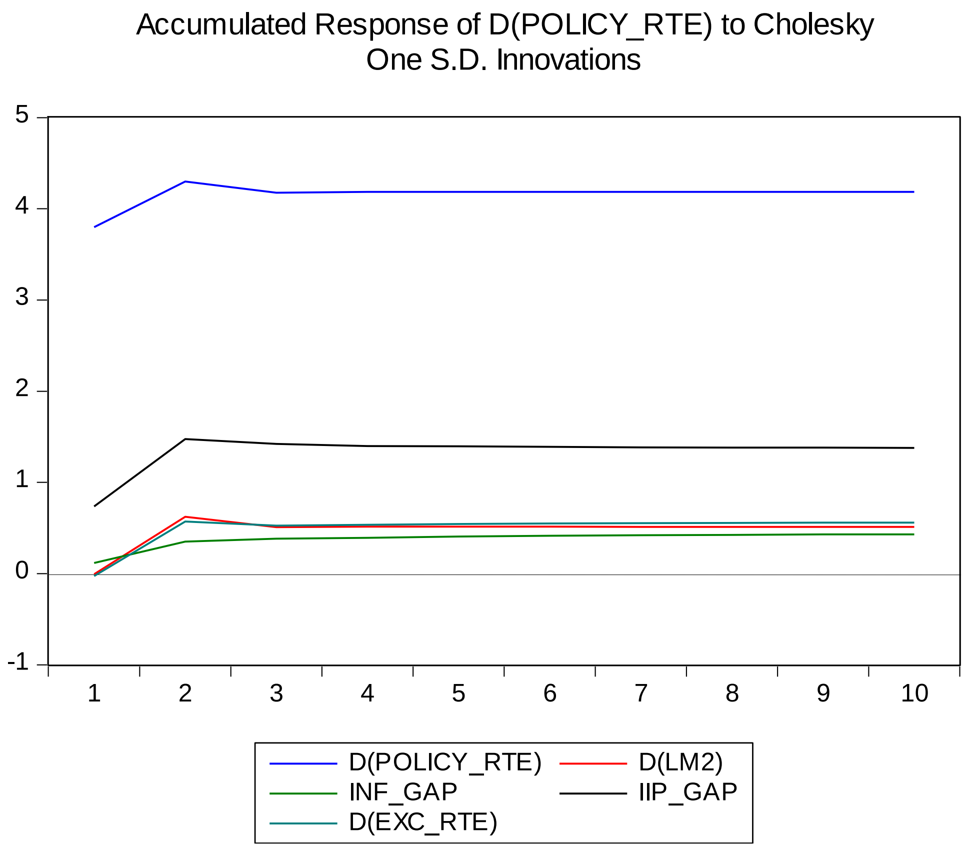
IIP_GAP = Output gap (Actual Output – Potential Output)

D(EXC_RTE) = Exchange rate in first difference

From the impulse response functions above, it can be observed that the policy rate responds positively to a shock in inflation gap, output gap, exchange rate and also to the lagged policy rate. However, the positive reaction dies down after 2 quarters as is clear in the table which is expected since the response functions are based on a VAR (1) model. In the first period, the output gap has the biggest impact multiplier which continues to second period but the exchange rate has a significantly bigger multiplier in the second period. Inflation gap has the smallest multiplier despite it being significant. These findings are similar to Inoue & Hamori (2009) findings' for a study done in India where the impact of output gap is more prevalent than that of the inflation gap.

The impulse response functions show us the response of the policy rate to macroeconomic changes. The policy rates generally have a positive instantaneous reaction to a shock in inflation gap, output gap or exchange rates. This is expected as deviation from targets particularly for inflation will require the Central Bank to increase the interest rates so that investment falls, aggregate demand falls and thus the price level declines in a quest to reduce the inflation gap (based on the IS-LM Model). Similarly an appropriate response to actual output exceeding potential output would require an increase in interest rate so that investment falls and thus output falls reducing the output gap. For exchange rates, depreciation is responded to by increased interest rates since this will increase the interest rate differential so that demand for domestic currency rises as more people purchase domestic capital assets. Thus the exchange rate will appreciate making the response of policy rate effective in stabilising the exchange rate. These responses are in line with Mundell-Flemings-Dornbusch model under a flexible exchange rate.

Figure 5: Accumulated Response for Policy Rates



Ronanye (2011) suggests use of cumulative responses as it makes inference easier particularly for differenced variables. Thus the above graph reflects accumulated response of the interest rate due to various shocks. Based on the graph, we can say the Central Bank behaviour is in line with Taylor's rule since all the variable respond positively with in the 95% confidence interval. The results indicate the Central Banks policy may have been biased towards output stabilisation.

