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Abstract

Macroeconomic forecasting and policy tools are cardinal in an inflation targeting framework of monetary policy. In this regard, the Bank of Zambia has been developing and refining models used in forecasting and policy analysis. In its initial attempt, the staff of the Bank of Zambia with support from the IMF short-term consultant developed the Zambia Quarterly Model (ZQM). However, the initial ZQM did not include a fiscal sector. This prompted the development of an extended ZQM which also includes fiscal sector variables. This paper documents the extended ZQM. The extended ZQM consists of seven endogenous equations. Just like its predecessor, the extended ZQM is estimated using the error correction methods. In the extended ZQM, the fiscal deficit is modelled to affect other macroeconomic variables through its effect on excess liquidity in the banking system and the yield rate on government securities. The results indicate that increase in fiscal deficits leads to a rise in the yield rates on government securities as well as an increase in excess liquidity in the financial sector. Furthermore, this paper demonstrates the use of the ZQM in forecasting and policy analysis. In particular, it demonstrates the effects of monetary policy and copper price shocks on other variables in the system.

JEL classification: E17
Key words: Macroeconomic forecasting; policy analysis; fiscal policy

[1] This paper documents the macroeconomic model developed in the Bank of Zambia. The development of the model was spearheaded by Farook Akram under the IMF-Norges Bank Technical Assistance program on broad-based modernization of the Bank of Zambia

Contents

1. Introduction

The quantitative based macroeconomic models have become the cornerstone of modern day monetary policy formulation and implementation. The importance of quantitative models has become even more cardinal as central banks shift their monetary policy frameworks to inflation targeting. Zambia embarked upon this journey towards inflation targeting from monetary aggregate targeting in April 2012 with the introduction of the Bank of Zambia Policy Rate as a monetary policy tool.

In an inflation targeting monetary policy framework, quantitative based macroeconomic models are useful in many ways. Firstly, these macroeconomic models are used as guiding tools for short-term and medium term forecasting macroeconomic variables (Whitley, 1994) such as inflation, economic growth, interest rates and monetary aggregates. Forecasts of macroeconomic variables, especially inflation forecasts, form the basis on which monetary policy stance is formulated with a purpose of achieving a set target. Secondly, models are used for policy analysis. Policy analysis involves evaluating the response of the endogenous variables or a variable of interest to various shocks (example monetary policy) that might affect the economy over the forecast horizon.

Given the importance of quantitative models in modern monetary policy formulation and implementation, the Bank of Zambia has been developing a suite of models for both forecasting and policy analysis. A suite of models has since been developed for forecasting and policy analysis. The suite of models at the Bank of Zambia is categorised in two, the core model known as the Zambian Quarterly Model (ZQM) and auxiliary models. The ZQM is used for policy analysis as well as forecasting while auxiliary models are used for now casting and short-term forecasting of macroeconomic variables. The ZQM was first operationalized in 2014 but lacked a key component of Zambia's economy, the fiscal sector. However, following the dominant role played by fiscal variables in the evolution of key macroeconomic variables since 2014 the need for extending the ZQM arose to incorporate the fiscal sector explicitly in the model.

The main objective of the paper, in this regard, is to discuss the extended ZQM (incorporating the fiscal sector) developed by the Bank's research division with help of an IMF short-term consultant. Specifically, the paper discusses the key components of the model, the variables and the use of the model. To demonstrate the use of the model, forecasting and policy analysis are undertaken.

2. Behavioural Equations in the Extended ZQM: Description of the model equations

2.1. Introduction

The extended ZQM with fiscal sector consists of seven (7) behavioural equations estimated independently, numerous identities for exogenous variables and it is closed by a Taylor type monetary policy rule. In this section, the behavioural equations are discussed looking at their theoretical foundations and estimation procedures as well as the variables used in each of

them. In addition, a description of the data sources as well as the statistical properties of each time series in the ZQM is provided.

2.2. Data and Diagnostic Tests

The Zambia Quarterly Model is developed using quarterly time series data, covering the period Q1 1992 to Q4 2014. Data on endogenous variables in the ZQM are obtained from the Bank of Zambia database and Central Statistical Office (CSO) publications. Endogenous variables include; the average nominal exchange rate (K/USD), the average consumer price index (CPI), the average broad money (M2), real GDP (Y), the average lending rates, 5-year Bond Yield Rate and Excess liquidity of commercial Banks. At the time of developing the model, Zambia did not have quarterly GDP data and hence the Index of Industrial Production was used to decompose the annual GDP figures into quarterly GDP data. Exogenous variables in the model include; copper prices in US dollars, the US Federal Funds rate, crude oil prices in US dollars, Government deficit, US Consumer Price Index, and South African Consumer Price Index. Data on exogenous variables was obtained from the IMF, the US Bureau of Labour Statistics, the US Federal Reserve System, Statistics South Africa, Bank of Zambia and World Bank databases.

It has become standard in empirical analysis involving time series data to check for the stationarity of the series. This is because estimating equations with time series that are differently integrated would lead to spurious results. Hence, tests for stationarity in the time series used were undertaken using the Augmented Dickey Fuller (ADF) test. Results of the tests are presented in the appendix of this paper. Results of non-stationary time series indicate that most of the series are integrated of order one, I (0). Hence, to avoid spurious results from regressions, the equations that comprise the model were estimated using data in first differences. In addition, the equations include an ECM component to capture the long run phenomenon of the data.

2.3. The Determinants of Consumer Price Inflation in Zambia

2.3.1. Theoretical and Empirical Literature

In theory, there are two main sources of inflation which are prominent namely; demand and supply-side factors. Demand-side sources of inflation have been identified as being loose (expansionary) monetary and fiscal operations while supply-side factors are predominantly related to the costs of production. However, Ubide (1997) identifies three theories, namely: (i) external sector theory; (ii) the monetary theory (quantity theory); and (iii) the mark-up theory.

Debate on the causes of inflation has been dominated by the monetarists and the structuralists with the former arguing that inflation is basically a monetary phenomenon while the latter have been arguing that inflation is essentially an outcome of supply-side constraints (bottlenecks) in a given economy. The monetarists base their argument on the belief that an increase in money supply will positively affect the general prices leaving output and real money balances unaffected. The rise in general prices manifests itself in inflation.

From the structuralists' perspective, the non-responsiveness of supply in the short-run leads to shortages that exert an upward pressure on prices, leading to inflation.

In empirical literature, researchers make distinctions with regard to the determinants of inflation. They have generally focused on distinguishing between supply-side factors, demand-side issues, external sector impulses and second round effects as well as the role of inflation expectations in domestic price dynamics (Kandil and Morsy, 2011).

At the empirical front, efforts have been made to estimate the determinants of inflation for several countries with mixed results regarding some factors behind the determination of inflation and particularly for money supply. For instance, while Khan and Gill (2010) does not find money supply to be significant in Pakistan's inflationary process, Ahmed et al (2014) on the same country finds money supply to play a significant role in inflation dynamics. However, Basher and Elsamadisy (2012) findings on the Gulf Cooperation Council (GCC) supports the significant role of money supply in causing inflation although, the paper by Kandil and Morsy (2011) shows contradicting results for some GCC member countries on the role of money supply in the formation of inflation. For Sri Lanka, Bandara (2011) found money supply as one of the factors determining inflation and this is similar to Nguyen et al (2012)'s findings on Vietnam.

In Africa, a study on Malawi by Simwaka et al (2012) shows that money supply has had an important role in explaining inflation developments and this is true in Tanzania as well (see Adam et al, 2012), Uganda (Kabundi, 2012), Sierra Leone (Gottschalk, 2008), and Mali (Diouf, 2007). In South Africa, inflation is influenced by money supply only in the short-run (Akinboade et al, 2004). In Zambia, a study by Simatele (2004) and Pamu and Simuchile (2004) found money supply to have a significant effect on inflation. A recent study by Mutoti et al (2011) confirms the significant role of money supply in inflation determination in Zambia.