5.5.2 Impulse Response Functions for Money Supply

Figure 6: Impulse Response Functions for Money Supply

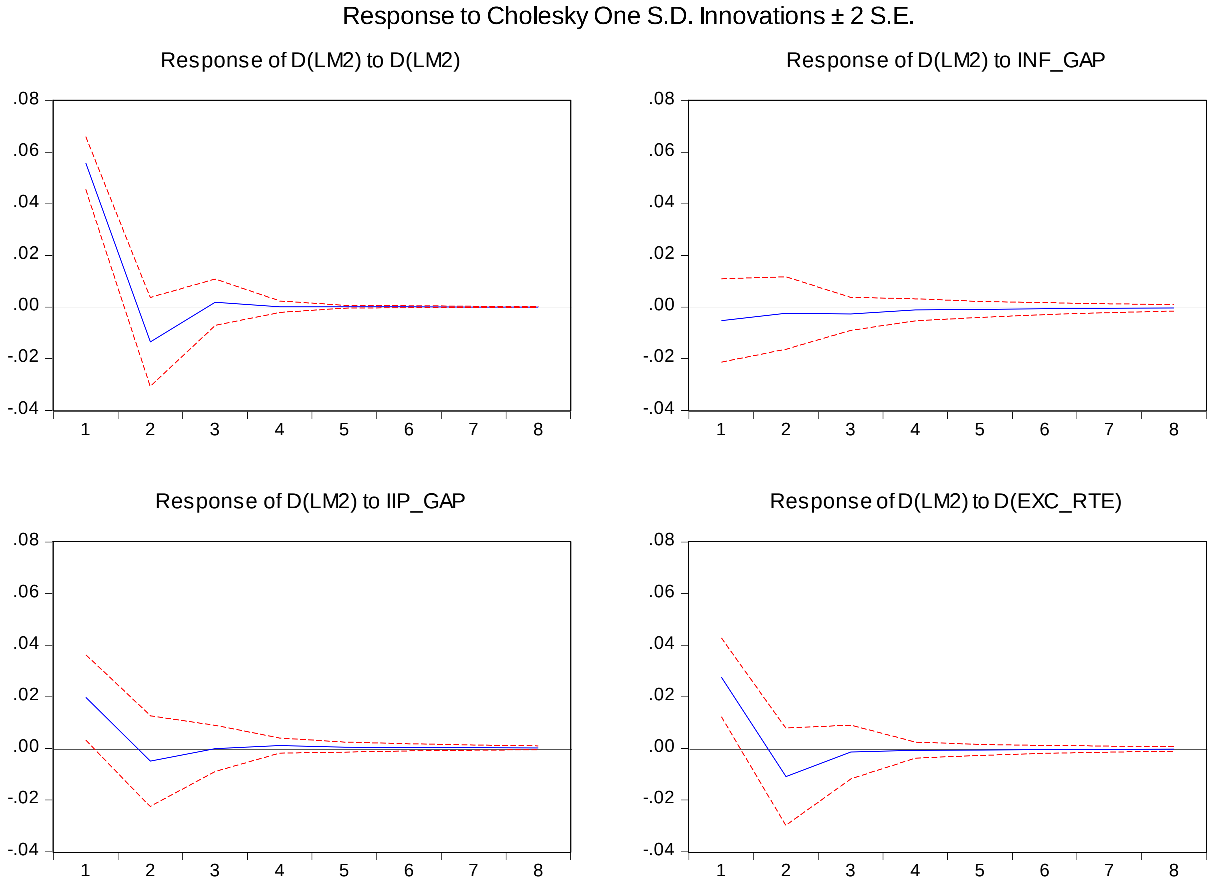


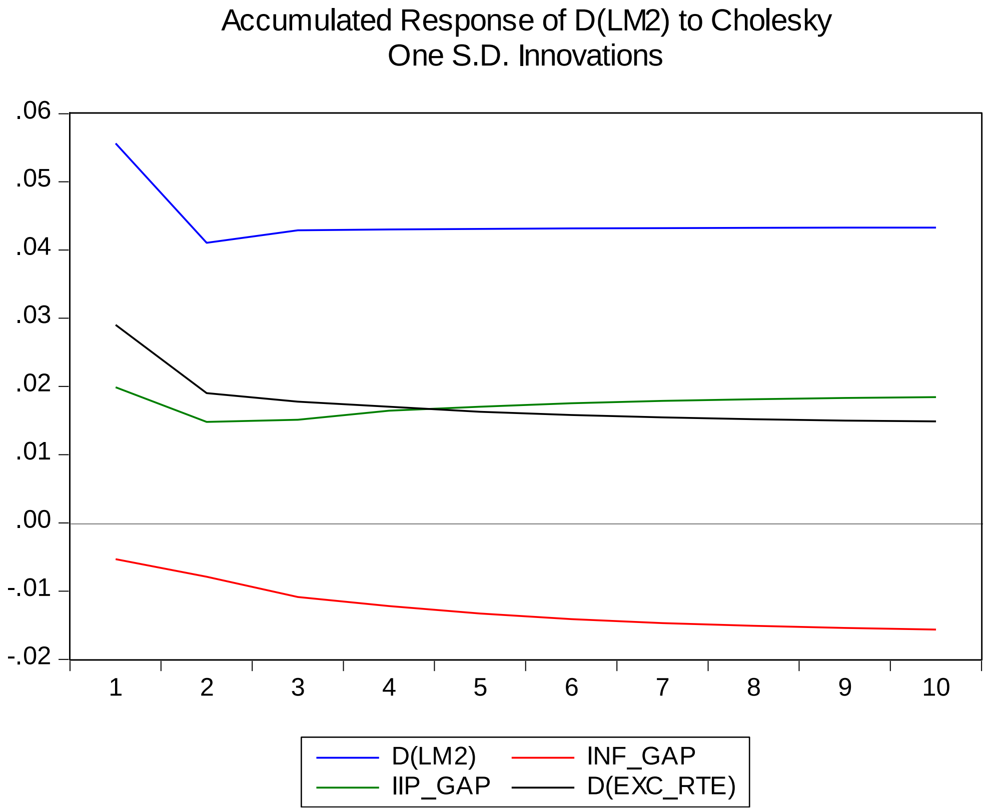
Table 11: Impulse Response for Money Supply

Period	D(LM2)	INF_GAP	IIP_GAP	D(EXC_RTE)
1	0.055836	-0.005213	0.019791	0.027565
2	-0.013824	-0.002371	-0.004921	-0.010945
3	0.001868	-0.002674	-4.29E-05	-0.001406
4	8.50E-05	-0.001086	0.001106	-0.000687
5	8.31E-05	-0.000919	0.000489	-0.000650
6	7.99E-05	-0.000640	0.000391	-0.000437
7	5.22E-05	-0.000456	0.000276	-0.000313
8	3.78E-05	-0.000326	0.000196	-0.000224

The graph above shows impulse response functions of money supply to shocks from the macroeconomic variables. Money supply is shown to have a negative response to inflation gap, output gap, exchange rate and lagged money supply particularly in the second quarter. From the graphs it can be noted that the money supply does not fall instantaneously when impacted by some of the variables. As noted previously, the effects die down affect 2 quarters. The impact multiplier for exchange rate is the greatest of the macroeconomic variables but only the inflation gap has a consistently negative impact on money supply.

The impulse response functions of money supply reflect the Central Banks response to changes in the macro economy using monetary aggregates. Only a shock to inflation gap has a negative instantaneous effect on money supply. This implies an immediate response by the Central Bank to reduce money supply if the inflation rate is over the target inflation rate. When it overshoots, the Bank reacts by reducing money supply which according to Irving Fisher will directly reduce the price level. A shock in the output gap results in an initial positive impact but generally a negative response by the Bank through monetary aggregates. When actual output exceeds potential output, the reaction is to reduce money supply since this will reduce money available for investment so that output falls. This could be through increased interest rates when money supply falls which reduces investment and thus output. Exchange rates impact on money supply is similar to that of output gap but has a more consistent negative impact. When the exchange rate depreciates, we observe that the Central Bank reacts by reducing money supply. This is because a fall in supply domestic currency will cause the currency to appreciate at least in the short run based on the Mundell-Fleming model. This will counter the depreciation and restore stability.

Figure 7: Accumulated Response for Money Supply



The accumulated responses emphasize the above observations as the money supply falls when a shock is introduced to the other variables. The inflation gap seems to have the most negative effect on money supply as the multiplier is negative throughout. The output gap does not respond as expected as it has a slight upward trend in the long run. This implies an increase in money supply as actual output exceeds potential output which exacerbates the gap. This could be attributed to the fact that developing countries are always keen to increase their productivity which is relatively low and so the Central Bank will rarely pursue contractionary monetary policy due to an increase in output. These results are similar to Sanchez-Fung (2002) who found output gap to have a positive response to a monetary base instrument in Dominic Republic. These results show that the Central Bank has followed some systematic rule in conducting monetary policy during the study period.