With regard to the impact of the exchange rate on inflation, empirical literature is consistent for many countries. Ahmed et al (2014) found the exchange rate depreciation to be the most significant factor in causing inflation in Pakistan and this is consistent with the findings by Khan and Gill (2010). Bandara (2011) reports similar results on Sri Lanka. Elsewhere, Basher and Elsamadisy (2012) found the exchange rate to be an important factor in explaining inflation in the GCC block, a result that is similar to that obtained by Kandil and Morsy (2008) on some GCC countries. But Nguyen et al., (2012) does not find conclusive results on the role of the exchange rate in influencing inflation in Vietnam. Nonetheless, the story for some African countries reviewed in literature is the same were inflation was found to be greatly influenced by exchange rate dynamics. These include Malawi (see Simwaka, et al 2012); Sierra Leone (Gottschalk, 2008); South Africa (Akinboade, 2004); Chad (Kinda, 2011); and Mali (Diouf, 2007). Past studies on Zambia also confirm the significant effect of changes in the exchange rate on inflation (see for instance Mutoti et al, 2011; Mutoti, 2006; and Simatale, 2004).

The other determinant of inflation in the empirical literature is one representing fiscal performance. Theoretically, persistent fiscal deficits are regarded to be inflationary but

empirical evidence is inconclusive on this (Catao and Terrones, 2005). In their paper "Fiscal deficits and inflation", Catao and Terrones (2005) sought to test this mixed understanding using alternative modelling techniques and a broader database for 107 countries. They found a strong association between inflation and fiscal deficits among high-inflation prone and developing countries but this was not the case for low-inflation and advanced economies. Lin and Chu (2013) finds similar results for a long data set covering 91 countries. However, Khan and Gill (2010) and Ackay (2003) in their individual country studies did not find high budget deficit to be inflationary in Pakistan and Turkey, respectively mostly as a result of the deficit being financed by way of borrowings although the paper by Ahmed et al., (2014) contradict the earlier findings by Khan and Gill (2010). Sowa (1994) also finds periods of inconsistency in the fiscal deficit to be associated with high inflation in Ghana as Kinda (2011) somewhat confirms the adverse effect of expansionary fiscal policy on inflation in Chad.

Interest rates are also one of the determinants of inflation with a rise in lending rates, for instance, expected to lower inflationary pressures by reducing private sector credit that in turn is anticipated to reduce aggregate demand and thus, prices. However, Tillmann (2008) provides empirical evidence that changes in interest rates have an adverse effect on firms' marginal costs and, thus, on inflation within a forward-looking Phillips curve framework. This is consistent with the findings by Chowdhury et al., (2006) who empirically demonstrated that changes in interest rate (when they are policy induced) can even lead to inverse inflation responses (rise in inflation with the increase in interest rates), when the cost channel is – relative to the demand channel – sufficiently strong. In view of this, there is a possibility of finding mixed outcomes with regard to the relationship between inflation and interest rates in empirical literature.

Diouf (2007) finds a significant negative relationship between a discount interest rates and inflation in Mali. This is also true with South Africa (Akinboade, 2004). Similarly, Khan and Gill (2010) finds similar result for Pakistan were the relationship between the two variables is negative and significant. But this is not the case with Nguyen et al., (2012)'s findings on Vietnam were interest rates are seen not to play any role in the inflation formation process. Simwaka et al., (2012)'s results on Malawi are similar to Nguyen et al., (2012).

In the determination of domestic inflation, the role of foreign prices (imported inflation) is important. Researchers use different measures of foreign prices with some using commodity prices as a proxy while others construct an index of foreign prices. Kandil and Morsy (2011) confirms the adverse impact of foreign prices on inflation in the long-run in all the GCC countries except for Bahrain, Oman and Qatar. This is also consistent with the findings by Basher and Elsamadesy (2012). Ahmed et al., (2014) finds Pakistan's inflation to be also influenced by foreign prices in the long- run with Nguyen (2012) finding similar results on the role of foreign prices in Vietnam's inflation dynamics. In South Africa, foreign prices have also been found to adversely influence inflation in the long-run (Akinboade, 2004), and this is also the case with Sierra Leone where Gottschalk (2008) found an increase in oil prices to adversely feed into the domestic inflationary process. Simwaka et al, (2012) also confirms the impact of foreign prices on Malawi's inflation but only in the short-run.

From the empirical perspective, inflation inertia/persistence (lagged inflation, which is also sometimes used to proxy inflation expectation) is found to be one of the significant factors in the determination of inflation (see Khan and Gill, 2010; Kandil and Morsy, 2011; Nguyen (2012); Simwaka et al, (2012 and Akinboade et al, 2004). The literature surveyed generally shows consistent results with regard to all the possible determinants of inflation with the exception of money supply, interest rates and fiscal deficit were divergent findings have been recorded. Some empirical results show money supply to be significant while others do not. This is also the issue with fiscal deficit and interest rates.

2.3.2. Theoretical and Empirical Framework

The theoretical framework underlying the inflation process in the ZQM is borrowed from Ubide (1997). In this regard, inflation in Zambia could be explained using three theories, namely: (i) external sector theory; (ii) the monetary theory (quantity theory); and (iii) the mark-up theory.

In developing a theoretical framework for inflation in Zambia, the ZQM relies on the first two theories (external sector theory and monetary theory) as the third one relies on the domestic labour market dis-equilibrium on which data is difficult to find. Furthermore, labour markets in Zambia are full of market distortions such as employment contract and labour unions such that wages do not respond to changes in market conditions.

In applying the Mundell-Fleming model to a small open economy, the requirement is that the general price level be weighted average prices of tradable and non-tradable goods:

$$p_t = \delta p_t^T + (1-\delta)p_t^{NT} \ldots\ldots\ldots\ldots\ldots 1$$

Where all variables are in logs, δ is the share of tradable goods in the consumption basket. Assuming that the prices for tradable goods are determined in the international market and also that purchasing power parity (PPP) holds, and then the price for tradable goods is given by;

$$p_t^T = p_t^* + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

In equation 2, P_t^* is the price in a foreign country and $e_t$is the exchange rate of the country's currency.

On the other hand, the prices for non-tradable goods depend on the domestic level of aggregate demand. Assuming that, the price for non-tradable goods is determined by equilibrium in the money market;

$$\frac{M^s}{P_t} = \frac{M^d}{P_t} \; or \; in \; logs \; as \; m_t - p_t = m_t^d - p_t \ldots\ldots\ldots\ldots\ldots 3$$

Where: $m_t - p_t$ is real money supply while $m_t^d - p_t$ is real money demand, and p_t is the general price level given by the CPI.

Representing the relationship between the price of non-tradable goods and aggregate demand byω, the price for non-tradable goods is;

$$p_t^{NT} = \omega\left(m_t - \left(m_t^d - p_t\right)\right) \dots\dots\dots\dots 4$$

Assuming the demand for real money balances $\left(\mathrm{m_t^d} - \mathrm{p_t}\right)$ is of the Keynesian form with inflation expectations, the real demand for money is a function of real income $(\mathrm{y_t} - \mathrm{p_t})$, interest rates $(\mathrm{r_t})$, and inflation expectations $(\mathrm{E}(\pi))$.

$$\left(m_t^d - p_t\right) = \alpha + \beta(y_t - p_t) + \rho r_t + \mu E(\pi) \dots\dots\dots\dots 5$$

Assuming that inflation expectations are formed on the basis of adaptive expectations, then expected inflation at any time period is the previous period inflation rate $(\mathrm{E}(\pi_t) = \Delta \mathrm{p_{t-1}})$.

$$\left(m_t^d - p_t\right) = \alpha + \beta(y_t - p_t) + \rho r_t + \mu \Delta p_{t-1} \dots\dots\dots\dots 6$$

Replacing equation 6 in equation 4 we get;

$$p_t^{NT} = \omega\big(m_t - (\alpha + \beta(y_t - p_t) + \rho r_t + \mu \Delta p_{t-1} \dots\dots\dots\dots)\big) \dots\dots\dots\dots 7$$

Using equations 7 and 2, replacing them into equation 1;

$$p_t = \delta p_t^* + \delta e_t + \omega(1-\delta)\big(m_t - (\alpha + \beta(y_t - p_t) + \rho r_t + \mu \Delta p_{t-1} \dots\dots\dots\dots)\big) \dots\dots\dots 8$$

Thus, in reduced form the CPI equation can be written as follows;

$$p_t = f(e_t, p_t^*, m_t, y_t, r_t, p_{t-1}) \dots\dots\dots 9$$

In equation 9, a depreciation of the exchange rate is expected to lead to increase in inflation by increasing import prices. Higher prices in trading partners, money supply, and real income are also expected to increase inflation. A higher interest rate is expected to be associated with a decrease in money holding, thereby reducing inflation. The effect of past inflation on the current price level is undetermined. On the one hand, higher inflation expectations, resulting from higher inflation in the previous period, could reduce money demand and consequently increase prices. On the other hand, inflation could persist because of sluggish adjustment owing to rigidities and structural constraints, such as those associated with poor infrastructure. Further, assuming adaptive expectations we expect that previous period level of prices will have an impact on future prices as economic agents expect these prices to persist.