5.5.3 Other Impulse Response Functions

More impulse response functions are shown in the Appendix. The functions reflect the response of the macroeconomic variables to a shock in the monetary policy instrument. Appendix 1 shows the response of inflation gap. Inflation gap is seen to be more responsive to a shock from money supply relative to that of policy rate. However all responses lie within the 95% confidence interval and the inflation gap responds negatively to all except for money supply and exchange rates as expected. This is because increased money supply will increase inflation and thus the inflation gap. The depreciation of exchange rates will increase inflation gap by increasing actual inflation since it will directly increase the price of imports for which there are few substitutes.

The response of output gap in Appendix 2 is also as expected. When there is an increase in the output gap, we expect the Central Bank to enact measures that will reduce the gap. These will generally be contractionary monetary policy as this will reduce the actual output and consequently the output gap. The results show that an increase in output gap is responded to by reducing money supply as this the output. The exchange rate is also seen to appreciate which will cause traded goods to become relatively expensive, reducing demand for domestic products and consequently a fall in output. It should also be noted that the inflation gap and output gap are more responsive to exchange rates than any of the two policy instruments. This could be because the exchange rate has been used as intermediate target. The intermediate target is expected to have a highly significant impact on the policy goal and the instrument. These results are also consistent with the impulse reactions due of the policy instruments above.

Appendix 3 shows the impulse response function for exchange rates. Exchange rates respond negatively to policy rate and inflation gap. Inflation gap has a negative impact on exchange rates since an increase in inflation will require the exchange rate to appreciate as this will increase the price of domestic goods relative to foreign goods so that inflation is brought down and the gap is reduced. An increase in policy rate will increase interest rates of other capital assets making more attractive relative to foreign assets. This will cause an influx of foreign currency resulting in appreciation of domestic currency.

5.6 Variance Decomposition

The variance decomposition function gives the proportion of variation in each series caused by a shock to the series. It decomposes variation in an endogenous variable into the component shocks of the other endogenous variable. The table below shows the variance decomposition of the policy instruments.

Table 12: Variance Decomposition of Policy Rate

Period	S.E.	D(POLICY_RTE)	D(LM2)	INF_GAP	IIP_GAP	D(EXC_RTE)
1	3.867269	96.45300	0.000000	0.073333	3.440140	0.033524
		(5.98474)	(0.00000)	(2.33964)	(5.69586)	(1.53809)
2	4.074863	88.64768	1.727962	0.338042	6.224900	3.061414
		(9.81826)	(3.78417)	(2.96012)	(7.06307)	(5.61567)
3	4.077319	88.58912	1.785386	0.337940	6.217718	3.069836
		(9.97975)	(3.71170)	(3.17608)	(6.93258)	(5.51399)
4	4.077380	88.58695	1.786061	0.339110	6.217750	3.070128
		(10.0800)	(3.69708)	(3.33935)	(6.95489)	(5.46993)
5	4.077386	88.58670	1.786057	0.339189	6.217918	3.070141
		(10.1332)	(3.68262)	(3.48029)	(6.95271)	(5.45256)
6	4.077389	88.58657	1.786055	0.339266	6.217927	3.070177
		(10.1800)	(3.67409)	(3.59501)	(6.95038)	(5.44393)
7	4.077391	88.58651	1.786054	0.339303	6.217937	3.070192
		(10.2217)	(3.66761)	(3.68598)	(6.94986)	(5.44046)
8	4.077391	88.58648	1.786054	0.339322	6.217942	3.070200
		(10.2580)	(3.66337)	(3.76121)	(6.94960)	(5.43956)

The results show that output gap explains the biggest proportion of the policy rate instantaneously apart from the policy rate itself. It is followed by inflation gap then exchange rate which is not significant. Generally, all the variables significantly explain a proportion of policy rate. After 2 years, the exchange rates explain a bigger proportion than inflation gap does. Of the 3 policy variables', output gap continues to carry the biggest proportion of forecast error variance. The importance of output gap on policy rate as reflected in the impulse response function is re-emphasized here.

Table 13: Variance Decomposition of Money Supply

Period	S.E.	D(POLICY_RTE)	D(LM2)	INF_GAP	IIP_GAP	D(EXC_RTE)
1	3.867269	0.040021	72.53673	0.632313	9.112903	17.67803
		(1.58454)	(9.45370)	(3.37676)	(8.49311)	(8.05053)
2	4.074863	4.006444	68.49619	0.679025	8.609576	18.20876
		(3.24571)	(9.49491)	(3.36130)	(7.87572)	(7.67435)
3	4.077319	4.036323	68.36104	0.824585	8.583575	18.19448
		(3.35281)	(9.60578)	(3.36774)	(7.99210)	(7.68892)
4	4.077380	4.034168	68.32039	0.848410	8.603673	18.19336
		(3.38041)	(9.66706)	(3.44779)	(7.90483)	(7.69701)
5	4.077386	4.032974	68.29918	0.865543	8.605914	18.19638
		(3.39054)	(9.71538)	(3.52402)	(7.92522)	(7.69945)
6	4.077389	4.032351	68.28861	0.873857	8.607712	18.19747
		(3.39092)	(9.74569)	(3.58402)	(7.90498)	(7.69799)
7	4.077391	4.032039	68.28324	0.878084	8.608592	18.19805
		(3.39060)	(9.76951)	(3.63713)	(7.90043)	(7.69665)
8	4.077391	4.031879	68.28051	0.880234	8.609038	18.19834
		(3.38884)	(9.78892)	(3.68472)	(7.89195)	(7.69490)

The above table gives the variance decomposition of money supply. All the variables significantly explain a proportion of the money supply forecast error variance. Initially, exchange rates explain the biggest proportion amongst the variables. After 2 years, the exchange rates continue to explain the biggest proportion whilst the inflation gap explains the smallest (but significant) proportion.

CHAPTER SIX: CONCLUSION, POLICY IMPLICATIONS AND RECOMMENDATIONS.

6.0 Summary and Conclusions

The objective of this study was to estimate the monetary response functions for the Zambian economy based on two policy instruments i.e. Policy Rate and Money Supply. The responsiveness of these instruments was then used to establish the effectiveness of the current monetary policy. The analysis was done using a VAR model as it overcomes the problem of simultaneous bias which is usually present in monetary models and also provides information on the interrelationships which help in determining effectiveness.

Using a VAR model, we were able to obtain impulse response functions showing the policy rates reaction to shocks in inflation gap, output gap and exchange rate synonymous to an extended Taylor-rule Function. The results show that the policy rate respond positively to the inflation gap, output gap, exchange rates and lagged policy rate. This is in line with Taylor-rule showing the Central Bank has a systematic monetary policy. It is however, more responsive to output gap than the inflation gap which is unlike most studies. This is emphasized by the variance decomposition function which showed the output gap takes a larger proportion of explaining policy rate than inflation gap or exchange rates. This could be due to the low financial inclusion rate (38%[5]) so that changes in interest rates can't be easily understood or used by majority. Therefore changes in interest rates may not easily translate to changes in general price level. However, the few who can participate in the capital asset market are more likely to invest or disinvest so that there is a substantial influence on output as they are more likely to have higher incomes. Those with lower incomes are less likely to respond changes in interest rates than to inflation rate changes.

The VAR was also used to obtain impulse response functions synonymous to the McCallum rule. The results show that response of money supply to inflation gap, output gap, exchange rates and lagged money supply are all negative. This is in line with prior expectations and thus the McCallum rule. Inflation gap has the most negative impact on money supply. This shows systematic behaviour of Central Bank when it used monetary aggregates as policy instrument with bias towards the inflation gap.

[5] See Finscope Zambia 2015

The variance decomposition function however allocated a larger proportion of money supply to exchange rates. This could be because the exchange rates acts as a key intermediate target variable when money supply is used as policy instrument. This was emphasized by the significant response of exchange rate due to shock from inflation gap but smaller response from money supply implying exchange rates respond more to inflation gap as its goal compared to money supply. The intermediate target is expected to have more impact from the policy instrument than the policy goal is. Thus it is also expected that the policy instrument be responsive to the intermediate goal. In this case, money supply is most responsive to exchange rates (Setlhare, 2004).

From the reaction functions we conclude that policy rate is biased towards output stabilisation whilst money supply is biased towards price stability. The exchange rate also plays a significant role under both policies but more so under money supply. These results are consistent with Rotich, Kathanje & Maana (2007) who also found Kenyas' Central Bank behaviour to be biased towards inflation with output gap not being as significant and exchange rates playing a key role.

These interrelationships help in determining if one policy instrument is more superior to the other. The main objective of monetary policy is price stability thus which ever policy instrument is more responsive to inflation gap overtime can be said to be more effective in carrying out monetary policy. Based on the accumulated impulse response functions, it is observed that money supply is more responsive to inflation gap than the policy rate is. The value of impact multipliers is not considered since money supply is entered in logarithmic form whilst policy rate is entered otherwise. However, the response of inflation gap due to the money supply compared to other variables shows that the inflation gap is prioritized when money supply is the policy instrument. The other response functions, in Appendix 1, particularly the inflation gap response function indicate that inflation gap is more responsive to money supply than policy rate thus supporting the accumulated response functions observation. This was further confirmed by the variance decomposition function where the proportion of the policy instruments that inflation gap explained was larger for money supply than for policy rate. Inflation gap explained 0.07% of the policy rate whilst it explained 0.6% of money supply even both are significant. Thus from this we can conclude that money supply is more responsive to inflation gap. Since the objective of monetary policy is price stability, money supply can be said to be a more effective policy instrument for the current monetary policy.

1.1 Policy Implication and Recommendations

Monetary policy objective in Zambia has been to stabilise price for decades. Looking back, much progress has been made in achieving this goal as inflation rates have on average been below 10%. Now as the Central Bank aims to shift to an inflation targeting regime, more evidence on an effective policy instrument is required. Inflation targeting regime implies more transparency as the Central Banks action are usually explicitly publicized. In this quest, the Bank of Zambia shifted to using interest rates as policy instrument as they are more easily understood by the public.

Evidence in this study shows that the policy instruments i.e. policy rate and money supply can both significantly reduce the inflation gap. Thus use of either instrument may have significant success in achieving monetary policy objectives. However, inflation rate continues to be vulnerable as can be seen from the high rates in recorded in 2016 (16% in September, 2016). The high rates in 2016 were mainly attributed to changes in exchange rates due to a fall in world copper prices. Since Zambia is a small open economy it is prone to external influences so that its flexible exchange rate is easily affected and consequently inflation shoots up.

From the results it is also observed that exchange rates are more responsive to money supply than policy rates and that exchange rate explain a huge proportion of money supply. Money supply, since it responds to exchange rates quickly, will thus affect inflation gap (caused by exchange rate depreciation) not only directly but also through exchange rates themselves causing the inflation gap to quickly fall when it increases. Policy rate on the other hand will not be directly affected by exchange rates given the small response of exchange rates to the policy rate. Thus policy rate will not reduce inflation gap as quickly as money supply if the source of high inflation is exchange rate fluctuations. Thus the use of monetary aggregates particularly when cause of inflation is exchange rate volatility as is usually the case is suggested.

If exchange rates are to continue being flexible, monetary aggregates may be a better policy instrument for a small economy like Zambia. Unless there is an increased participation in foreign capital assets markets, the policy rate will not be as effective in achieving the monetary policy objective.

Taylor J (2000) recommended the use of monetary aggregates in inflation targeting regime since inflation targeting allows for more accountability. He argued that inflation targeting and monetary aggregates instruments are not mutually exclusive. Thus modernising monetary policy is not restricted to the use of interest rates but should be based on existing workable relationships. The use of monetary aggregates is recommended coupled with a money supply target that is consistent with the inflation target. This will provide for the required transparency and increase efficiency suggested in an inflation targeting regime.

Alternatively, the Central Bank could adopt a crawling peg regime for its exchange rates so as to reduce foreign influences on the economy and consequently inflation. In this case, the policy rate can be adopted as policy instrument since exchange rates can be fixed in line with inflation target making money supply less effective.

6.1 Limitations of Study

This study was limited by unavailability of data. Output, which was proxy by the industrial production index, was only available for the period 2000 to 2016 in quarterly series. Thus all other variables where restricted to this period and series requiring exclusion of some years and variables like fiscal deficit[6].

Target output was obtained using Hendrick Prescott filter. This was because only annual GDP growth rate targets were available and not GDP targets. The use of a trend series could be smoothed and consequently a poor representative of the actual targets set by the Central Bank. This could have biased the results obtained.

6.2 Areas of Further Research

There is much more research that can be done in this area. A study using policy rates for the period that Central Bank has used it as a policy instrument and money supply for the period that monetary aggregates where the policy instrument can be considered. Another study could include more variables such as stock prices, fiscal deficit, private credit etc. Furthermore,

[6] Only available in annual series

alternative models that incorporate both stationary and nonstationary variables can be considered so that variables are not differenced. The Dynamic Stochastic General Equilibrium (DSGE) models can also be considered to get a fuller picture of how the monetary policy variables react to macroeconomic changes.

Taylor (1993) states that quarterly time series would be good for studying changes in interest rates since changes in interest rates generally can't be held constant in a quarter. However, price changes are more likely to be constant in a quarter and thus quarterly series may be considered too short to average out price changes. Thus further research may be done with monthly and annual series and a better representation can be established from this.

REFERENCES

Agu, C. (2011). *An Econometric Analysis of the Monetary Policy Reaction Function in Nigeria.* Nairobi: African Economic Research Consortium, AERC.

Bahmani-Oskooee, M., & Gelan, A. (2009). How stable is the demand for money in African countries. *Journal of Economic Studies*, 19.