The empirical framework used in estimating behavioural equations in ZQM is the error correction framework, in which the Ordinary Least Squares (OLS) estimation methodology is employed. We estimate an ECM model to capture short-run and long-run dynamics of the inflation process. The long-run relationship is captured through the error correction mechanism (ECM). Specifically, we estimate the following model;

$$\Delta cpi = ECM_{t-1} + \beta_2 \Delta usd_t + \beta_3 \Delta (y - y^*)_{t-4} + \beta_4 pcop_t + \beta_5 \Delta cpi_{t-4} + \beta_6 + \varepsilon \dots\dots\dots\dots\dots 10$$

Where the ECM is the error correction mechanism, usd is the natural log of Kwacha-US dollar exchange rate, y is the log quarterly decomposed GDP, y* is potential GDP, $pcop$ is log of copper prices in US dollars, s are the estimated short term parameters and is the shock to inflation.

The estimated results for consumer prices suggest that in the long-run consumer price inflation in Zambia is determined by money supply, average lending rates, the exchange rate, and oil prices, which are captured in the ECM term in equation 10. In this regard, an increase in money supply, exchange rate and oil prices leads to a rise in consumer prices while an increase in average lending rates results in a decline in prices. These results are similar to those obtained by Akinboade et al. (2004) on South Africa who also find that in the long-run the main determinants of prices are money supply, lending rates and nominal exchange rate.

In the short-run, the key determinants of inflation are changes in the nominal exchange, excess demand, and copper prices as well as inflation dynamics. Specifically, the estimated results indicate that exchange rate depreciation leads to an increase in consumer prices as does an increase in excess aggregate demand. Furthermore, the lagged effects of prices, which represent consumer inflation expectations, are found to play a key role in determining inflation. Finally, empirical findings also suggest that increase in economic activity denoted by copper prices leads to an increase in aggregate demand, and consequently rising consumer prices.

In the model, nominal exchange rate and crude oil prices represent the effects of import prices and external sector shocks on domestic consumer prices. Effects of import prices may be directly due to the presence of final imported goods in the consumer price index and indirectly through their cost-push effects on domestically produced goods and services.

2.4. Money Demand Equation in the ZQM

2.4.1. Theoretical and Empirical Literature

There are a number of theories on the demand for money. In the classical tradition, cash balances are held primarily to undertake transactions, and therefore depend on the level of income and prices. However, this position was changed in the 1930s when Keynes postulated three motives for holding real money balances: transactions; precautionary; and speculative demand for money. Transactions and precautionary motives of the demand for real money balances follow the classical tradition in that it depends on the level of income

while the speculative demand for money departs from the classical tradition by arguing that the demand for real money balances depend on the interest rates.

Following Keynes liquidity preference theory, several authors have offered criticisms regarding Keynes rationale for a speculative demand for money and have contributed to the theoretical literature by distinguishing broadly between the transactions demand (Baumol, 1952; Tobin, 1956) and the asset motive (Tobin, 1956; Friedman, 1956). In general, all available theories portray that the demand for money depends positively on the real GDP and the price level due to the transactions motive while it is negatively related to interest rates due to the speculative motive.

In recent years, theoretical works have tended to provide explanations for growth in money supply from the perspective of fiscal deficits. This literature argues that fiscal deficits are a key driver of money supply growth especially when they are financed by way of money creation or drawing down on reserves (Mukthar and Zakaria, 2010; Umeora and Ikeora, 2016). However, if fiscal deficits are financed by borrowing from the domestic market, money supply is unaffected. They explain this by saying that increase in money supply due to government expenditure is offset by a decline in money balances of purchasers of instruments issued to borrow.

In empirical literature, Goldfeld (1973) led the works on this subject with his estimations on the stability of the money demand function for both short and long-run using interest rates and output as determinants. In line with new developments in econometrics, recent studies have employed cointegration techniques in estimating the money demand function (see Ball, 2012 and Jenkins, 1999 for instance). However, some researchers have used inflation as a proxy for opportunity cost instead of interest rates. Bahmani-Oskooee and Malixi (1991) justifies the use of inflation as a better opportunity cost for countries that have financial markets which are not well developed. Other studies have incorporated exchange rate or the real effective exchange rate as one of the determinants of the money demand function (see Bahmani-Oskooee, 1996; Bahmani-Oskooee and Tanku, 2006; and Valadkhani, 2008, for example). This followed Mundell (1963)'s postulation that the demand for money can be a function of exchange rate, besides income and interest rates.

Studies on money demand functions for developing and least developed countries (LDCs) have generally assumed a varied number of determinants labelled as either domestic variables (inflation, income, and interest rate) or openness or foreign variables (foreign interest rates, volatility of the real effective exchange rate, and or nominal exchange rate). For instance, see Hamori (2008) on Sub-Saharan Africa; Arize (1989) on Pakistan, the Philippines, South Korea, and Thailand; Khalid (2010) on Philippines, Singapore and South Korea; and Bahmani-Oskooee and Tanku (2006) that test the validity of the black market exchange rate as opposed to official rates for 25 LDCs.

In Africa, Jenkins (1999) reviews some evidence on money demand in which income, exchange rate, interest rates and volatility in inflation are used as determinants. Anoruo (2002) investigates the stability of the Nigerian money demand function during the structural adjustment era. A stable relationship among the variables is established. Kallon

(1992) uses income, real money, Bank of Ghana discount rate, and inflation as determinants. Umeora and Ikeora (2016) undertake a study of the link between money supply and fiscal deficits in Nigeria using an error correction model. They find that fiscal deficits have positive effect on money supply and inflation in the short and long-run. They argue that this was mainly due to the monetisation of fiscal deficits by the central bank, which led to a growth in broad money.

Adam (1999) explores money demand in Zambia in light of financial markets liberalisation. The choice of determinants include income, inflation, deposit rate and treasury bill rate as interest rates, and black market exchange rate depreciation, and concludes that financial markets liberalisation led to a permanent shift in the demand for narrow money. Pamu et al., (2008) estimates the money demand function (M3) using non-traditional exports (as a proxy for real economic activity), measure of inflation (CPI), and copper prices (proxy for foreign variable). The study found exchange rate and inflation to be important determinants of money demand in Zambia. A recent study by Chileshe and Zgambo (2014) estimates an Auto-Regressive Distributive Lag model to investigate the short-run and long-run determinants of money demand in Zambia. Their estimates using quarterly data indicate that in the long-run money demand is determined by income, exchange rate, inflation and domestic short-term interest rates. Furthermore, the error correction term indicates that disequilibrium among these variables is corrected at the rate of around 17.4 percent per quarter. Moreover, their results indicate that the demand for real money balances in the short-run is significantly influenced by nominal exchange rate, short-term interest rates, inflation, and income dynamics.

From the survey of literature, money demand functions are estimated for the purpose of determining stability of the money demand so as to establish its suitability in stimulating real sector activities through monetary impulses. Alternatively, estimations of the money demand functions are aimed at establishing relevant variables that can be termed as determinants. Many variables are used as determinants with classical ones being income and interest rates. Inflation can also be used as an alternative to interest rates in an effort to capture opportunity cost. In addition, foreign exchange rate enters the model as a measure of currency substitutions with an option of using a black market rate for economies were the parallel market exists. Foreign interest rates and other outward looking or oriented variables can be incorporate in the modelling in order to capture openness or the external sector. Technological changes have also been considered in literature as one of the factors influencing demand for money. In recent years, studies have brought into picture the role that is played by fiscal deficits as a driver of money supply growth and consequently inflation.

2.4.2. Theoretical and Empirical Framework

In line with the general agreement, money demand in the ZQM is modelled as the demand for real cash balances (Nacega, 2001). In the absence of money illusion, an increase in the general prices will induce a proportionate increase in nominal demand for money, leaving the real balances unchanged.

The basic model underpinning the real money demand function is that in equilibrium;

$$\frac{M^s}{P} = \frac{M^d}{P} = f(Y, R) \ldots\ldots\ldots 11$$

Where M^s is money supply, M^d is money demand, P is the price level, Y is output or income and R is the interest rate.