Bank of Zambia. (2004). Bank of Zambia. (Accessed: 16 May, 2017) [Online]: www.http://www.sadcbankers.org/SADC/SADC.nsf/LADV/3219A8D41B9C7A9542257279004C376B/$File/Zambia+(2004).pdf

Bank of Zambia, BOZ. (2012). *Bank of Zambia Communique.* Lusaka: Bank of Zambia.

Bank of Zambia, BOZ. (2016). *Bank of Zambia Monetary Framework.* Retrieved April 23, 2017, from Bank of Zambia: http://www.boz.zm/monitory-policy-framework.htm

Bank of Zambia, BOZ. (2012). *Monetary Policy Statement; July-December 2012.* Lusaka: Bank of Zambia.

Bernanke, B. S., & Mihov, I. (1998, August). Measuring Monetary Policy. *Quarterly Journal of Economics, 113,* 869-902.

Bernanke, B. S., Biovin, J., & Eliasz, P. (2005). Measuring the Effects Of Monetary Policy:A Factor-Augmented Vector Autoregressive (FAVAR) Approach. *Quarterly Journal of Economics*, 387-422.

Boivin, J., & Giannoni, M. P. (2006). Has Monetary Policy Become More Effective. *The Review of Economics and Statistics*, 445-462.

Central Statistical Office, C. (2016). *The Monthly; September.* Lusaka: Central Statistical Office.

Chang, H. S. (2005). Estimating the Monetary Response Function for Taiwan; A VAR Model. *International Journal of Applied Economics,* 50-61.

Chileshe, P., & Zgambo, P. (2014). Emperical Analysis of the Effectiveness of Monetary Policy in Zambia. *COMESA Monetery Institute*.

Chileshe, P., Mbao, F., Mwanza, B., Mwansa, L., Rasmussen, T., & Zgambo, P. (2014). Monetary Policy Transmission Mechanism in Zambia. *Bank Of Zambia Working Papers*(WP 01/2014).

Chiselebwe, N. (1980). *Inflation in Zambia; 1964-1976.* University of Connecticut.

Chuku, C. A. (2009). Measuring the Effects of Monetary Policy Innovations in Nigeria; A Structural Vector Autoregrssive(SVAR) Approach. *African Journal of Accounting, Economics, Finance and Banking Research, 5*(5), 112-129.

Clarida, R., Gali, J., & Gertler, M. (2000). Monetary Policy Rules and Macroeconomic Stabilty; Evidence and some Theory. *The Quarterly Journal of Economics*, 147-179.

Duca, J., & Vanhoose, D. (2004). Recent Developments in Understanding the Demand for Money. *Journal of Economics an Business*, 27.

Emir, O., Karasoy, A., & Kutner, K. (2000). Monetary Policy Reaction Function in Turkey. *Banking, Financial Markets and The Economies of the Middle East and North*, (pp. 1-25). Beirut.

Enders, W. (2015). *Applied Econometric Time Series* (4^{th} ed.). New Jersey: John Wiley and Sons.

Evans, C. L., & Kuttner, K. N. (1998). *Can VARs describe Monetary Policy?* New York: Federal Bureau of New York.

Frank, Robert. & Bernanke, Ben. (2009) *Principle of Economics* (4 ed.). McGraw-Hill Companies Inc.

FSD Zambia, F. S. (2015). *FinScope Zambia 2015.* Lusaka: Financial Sector Deepening Zambia (FSD Zambia).

Fundanga, C. (2008). The Conduct of Monetary Policy in Zambia. *Philadelphia Federal Reserve Bank* (p. 18). Philadelphia: Bank Of Zambia.

Greene, W. H. (2000). *Econometric Analysis* (5^{th} ed.). New Jersey: Prentice Hall.

Gujarati, D. N., D, P., & Gunasekar. (2012). *Basic Econometrics* (5 ed.). New Delhi: McGraw-Hill Education Private Limited.

Hangoma, P. (2010). *Appropriateness of Inflation Targeting as a Monetary Policy Framework in Zambia.* Lusaka: University of Zambia.

Hashmi, M. S., Xu, C., Khan, M. M., Bashir, M., & Ghazanfar, F. (2011). Monetary Policy Reaction Function and Sterilization of Capital Inflows: An Analysis of Asian Countries. *Asian Social Science*, 19-32.

Hsing, Y. (2004, June). Estimating the Bank of Japans' Monetary Policy Reaction Function. *BNL Quarterly Review*(229).

Hsing, Y., & Lee, S. H. (2004). Estimating the Bank of Korea's Monetary Policy Reaction Function: New Evidence and Implications. *The Journal of the Korean Economy, 5*(1), 1-16.

Iklaga, F. O. (2009). *Estimating a Monetary Policy Reaction Function For The Central Bank OF Nigeria (1999 – 2007).* Abuja: Central Bank Of Nigeria.

Inoue, T., & Hamori, S. (2009). *An Empirical Analysis of Monetary Policy Reaction Function in India.* Chiba: Institute of Developing Economies JETRO.

Kalyalya, D. H. (2001). Monetary Policy Farmework and Implementation in Zambia. *South African Reserve Bank Conference on Monetary Policy Frameworks.* Pretoria: Bank of Zambia.

Kelikume, I., Alabi, F. A., & Ike-Anikwe, R. C. (2016). An Empirical Analysis of Monetary Policy Rseponse Function; Evidence from Nigeria. *The International Journal of Business and Finance Research*, 13-25.

Mankiw, N. (2000). *The Science of Macroeconomics* (5th ed.).

McCallum Bennet, J., & Edwards, N. (1999). Performance of Operational Policy Rules in an Estimated Semiclassical Structural Model. In J. B. Taylor, *Monetary Policy Rules* (pp. 15-56). Chicago: Univerisity of Chicago Press.

McCallum, B. T. (2000). *Alternative Monetary Policy Rules: A Comparison with Historical Settings for the United States, the United Kingdom, and Japan.* Richmond: Economic Quarterly of the Federal Reserve Bank of Richmond.

McPherson, M. F. (1995). The Sequencing of Economic Reforms: Lessons From Zambia. *Special Programme of Assistance for Africa.* Paris: Ministry of Foreign Netherlands.

Mehrotra, A., & Sánchez-Fung, J. R. (2009, December 18). Assessing McCallum and Taylor Rules in a Cross-Section of Emerging Market Economies. *BOFIT Discussion papers*(23).

Ministry of National Planning. (2017). *Seventh National Development Plan 2017-2021*. Ministry of National Planning. Lusaka.

Mishkin, F. (2004). *The Economics of Money, Banking and Financial Markets* (7 ed.). New York: Addison-Wesley.

Mutale, F. C. (1991). *The Effectiveness of Traditional Instruments of Monetary Policy during the Foriegn Exchange Auction System in Zambia.* Department of Economics. Lusaka: University of Zambia.

Mutoti, N. (2005, June). *Monetary Policy Transmission in Zambia.* Bank of Zambia, Economics. Lusaka: Bank of Zambia Working Papers.

Mwenda, A. (1998). The Effectiveness of Monetary Policy. In S. K. Mugerwa, *The African Economy: Policy, Institutions and the Future* (pp. 83-97). London: Routledge.