We can rewrite the above equilibrium condition as a demand for money function incorporating the money supply as follows;

$$M^d = \emptyset(Y, P, R, M^s) \ldots\ldots\ldots\ldots\ldots 12$$

Assuming that the money supply process is determined by the following mechanism:

$M^s = mRM$, as well as the fact that monetisation of fiscal deficits occurs through base money while commercial banks' ability to create credit depends on the availability of excess reserves. Equation 12 can be written as;

$$M^d = \emptyset(Y, P, R, \text{fiscal deficit}, RM) \ldots\ldots\ldots\ldots 13$$

We would expect that an increase in prices and income or wealth increases the demand for money as in the classical tradition. A rise in the opportunity cost of money (R) will lead to a fall in the demand for money. If the central bank uses a bank rate to influence liquidity conditions in the money market, then an increase in the bank rate reduces money supply indirectly reducing prices and hence the demand for money. Furthermore, we expect the sign on fiscal deficits to be indeterminate for two reasons. First, if fiscal deficits are mostly financed through monetisation by the central bank, then we expect that there will be a positive relationship. Secondly, if the fiscal deficits are financed through domestic borrowing then it will be negative because high fiscal deficits will lead to an increase in yield rates and other retail rates in general.

Based on the literature reviewed above, the estimated money demand function in the extended ZQM is specified as follows;

$$\Delta m_t = \beta_{11}\left(m_{t-1} - (cpi_{t-1} + y_{t-1})\right) + \beta_{12}\Delta BOZR_t + \beta_{13}\Delta\pi_t + \beta_{14}\Delta Excess_t + \beta_{15}\Delta(G2RAG - meanG2RAG)_{t-1} + \beta_{16} + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

Where m is the natural log of broad money excluding foreign currency is deposits, BOZR is the Bank of Zambia policy rate, π is the annual inflation rate, Excess is commercial bank reserves excluding required reserves and G2RAG is the ratio of government expenditure to revenue and grants.

According to the classical theory of money demand, there exists a one-to-one positive relationship between broad money and the price level while there is a negative relationship

with output. In this regard, we impose a long-run relationship between broad money demand on one side and prices as well as output on the other. The imposed theoretical relationship is then used to estimate the rate of adjustment to long-run equilibrium whenever there is disequilibrium in the short-run.

The results from the estimated model suggest that short run determinants of money demand are the Policy Rate, growth in inflation, excess reserves and fiscal deficits. Specifically, results show that broad money growth falls in response to higher interest rates, which is in line with expectations and findings by Hamori (2008) on Sub-Sahara Africa and Zgambo and Chileshe (2014) on Zambia. Changes in annual inflation are also found to have a negative effect on broad money growth consistent with theoretical and empirical results from other studies (Jenkins, 1999 on Zimbabwe; Zgambo and Chileshe, 2014 on Zambia). Furthermore, the results indicate that fiscal deficits have a positive impact on broad money growth consistent with findings by Imeora and Ikeora (2016) on Nigeria.

2.5. Determinants of Nominal Lending Rates (interest rate pass-through)

2.5.1. Theoretical and Empirical Literature Review

It is generally accepted that the effectiveness of monetary policy action is dependent on its ability to affect the continuum of interest rates, ranging from the short- to long-term interest rates. The continuum of interest rates is better known as the term structure or yield curve (Bonga-Bonga, 2010). The term structure relates the short- and long-term rates, whose slope and dynamics can be explained by three theories, namely, the liquidity preference view, the market segmentation theory and the expectations theory (Balazs and Macdonald, 2009).

According to the liquidity preference theory, the rate of interest is determined by two factors, which are the supply of money and liquidity preference (Millikan, 1938). In this regard, the liquidity preference view asserts that investors require a liquidity premium for holding less liquid assets. The market segmentation theory hypothesises that short- and long-term interest rates can be determined independently in segmented markets. Expectations hypothesis theory maintains that long-term interest rates are an average of future expected short-term interest rates plus a term premium. This hypothesis asserts that in the absence of a term premium, short- and long-term interest rates should be equal (Misati et al, 2011).

The time preference theory of interest is concerned with the relationship between increase or decrease in the rate of interest with respect to time periods. According to this theory, the variation in the premium or the interest rate depends totally upon the risk of occurrence of an event. Therefore, the longer the expected date of loan settlement, the higher the rate of interest as risk increases with time (Herbener, 2012). The above theories shed light on how interest rates with different maturities may be related to both short-term and long-term interest rates. The major question is on the speed and magnitude of these adjustments, better known as the interest rate pass-through (John and Pokhariyal, 2013). Interest rate pass-through refers to the measure of the size and speed of interest rate transmission from the policy rates through the short-term rates and eventually to the commercial bank deposit and lending rates. The size or degree of pass-through refers to the extent to which changes in the

money market rates are passed through to the banking rates in the long-run. The speed of the pass-through refers to the length of time required for the adjustment to occur. The manner in which changes in central bank interest rates are passed through to changes in banks' interest rates determines the strength of these effects with a great magnitude (Amarasekara, 2005).

There are several pieces of empirical evidence on the determinants of nominal lending rates with various theoretical frameworks in mind. In this particular review, focus is on the empirical literature with regard to the interest rate pass-through. The interest rate pass-through literature focuses on the rate at which changes in short-term interest rates are passed on to the market rates in the short and long-run.

Studies on most African countries have shown a consistent outcome that interest rate pass-through is incomplete (Makaambi et al.., 2013; Shefeni-Shefeni, 2013). Makaambi, Wawire, and Omolo (2013) investigate the nature and dynamics of speed of adjustment of bank retail rates in Kenya using both linear and non-linear error correction models. Using monthly time series data, they find that adjustments of lending rates to policy rates are sluggish and incomplete. Specifically, the speed of adjustment is between 0.05 - 0.15 per month, implying it would take 11 - 22 months for a complete pass-through. Another study using a similar approach and data by Shefeni-Shefeni (2013) on the size and speed of the pass-through in Namibia reach the same conclusions that the interest rate pass-through from policy rates to retail rates is incomplete, especially in the short-run. Specifically, they find that the speed of adjustment is 0.004 - 0.136 in short-run while it is between 0.739 - 0.762 in the long-run between money market rates and lending rates. Furthermore, they find that the rate of adjustment between policy rates and short-term money market rates is higher.

In addition, Okello (2014) in his assessment of the effectiveness of the pass-through of interbank rates to market rates in Uganda using a bivariate co-integration method following Engel and Granger (1987) finds the long-run pass though from 7 day interbank rates to lending rates to be 0.43 while it is between 0.56 - 0.60 for deposit rates. Finally, in a comprehensive study, Sander and Kleimeir (2006) investigate interest pass-through in the Common Market Area (CMA) of South African Customs Union (SACU) using the Auto-regressive Distributive Lag approach to co-integration. Their results show that the pass-through between short-term rates and lending rates in the CMA is homogenous, fast and complete while the pass-through to deposit rates is not.

A few studies on Zambia have examined the interest rate path-through (Chileshe et al., 2014; Zgambo and Chileshe, 2014). They all conclude that interest rate pass-through is incomplete. Chileshe et al., (2014) and Zgambo et al. (2014) use similar approaches to investigate the interest rate path-through in Zambia. Specifically, using monthly data Chileshe et al. (2014) finds that the pass-through between interbank rates and lending rates is 0.02 and 0.13 in the short and long-run, respectively while using quarterly data Zgambo and Chileshe (2014) finds that it is 0.21 and 0.45.

2.5.2. Theoretical and Empirical Framework

The theoretical model for the interest rate equation is based on the portfolio effect of the term structure relations between the short and long-run interest rates within the expectations theory. The portfolio effect occurs because money and other assets are seen as substitute forms of holding wealth. A change in the short-term interest rates occasioned by changes in the Central Bank's policy rate induces economic agents to change asset portfolio combinations. For example, a rise in short-term rates may have a "portfolio effect": that is, investors re-direct their funds to short-term money market instruments, and away from bonds, thus leading to a fall in bond prices and a rise in yields (i.e. long-term rates). Similarly, a fall in the short-term interest rate induces investors to move their funds into long-term instruments, away from short-term market instruments.

Thus, there is a positive relationship between long-term interest rates and short-term changes while there is a positive relationship between lending rates and yield rates on securities because of rising opportunity cost of holding assets. This relationship can be captured in the following equation:

$$r_l = f(i_t, i_t^b) \text{ where } \frac{\partial r_l}{\partial i_t} > 0 \text{ and } \frac{\partial r_l}{\partial i_t^b} > 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots 15$$

Where i_t is the short-term interest or policy rate and i_t^b is the long-term interest rate, represented by the 5-year bond yield rate. Equation 15 implies that an increase in the policy rate will lead to increase in long-term rates, in line with the expectations theory.