Pamu, M. E. (2006). What is the appropriate Nominal Anchor for Inflation in Zambia? *Issues in the Zambian Economy*.

Pancrazi, R., & Vukotic, M. (2015). *Has Monetary Policy Maintained its Effectiveness.* Coventry: University of Warwick.

Patra, M. D., & Kapur, M. (2012, April). Alternative Monetary Policy Rules for India. *IMF Working paper*(WP/12/118).

Rafiq, M., & Mallick, S. K. (2008). The Effect of Monetary Policy on Output in EMU3: A Sign Restriction Approach. *Journal of Macroeconomics*, 1756-1791.

Rahman, M. U., Sarwar, K., & Khan, A. (2016). Effectiveness of Monetary Policy in Economic Growth: An Empirical Evidence from Pakistan. *Journal of Economics and Sustainable Development*, 96-105.

Rasche, R. H., & Williams, M. M. (2005). *The Effectiveness of Monetary Policy*. St Louis: Federal Reserve Bank of St Louis.

Romer, C., & Romer, D. (1989). Does Monetary POlicy Matter? A New Test in the Spirit of Friedmand and Schwartz. *NBER Macroeconomics Annual*.

Ronanye, D. (2011). Which Impulse Function? *Warwick Economic Research Papers*(971).

Rotich, H., Kathanje, M., & Maana, I. (2007). *A Monetery Policy Reaction Function for Kenya*. Nairobi: Central Bank of Kenya.

Rudebusch, G. (1998). Do Measures of Monetary Policy in VAR make sense? *International Economic Review, 39*(4), 907-931.

Saasa, O. (1996). Policy Reforms and Structural Adjustment in Zambia; The case of Agriculture and Trade. *USAID Technical Paper*, No. 35.

Sánchez-Fung, J. R. (2002). Estimating a Monetary Policy Reaction Function for the Doiminican Republic. *University of Kent, Department of Economics*.

Setlhare, L. (2004). Bank Of Botswana’s Reaction Function: Modelling Botswana’s Monetary Policy Strategy. *The South African Journal of Economics, 72:2*, 384-406.

Simutanya, N. (1996). The Politics of Structural Adjustment in Zambia. *Third World Quarterly*, 825-839.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Canegie Rochester Series on Public Policy* (pp. 195-214). Stanford: Elsevier Science Publishers.

Taylor, J. B. (1999). *The Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank.* Stanford: Stanford University.

Taylor, J. B. (2000). Summary Remarks at Bank Indonesia. *Inflation Targeting and Monetary Policies in Emerging*. Jarkata: Central Bank of Indonesia.

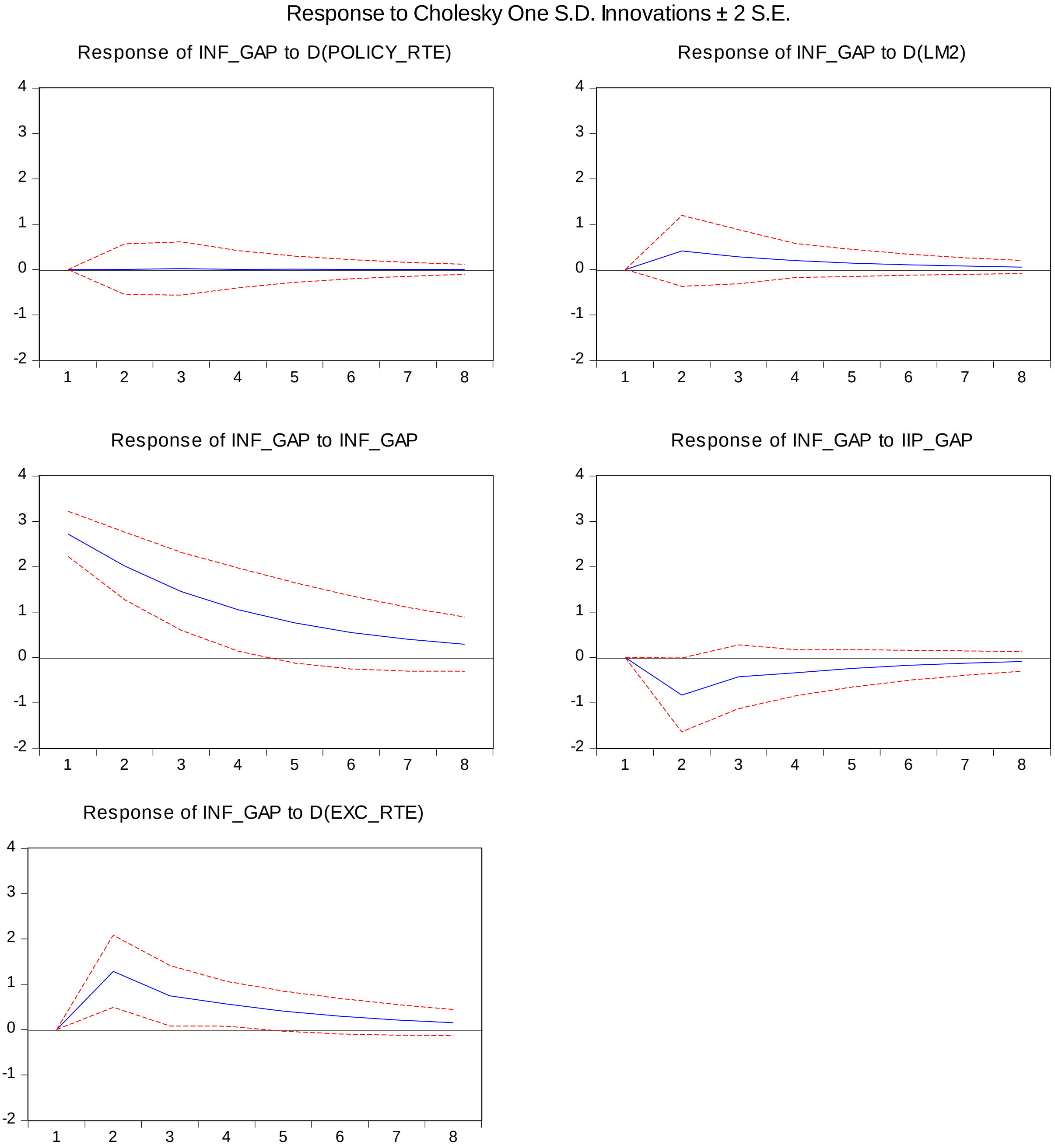
World Bank, W. (2005). *World Development Indicators.* Washington.

XE. (2017, April). *XE Currency Converter*. Retrieved April 3, 2017, from XE- The Worlds Trusted Currency Authority: www.xe.com

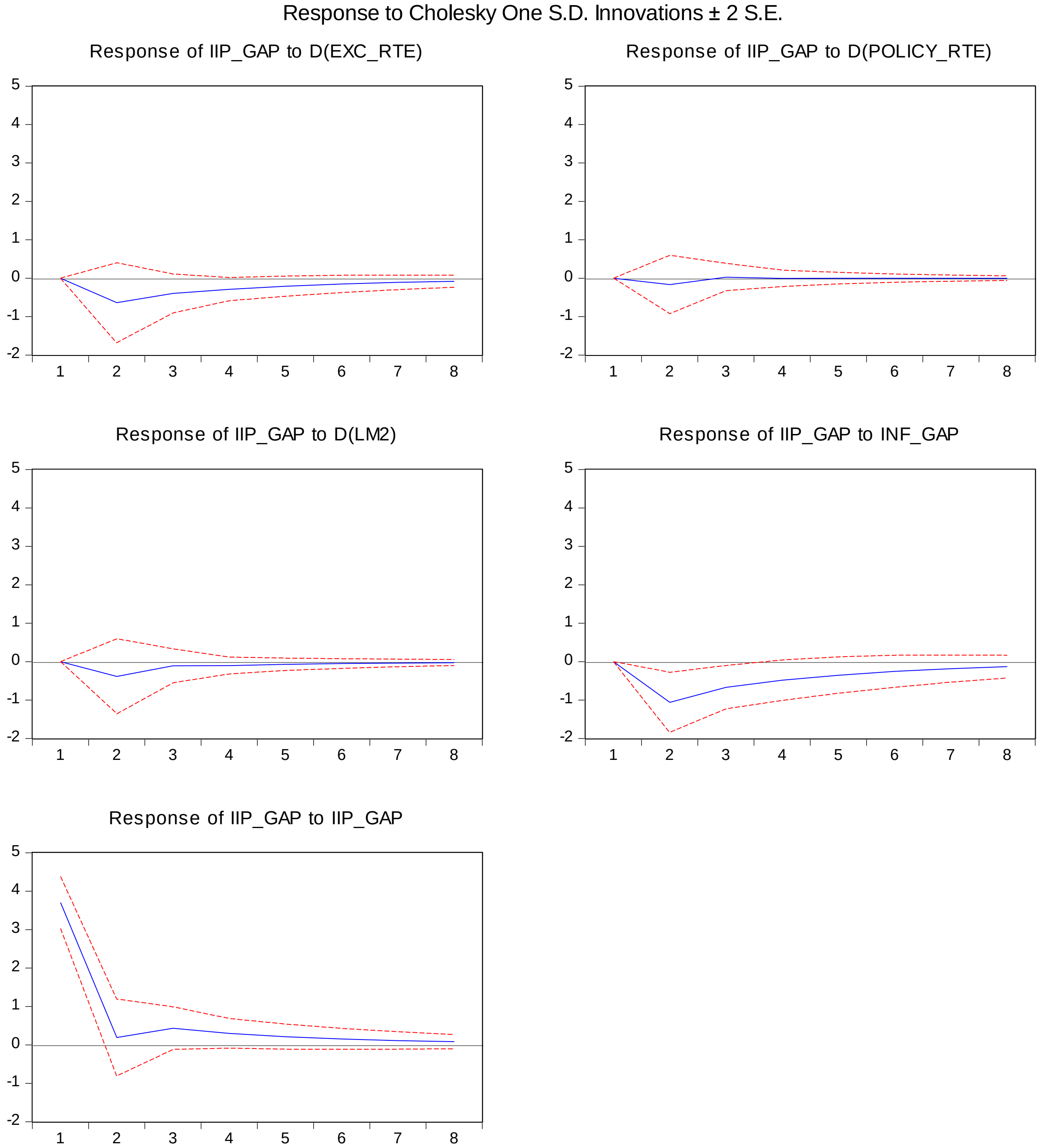
Younus, S. (2017, January). Responses of Inflation and Output to Shocks in Monetary policy: A case study with Bangladesh using the DSGE model. *Research Department Bangladesh Bank*(1701).

APPENDIX

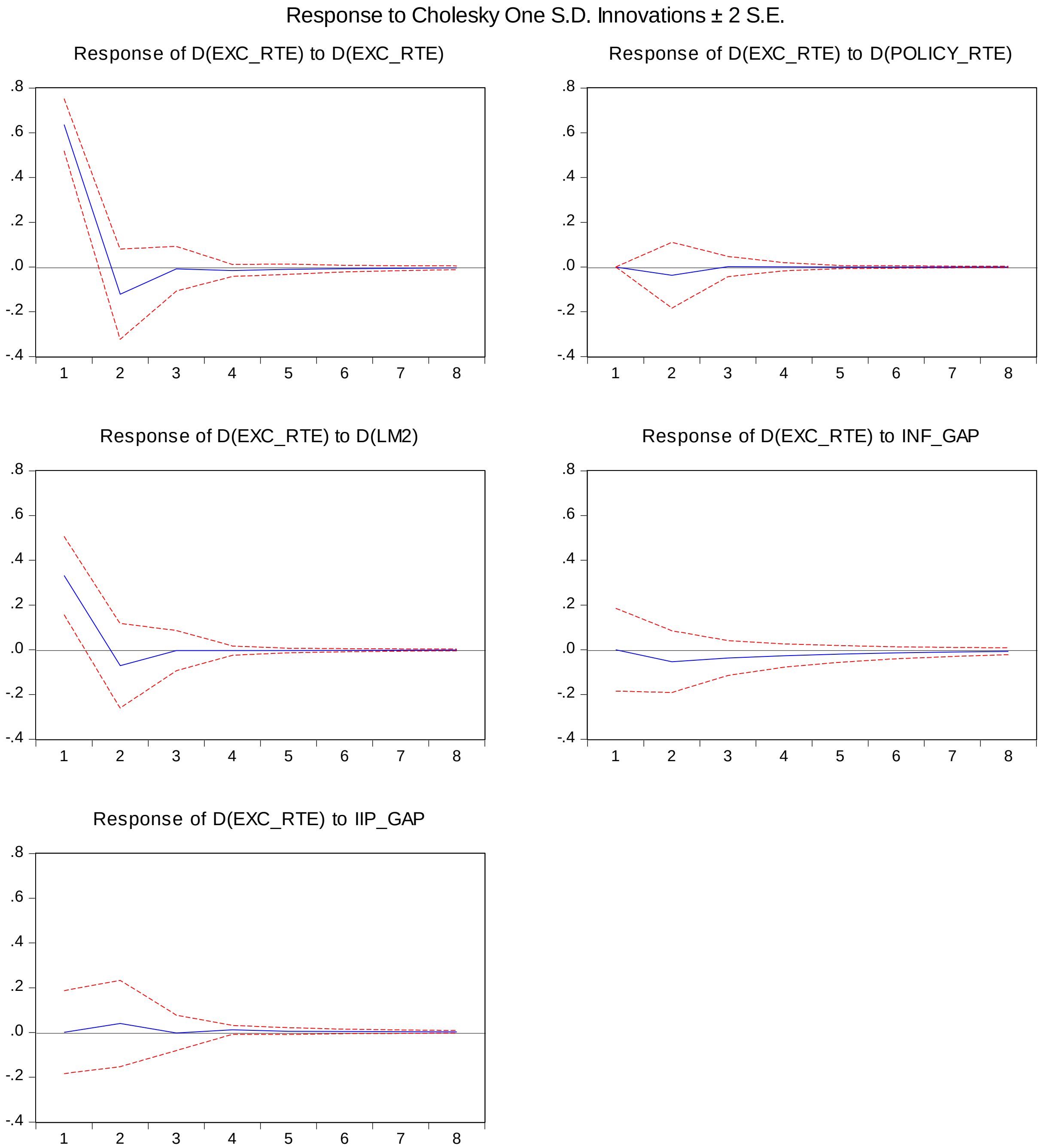
Appendix 1: Impulse Response Functions for Inflation Gap