Following the literature, the empirical model estimated is an error correction model in which we impose a one to one long-run relationship between nominal average lending rates and policy rate. Specifically, the equation estimated is given below;

$$\Delta i^L{}_t = \beta_{17}[i^L - i]_{t-1} + \beta_{18}\Delta i_t + \beta_{19}\Delta i_t^b + \beta_{20}\text{Dummy} + \varepsilon \ldots\ldots\ldots 16$$

In equation 16, i^L is the average nominal lending rate, i_t is the policy rate proxied by interbank rate. β_{17} is the error correction coefficient with an imposed one-to-one long-run relationship between average lending rates and the policy rate. The sign on the error correction coefficient is expected to be negative, indicating the existence of a co-integrating relationship between short-term and long-term interest rates. β_{18} measures the contemporaneous effect of changes in the policy rate on lending rates and the dummy variable is an impulse dummy that captures the structural break in the lending rates data noted in 2001Q1.

The results from the estimated model suggest the existence of a long-run relationship between average nominal lending rates and the policy rate. The imposition of a one-to-one relationship between the lending rate and policy is consistent with findings in a recent study by Chileshe (2016) which showed that the pass-through of changes in the BoZ policy rate to lending rate is complete in Zambia. Specifically, results show that the speed of adjustment

between the policy rate and the lending rate is rather slow at 8.4 percent per quarter, a result which could point to a weak interest rate transmission channel in Zambia. The results also show that in the short-run, a rise in the policy rate will lead to an increase in the nominal lending rate.

Further, the empirical results indicate that the interest rate pass-through is incomplete in the short-run, but complete in the long-run due to the imposed relationship. We impose a one to one relationship between nominal lending rates and BoZ policy rate because in the current framework the policy rate is the base rate for the commercial banks' lending rates. This result is similar to previous studies on Zambia and other African countries (Chileshe et al., 2014; Makaambi et al., 2013; Shefeni-Shefeni, 2013; Okello, 2014; Chileshe, 2016). Specifically, the yield rate on 5-year bonds has significant positive relationship with the average nominal lending rate, indicating the complementarity among the two assets and the substitutability that exists.

2.6. Determination of the Nominal Exchange Rate

2.6.1. Theoretical and Empirical Literature Review

There are fundamentally two main schools of thought addressing issues of the exchange rate determination. One school of thought is of the view that the demand and supply of currencies determines equilibrium exchange rate and utilises the balance of payment information, while the other school holds the view that equilibrium values of financial assets determines the behaviour of the exchange rate (Saeed et al., 2012). According to the later approach, it is the changes in the stock of assets which determines the equilibrium exchange rate.

Research based on the balance of payment approach rests mainly on the elasticity or absorption approach to examine the behaviour of exchange rates. On the other hand, research based on monetary approach uses purchasing power parity (PPP) condition, Quantity Theory of Money (QTM), interest rates parity, money demand function and cumulative current account position to examine the behaviour of the exchange rate.

Several pieces of empirical evidence exist on the factors determining the exchange rate. A study by Saeed et al. (2012) uses an ARDL approach to co-integration to investigate determinants of the exchange rate in a flexible exchange rate regime. Their results indicate that in the short- and long-run, the nominal exchange rate is determined by money supply, the level of foreign exchange reserves and the debt. In the long-run, they find that a 1% increase in the money supply, foreign reserves and debt increases the nominal exchange rate by 0.46%, 0.06%, and 0.53%, respectively. Further, they find that approximately 3.6% of disequilibrium in the short-run is corrected for every quarter. Bashir and Luqman (2012) investigate the long-run determinants of the real exchange rate in Pakistan using the Johansen's cointegration method. The results indicate that the real exchange rate is determined by terms of trade, trade restrictions, price level, and remittances of Pakistanis working abroad. They show that a 1% change in the terms of trade, trade restrictions, and remittances lead 0.29%, 0.28% and 0.35% change in the real exchange rate in the long-run. The error correction term shows that disequilibrium is corrected at the rate of 14% per year.

In the Sub-Saharan Africa region, a number of studies have been undertaken to investigate the determinants of the nominal exchange rate. Simwaka (2006) investigates the determinants of nominal exchange rate in Malawi using a blended version of the monetary and portfolio models. Using quarterly data, they find that in the short-run nominal exchange rates are determined by changes in current account balances, net external flows, and growth in money supply and price differentials. However, the interest rate differential is found to have no effect on the nominal exchange rate. Furthermore, the error correction term shows that any disequilibrium is corrected for at the rate of 25% per quarter. Aron et al. (1997) present short-run and long-run influences in a model for the real exchange rate in South Africa. Using quarterly data from 1970 to 1995, the authors find that real exchange rate is influenced by factors such as terms of trade, real US dollar gold price, tariffs, capital flows, gross international reserves and government expenditure.

Mkenda (2001) analyses the main determinants of the real exchange rate in Zambia and estimated the degree of misalignment in the real exchange rate using a Johansen cointegration analysis on data for the period 1971 to 1993. The study establishes that terms of trade and government consumption tend to depreciate the real exchange rate while investment share, growth of real GDP, central bank reserves and trade taxes tend to appreciate the real exchange rate. Mungule (2004) investigates sources of movements in Zambia's real effective exchange rate using a VECM over the period 1971 to 1997. Empirical results suggest that the nominal effective exchange rate responds to shocks to copper prices while shocks to domestic prices have no effect. Furthermore, the VECM for the real exchange rate shows that the main determinants of the exchange rate in Zambia are terms of trade, excess credit growth and capital outflow while trade policies have very minimal effect. Weeks (2013) investigates the determinants of the exchange rate in the short-run using monthly time series data from 2005-2013. The results indicate that the key determinants of the nominal Kwacha-US dollar exchange rate in the short-run are relative interest rates, the trade balance and the BOZ foreign exchange interventions. Specifically, they find that a 1% rise in the trade balance leads to a 0.16% appreciation while a similar rise in relative short-term interest rates leads to 0.09% appreciation. However, they find that BOZ foreign exchange intervention leads to a marginal depreciation of 0.001%.

2.6.2. Theoretical and Empirical Framework

The theoretical framework used in the ZQM for the determination of the nominal exchange rate follows the monetary approach, based on the following theories: 1) the uncovered interest parity theory; and 2) the exchange rate expectations theory.

The uncovered interest parity (UIP) theory operates well in a small open economy. The model assumes that the domestic economy is a price taker because it is small in the global financial markets. In this model, a reduction in the domestic interest rates will induce investors to move their assets out of the country to seek higher returns in other markets, thereby depreciating the currency. Furthermore, an increase in domestic interest rates will attract the inflow of foreign currency and thereby appreciate the exchange rate. In addition to the UIP, the model also notes that expectations about the exchange rate, general prices

and the interest rates affects the exchange rate overtime. It is assumed that expectations are formed using the adaptive expectations hypothesis.

Based on these theories, the model for the nominal exchange rate estimated in the ZQM is specified as follows;

$$\Delta usd = \beta_1(usd_{t-1} - (cpi_{t-1} - uscpi_{t-1}) + \beta_2 pcop_{t-1})) + \beta_3 \Delta cpi_t + \beta_4 \Delta m2_t + \beta_5 \Delta pcop_t + \beta_6 \Delta(i_t - i_t^*) + \beta_7 \Delta(i_{t-1} - i_{t-1}^*) + \beta_8 \Delta usd_{t-1} + \beta_9 dummy + \beta_0 + \varepsilon_t \dots 17$$

where: usd is the natural log of the nominal Kwacha US dollar exchange rate; pcop is the natural log of copper prices in US dollars; cpi is the natural log of the consumer price index; i - i* is the difference between the BOZ Policy Rate and the US Federal Funds rate, representing the interest rate parity condition; dummy is an impulse dummy for Q3 2015 representing a sharp depreciation and, ε_t is an error term.

In the model, a long-run relationship between the real exchange rate and the price of copper is assumed. The results of the estimated model suggest the existence of a long-run relationship between copper prices and the real exchange rate, with an increase in the price of copper leading to an appreciation in the real exchange rate. In this regard, a rise in the price of copper, Zambia's major export, will improve the country's balance of payment position resulting in the appreciation of the real exchange rate in the long-run.