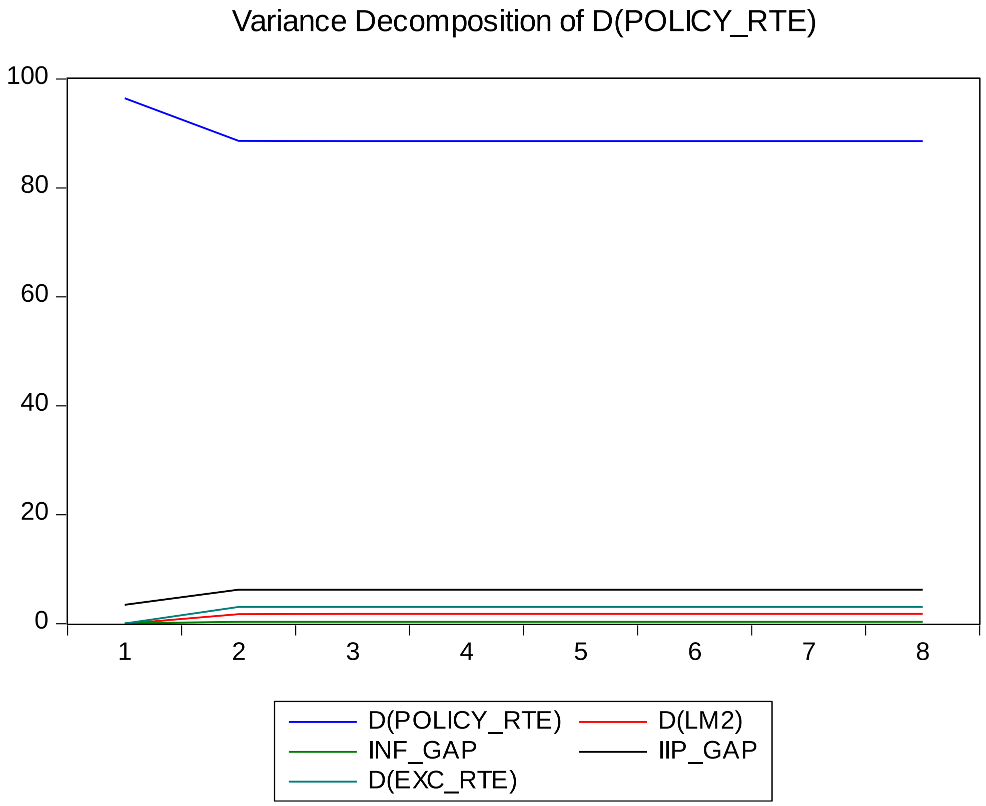
Appendix 2. Impulse Response Functions for Output Gap

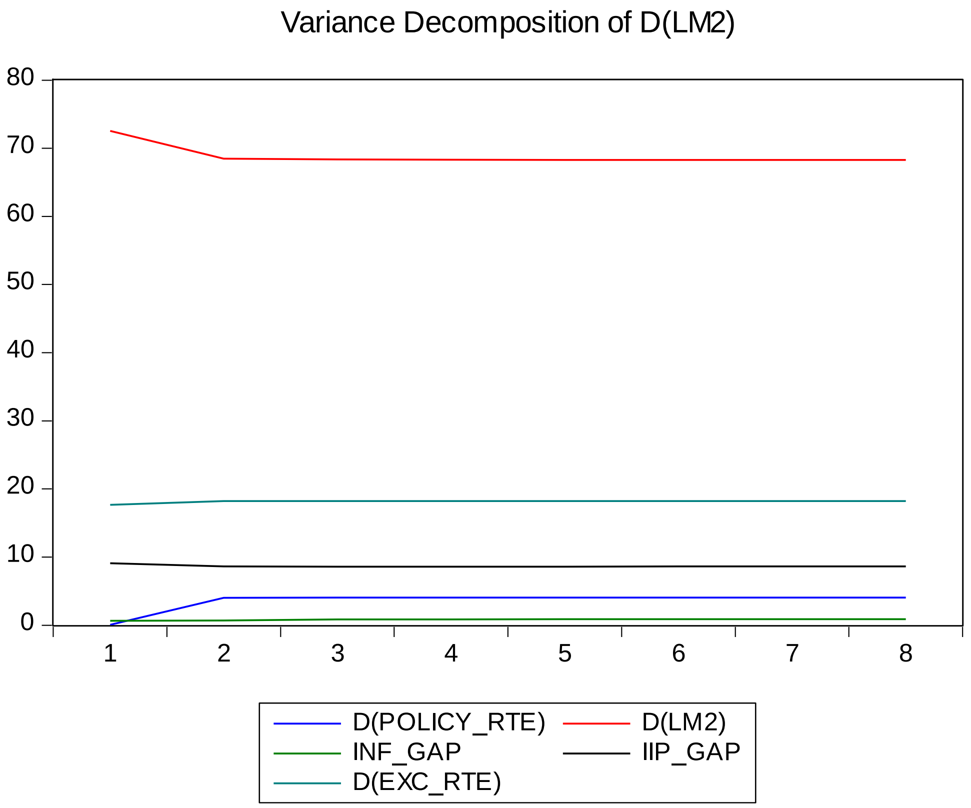


Appendix 3. Impulse Response Functions for Exchange rates.



Appendix 4. Variance Decomposition Functions





Appendix 5: Diagnostic Tests

Appendix 5.1: Normality Test

Component	Jarque-Bera	df	Prob.
1	128.9226	2	0.0000
2	2.862478	2	0.2390
3	3.814766	2	0.1485
4	0.505943	2	0.7765
5	449.3562	2	0.0000
Joint	585.4620	10	0.0000

Appendix 5.2: Test for Autocorrelation

Lags	LM-Stat	Prob
1	34.86608	0.0907
2	29.83840	0.2304

Appendix 5.3: Test for Heteroscedasticity

Joint test:		
Chi-sq	df	Prob.
182.8968	165	0.1616

Appendix 5.4: Inverse Roots