With regard to the determinants of the nominal exchange rate in the short-run, the results suggest that copper prices, inflation, money supply and interest rate differentials are key determinants. The results are similar to those obtained in Mungule (2004) and those which have included an indicator of terms of trade (Mkenda, 2001; Weeks, 2013). In addition, an increase in domestic interest rates relative to global (US) interest rates leads to an appreciation, similar to Weeks (2013). On the contrary, the results also suggest that growth in money supply and domestic prices leads to the depreciation of the exchange rate, similar to Mungule (2004) who shows that credit growth leads to depreciation.

2.7. The Bond Yield Rate Model

2.7.1. Empirical and Theoretical Literature

A number of theories have been proposed to explain the key determinants of yield rates on government securities. One strand of theoretical literature uses the now well-known loanable funds theory to explain the effect of fiscal deficits on long-term interest rates (Yu, 2011; Hoelscher, 1986; Cebula, 1998 and 2003). According to the loanable funds theory, the key determinant of market interest rates is the supply and demand conditions in the market. Hence, rising demand for loanable funds occasioned by government borrowing to finance deficits could cause interest rates to rise. Other factors which could affect interest rates according to the loanable funds theory are supply side factors such as rise in cost of funds occasioned by monetary policy and external factors. The two versions of the loanable funds theory, are: i) Closed economy loanable funds (Hoelscher, 1986), and; ii) Open-economy loanable funds theory (Cebula, 1998 and 2003). Other theories explaining determinants of

the long-term yield rates, discussed above, include: i) the liquidity preference theory; ii) the expectations theory; iii) and the market segmentations theory.

Earlier empirical studies utilising the loanable funds theory find mixed results regarding the role fiscal deficits. Studies by Feldstein (1982), Hoelscher (1986), Wachtel and Young (1987), Zahid (1988), Miller and Russek (1991), Cebula (2003) find that fiscal deficits have positive effects on long-term government bond yield rates while Kormendi (1983), Hoelscher (1983), Aschauer (1989), Makin (1983), McMillin (1986), Barro (1987, 1989), Evans (1985, 1987), and Darrat (1989) find that fiscal deficits have no effects. However, all these studies find that supply side factors such as monetary policy shocks have important implications on the yield rates.

Recent studies based on the loanable funds theory have using data have unanimously found evidence in support of positive effects of fiscal deficits on long-term yield rates (Wang and Rettenmaier, 2008; Barness, 2008; Yu, 2011; Hsieh, 2011). Furthermore, these studies have found that long-term yield rates are positively correlated with TB rate, expected inflation; US yield rates and exchange rates.

2.7.2. Theoretical, Empirical Strategy and Results

Following in the literature outlined in subsection 2.7.1, the theory used to develop the empirical model is the loanable funds theory.

In the loanable funds theory, it is assumed that the key determinants of the long-term yield rates are the demand and supply conditions. In this regard, the demand and supply of loanable funds is given by:

$$D^L = f\left(i_t, FD_t, i_t^b, \emptyset\right) \dots\dots\dots\dots .18$$

$$S^L = f\left(i_t, i_t^b, \omega\right) \dots\dots\dots\dots .19$$

Where i_t is the BoZ policy rate, FD_t is the fiscal deficit, i_t^b is the bond yield rate, and $\emptyset$ is a set of shocks which can have effect on the demand for loanable funds while ω is a set of shocks which could affect supply of loanable funds. Setting supply (S^L) to equal demand (D^L) in equilibrium we can obtain a function for yield rates (i_t^b) given by:

$$i_t^b = f(i_t, FD_t, \infty) \dots\dots\dots 20$$

The partial derivatives based on empirical and theoretical literature are:

$$\frac{\partial i_t^b}{\partial i_t} > 0 \ \ and \ \frac{\partial i_t^b}{\partial FD_t} > 0$$

The above partial derivatives imply that a rise in the policy rate and fiscal deficits will lead to an increase in bond yield rates.

Empirically, equation 20 can be estimated as:

$$i_t^b = \alpha + \beta_1 i_t + \beta_2 FD_t + \varepsilon_t \dots\dots\dots\dots 21$$

However, estimating equation 21 in the presence of non-stationary series would result in spurious results (Geda et al., 2011). In this regard, we estimate an error correction model. Specifically, we impose a one to one long-run relationship between the yield rate and policy rate in line with empirical literature (Chileshe, 2016). Hence, the model actually estimated is given by:

$$\Delta i_t^b = \beta_1 (i^b - i)_{t-1} + \beta_2 \Delta i_t + \beta_3 FD_t + \beta_4 dummy + \beta_5 \dots\dots\dots 22$$

Variables used to estimate equation 22 are 5-year bond yield rate which is the most actively traded bond, the BoZ policy rate, and the fiscal deficit is measured as a ratio of total government expenditure to total government revenue and grants.

The bond rates are assumed to depend on the BoZ policy rate in the long run as imposed by the complete pass-through. The ECM term is negative confirming the existence of a long-run co-integrating relationship between the BoZ policy rate and yield rate on bonds though sluggishly. In the short-run, the estimated model indicates that a change in the policy rate has a positive effect on bond yield as expected. Furthermore, the results show that a persistent increase in the fiscal deficit has positive effects on the yield rate. This result is similar to findings by others and consistent with the loanable funds theory (Wang and Rettenmaier, 2008; Barness, 2008; Yu, 2011; Hsieh, 2011).

2.8. Commercial Bank Excess liquidity

2.8.1. Empirical and Theoretical Literature

Several theoretical works have examined the motivation of banks to hold excess reserves. For example, banks may hold excess reserves in anticipation that they may be unable to obtain interbank loans to deal with temporal shortages of liquidity (Allen and Gale, 2004; Berrospide, 2013). Precautionary excess liquidity holding has also been linked to the fear by banks of forced asset liquidation in instances such as increase in reserve ratios (Diamond and Gale, 2004; Gale and Yorulmazer, 2011). In particular, Diamond and Gale (2004) develops a model in which banks hoard excess liquidity in anticipation of future liquidation of assets. Further, Gale and Yorulmazer (2004) notes that banks hoard liquidity to protect themselves against future liquidity shocks (precautionary motive) or to take advantage of potential sales (strategic motive). From this perspective, it is expected that periods of high uncertainty increases commercial bank hoarding of excess liquidity.

Another set of theories has analysed the excess liquidity hoarding from demand and supply for credit, treating it as a residual from this process (Alger and Alger, 2011). In these theories, banks are assumed to be risk neutral and sell credit using deposits as inputs. However, accepting deposits imply incurring administrative costs and interest payments. Hence, it is expected that banks are always seeking to invest funds in high yielding assets in order to be

able to meet these costs. In this regard, any excess reserves held by commercial banks are a residual from the lending and deposit taking activities. Furthermore, it is expected that a fall in economic activities which makes credit extension riskier may lead to an increase in excess liquidity.

Finally, some theories have used existence of market imperfection, associated with information asymmetries, as a reason for the banks to hoard excess reserves (Alger and Alger, 2011). In a theory proposed by Holmstrom and Tirole (1998), banks are unable to raise external finance due to moral hazard. Existence of moral hazard makes the external premium on banks high forcing commercial banks to hoard higher levels of liquid assets to avoid paying a high premium in case of a liquidity shock. A model proposed by Lucas and Macdonald (1992), links excess liquidity hoarding to adverse selection. Building on the insight of Myers and Majluf (1984) that information about asset quality affects a bank's ability to raise external finance. Given that external finance is uninsured it tends to be very sensitive to information about a bank's asset quality, which maybe low or high. Since asset quality is private information, good and bad banks would pay the same rates for external funding if they cannot signal asset quality (in a pooling system). Hence, banks with good quality assets would have an incentive to signal themselves; in this regard, the signal is the level of excess liquidity or liquid assets.

Following the theoretical works of the 1980s and 1990s, a number of empirical studies have been done on developed and developing economies (Lester, Birchwood, Prinus, 2013; Berrospide, 2012; De Haan and Van Den End, 2011; Achrya and Merrouche, 2011; Saxegaard, 2013; Moussa, 2015). Lester et al. (2013) studies the dynamics excess liquidity among commercial banks using monthly data for Trinidad and Tobago for the period 1995 to 2010. Using a GMM approach, they find that excess liquidity is held mostly for precautionary purposes. To investigate the dynamics of involuntary excess liquidity they use a VAR approach which shows that fiscal operations as well as economic volatility are a key driver of excess liquidity. Berrospide (2012) test for the precautionary motive of liquidity hoarding for USA banks using quarterly panel data covering the period 2005 to 2009. They find that US banks hold more liquidity in anticipation of loses while exposure to securities losses and expected loan losses are the key risks faced by banks. Hence, they conclude that the precautionary motive is strong in USA. Using a panel Vector Autoregression (p-VAR) approach, De Haan and Van den End (2011) find that in response to funding liquidity shocks, Dutch banks reduce wholesale lending, hoard liquidity in the form of liquid bonds and central bank reserves, and conduct fire sales of equity securities. Finally, using data for large settlement banks in the U.K., Acharya and Merrouche (2011) show that banks significantly increased their liquidity buffers after August 2007. This increase in liquid assets occurred when the interbank markets started to dry up and bank borrowing costs ballooned.

Two studies are reviewed from sub-Saharan Africa (SSA) (Saxegaard, 2013 and Mousa, 2015). Saxegaard (2013) investigates determinants of excess reserves and thereby develop a model for estimating involuntary excess reserves using quarterly data for the CEMAC region, Nigeria, and Uganda for the period 1992 to 2003. Using an ADL model, the results by Saxegaard (2013) indicate that for the CEMAC region the hoarding of precautionary reserves can be explained by volatility of private and government deposits. Specifically, an increase

in volatility of private sector deposits increases commercial banks' holding of excess reserves but contrary to expectations the rise in volatility of government deposits reduces excess reserves. Further, they find that movements in involuntary excess reserves reflect movements in banks' assets and liabilities. Specifically, increases in credit to public sector and private sector as well as ratio of aid to GDP increases excess reservedly. In Nigeria, commercial banks' demand for excess reserves for precautionary purposes is mainly due to changes in the required reserve ratio, the maturity structure of the deposit base and the volatility of the cash to deposit ratio. In Uganda, precautionary reserves mainly reflect uncertainty surrounding the size of the deposit base as proxied by the volatility of government deposits. A study by Moussa (2015) investigates determinants of bank liquidity in Tunisia using static and panel data approaches. The results indicate that bank liquidity in Tunisia is determined by the ratio of capital to total assets, operating costs to total assets, growth of GDP, inflation.

2.8.2. Theoretical, Empirical Strategy and Results

Following the theoretical literature outlined in section 2.8.1, the model developed in this section utilises the precautionary theories and involuntary excess reserves hypothesis.
Based on the theoretical and empirical studies, the model for excess reserves in ZQM is determined by its own lags, growth in fiscal deficits, inflation and broad money growth. In this regard, the empirical model for excess reserves is given by;

$$\Delta exliq = \beta_1 D(G2RAG) + \beta_2 \Delta cpi_t + \beta_3 \Delta exliq_t + \beta_4 \Delta excessM2\_growth + C(5) \dots\dots\dots\dots\dots\dots\dots\dots\dots 23$$

The model presented in equation 23 assumes that banks' need for excess reserves is driven by their need to make interbank payments. This transaction demand for liquidity depends on economic activity (represented by inflation). However, the last part of the model reflects liquidity management by commercial banks and/or the Central Bank. Specifically, it shows the tolerable growth levels in excess reserves and broad money.

The estimated model indicates that excess liquidity is positively related to fiscal deficits and economic activity. Furthermore, results show that growth in excess liquidity beyond its moving average over eight quarters contribute subsequently to a reduction in excess liquidity. In addition, broad money growth beyond its eight-quarter moving average is followed by a reduction in excess liquidity. These mechanisms can be associated with the central bank's liquidity regulation and money growth management associated with the monetary aggregate targeting policy framework.

2.9. Aggregate Demand Equation

2.9.1. Theoretical and Empirical Literature Review

What makes an economy grow is the usual question that most people ask. Macroeconomic theory has identified various factors that influence the growth of an economy from the classical, neo-classical, new endogenous growth and Keynesian theories. According to

growth theories with classical or neo-classical orientation, expansion in an economy's level of real output results from the expanding supply of inputs such as labour, capital and changes in technology (Solow, 1956; Fazzari et al., 2012). Other factors that influence economic growth include natural resources, human capital, economic policies, foreign aid, trade openness, institutional framework, foreign direct investment, political factors, socio-cultural factors, geography as well as demography (Dodzi et. al 2013).

In the Keynesian orientation, fluctuations in economic growth are mainly induced by variations in the economy's aggregate demand. The argument is that the cause of economic stagnation is inadequate demand for society's output given the existence of nominal rigidities. Hence, with nominal rigidities demand management policies such as fiscal or monetary policy can be used to move the economy out of a recession or stagflation (Keynes, 1936).

Other theories of growth note that economic growth can be either extensive, enhanced through the accumulation of capital, or intensive, arising from more efficient use of existing capital and other resources (Gylfason and Hochreiterb, 2008). Among a number of various ways of increasing economic and social efficiency, one of the most obvious is the accumulation of human capital – through education, on-the-job training, and health care. In addition, there are several other ways of increasing efficiency and economic growth, such as technical progress and research and development.

Furthermore, trade has proved to be a very viable ingredient to economic growth. This can be by way of dynamic or static means, dynamic in the sense of exchange of technological progress and static in the sense of increased volume of goods and services. Smith (1776) and Ricardo (1817) showed how free trade can enable individuals and countries to break outside the production frontiers and increase their welfare than would be the case under a controlled economy, which would confine them to lower standards of life.

The past two decades have witnessed renewed interest in the main factors driving economic growth in many countries. Consequently, empirical literature on economic growth has grown and aggregate demand-oriented studies, in particular, have flourished in the past decade (Temple, 1999 and Ahn and Hemmings, 2000). Some studies have focused on single countries while others involve multiple countries. While determinants of economic growth in developed economies have long been established, the resurgence of empirical growth literature has tended to focus on developing and emerging economies with the view to understanding the factors driving economic growth, or the lack of it.

Among the recent empirical studies on the determinants of economic growth in emerging and developing economies include Gylfason et al., (2008), who studied the determinants of long-run growth in Estonia and Georgia. The empirical findings from their study suggest that the determinants of growth in these countries include education, investment in physical capital and foreign direct investment, with a country that invested a proportionately higher amount in physical capital and education growing at a faster rate than the country with correspondingly lower amounts of investment in capital and education. Over the period 1989 to 2005, real GDP growth in Estonia averaged 6 percent while real GDP growth in

Georgia averaged 2 percent over the same period. The differences in the growth rates were attributed to the fact that Estonia invested 29 percent of GDP in machinery and equipment on average from 1989 to 2005 compared with 20 percent in Georgia while enrolment at primary school level in Estonia averaged 100 percent compared to 95 percent for Georgia (Gylfason et al., 2008). Furthermore, net inflows of foreign direct investment in Estonia averaged 7 percent of GDP between 1992 – 2005 compared with an average of 4 percent in Georgia (Gylfason et al.., 2008).

In Africa, based on a panel data of 19 SSA countries for the years 1982 - 2000, the study conducted by Ndambiri et.al, (2012) explored the determinants of economic growth in the region. The study results indicate that physical capital formation, a vibrant export sector and human capital formation significantly contributed to the economic growth among Sub-Saharan countries. However, government expenditure, nominal discount rate and foreign aid significantly led to negative economic growth (Ndambiri et. al, 2012).

Tsangarides (2012) compares the determinants of growth in Africa with the rest of the world and examines the determinants of growth spells in Africa. The factors considered include physical and human capital, macroeconomic policy, and socio-political factors. The results show that the determinants of growth spells in Africa are different from those in the rest of the world. In particular, the main determinants of growth in Africa were initial income, terms of trade, exchange rate under-valuation and inflation, while openness and droughts (seasonal effects) were found to negatively affect growth on the continent. However, capital (human and physical) and world interest rates had marginal effects on growth.

Other empirical studies on the determinants of output growth carried in Africa include that on Horn of Africa and Ghana. The Horn of Africa countries had poor economic growth spanning many decades before the 2000's and the study by Abdi et al., 2012 was aimed at unbundling the factors responsible for the poor economic performance and divergence from the developing regions. Their study revealed that among the factors responsible poor economic growth in the sub-region include limited access to finance (from both domestic and external sources), low domestic savings, weak infrastructure, and inadequate human capital and Governance issues. Havi et al.,(2013) find that the long-run determinants of growth include physical capital, labour force, foreign direct investment, foreign aid, inflation and government expenditure in Ghana. In the short-run, foreign direct investment and government expenditure were significant determinants of growth in real gross domestic product.

2.9.2. Theoretical and Empirical Framework

In ZQM, growth in the economy is modelled from the Keynesian perspective based on the assumption that fluctuations in the economy's aggregate demand are a result of deficient demand in the economy.

The model assumes that aggregate demand converges towards the trend in GDP, which represents aggregate supply. Aggregate demand is modelled as a gap that may be below or above the trend GDP. A positive output gap will lead to a fall in aggregate demand or output,

while a negative output gap represents excess supply that leads to an increase in aggregate demand. Higher real interest rate reduces aggregate demand while real exchange rate depreciations and real money growth increase aggregate demand, and hence output.

Borrowing from the literature review above, the output growth is assumed to be influenced by lagged output, real interest rates, real exchange rates and real money supply. Therefore, output growth equation is specified as follows;

$$\Delta_4 y_t = \beta_{41}\Delta_4 y_{t-1} + \beta_{42}[i^L - \Delta_4 p]_{t-2} + \beta_{43}\Delta\left[e - \left(p - p^f\right)\right]_{t-3} + \beta_{44}\Delta(m-p)_t + \beta_{45}\Delta(m-p)_{t-1} + \beta_{46}\text{Dummy} + \beta_{47} + \varepsilon_t \ldots\ldots\ldots 18$$

Where: y_t is output growth, $[i^L - \Delta_4 p]$ is the real interest rate, $\left[e - \left(p - p^f\right)\right]$ is the real exchange rate and $(m - p)_t$ is real money supply.

It should be noted that in the output equation specified above, quarterly data on GDP was interpolated from annual series. In this regard, annual GDP figures were decomposed using the Index of Industrial Production by following its seasonal pattern to get quarterly data.

The result of the estimated model shows that aggregate demand growth is determined by its previous growth, the real (lending) interest rate, the real exchange rate and real broad money growth. In particular, the results show that an increase in real lending rates leads to a decline in output growth while depreciation in the real exchange rate boosts output growth. In addition, growth in real broad money leads to an increase in output growth, which is consistent with theory. Furthermore, the results obtained for Zambia seem to be consistent with those obtained for Ghana, where growth in output was found to be negatively influenced by real interest rates, and positively influenced by the depreciation in the real exchange rate and real money growth (Havi et al., 2013).

3. Monetary Policy and Fiscal Policy in the ZQM

3.1. Monetary Policy in the extended ZQM

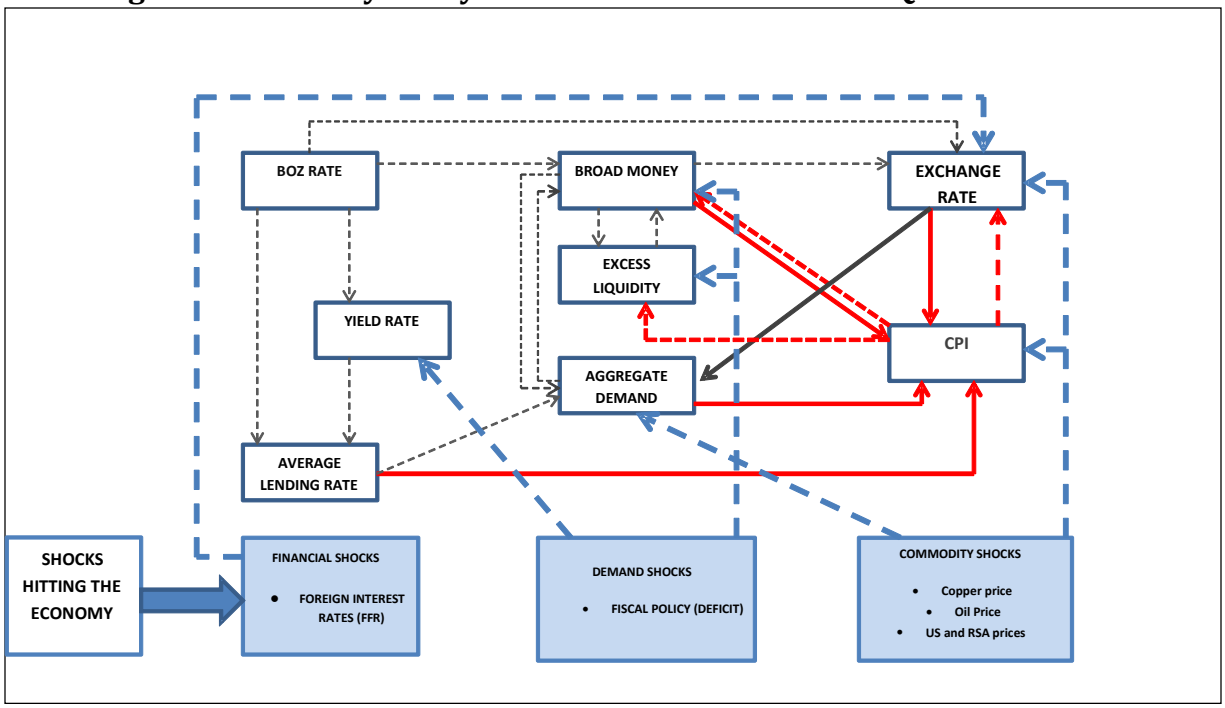
3.1.1. Monetary Policy Transmission and the Shocks

Figure 1 below portrays monetary policy transmission in the extended ZQM. It illustrates three channels of monetary policy transmission, namely;

- Interest rate channel;
- Exchange rate channel; and
- Money or credit channel;

In addition, the model has the expectations channel, which is included via the lags of macroeconomic variables or adaptive expectations.

Figure 1: Monetary Policy Transmission in Extended ZQM



***Source**: Staff Compilations*

Interest rate channel – In Figure 1, this operates through changes in the BoZ Policy Rate, which directly affects the lending rate given that the Policy Rate is the reference rate for banks' lending rates (black dotted line running from BoZ Rate to average lending rate). In this case, an increase in the Policy Rate will lead to an upward adjustment in lending rates. Higher lending rates will constrain credit growth, dampen aggregate demand and ultimately lead to a reduction in inflation (black dotted line moving from Average Lending Rate to Aggregate Demand as well as red solid line moving from Average Lending Rate to CPI).

Exchange rate channel – The increase in the Policy Rate will also work through the exchange rate channel and is expected to lead to an appreciation in the exchange rate. An appreciation in the exchange rate will have a direct impact on consumer prices as indicated by a solid red line running from the exchange rate to inflation. In this case, inflation will decline. Changes in the exchange rate will also have a direct impact on aggregate demand (black solid line in Figure 1 moving from the exchange rate to aggregate demand). For instance, an appreciation in the exchange rate will impact output growth through a decline in net exports, with lower aggregate demand leading to a reduction in consumer prices. Changes in consumer prices also impact on the exchange rate as illustrated by the red dotted line running from CPI to the exchange rate in Figure 1.

Money view channel - This occurs through the effects that monetary policy has on the incentives to hold money or other interest rate earning assets. For example, an expansionary monetary policy will lead to a reduction in interest rates on loans, providing banks with an opportunity to issue more credit. This will result in increased consumption and investment and consequently aggregate demand growth. Similarly, contractionary monetary policy

leads to an increase in interest rates, which makes credit expensive, resulting in lower demand for credit. A fall in credit will lead to a decline in broad money growth and consequently aggregate demand will decline (black dotted line in Figure 1 running from broad money to aggregate demand).

In the model, the impact of fiscal policy is also transmitted through the money view channel. In this regard, a fiscal deficit will be reflected in excess liquidity and higher money supply growth in the economy (blue dotted line running from the demand shock block to excess liquidity and broad money in Figure 1). The increase in broad money growth induced by the fiscal deficit will boost aggregate demand, leading to an increase inflation. Widening fiscal deficits will also prompt increased borrowing from the domestic market, which will push up yield rates on Government securities (blue dotted line moving from fiscal policy to yield rates in the Figure). In the model, yield rates on Government securities can also increase due to the tightening of monetary policy in response to inflationary pressures (black dotted line moving from BoZ Rate to yield rates in Figure 1).

Expectations channel – This works through the expectations economic agents form about key macroeconomic variables. For instance, an expectation of depreciation in the exchange rate following the loosening of monetary policy is likely to result in upward revision of consumer prices, thereby exerting inflationary pressure on overall prices. An increase in consumer prices will result in economic agents' expectation of higher interest rates in the future to contain inflationary pressures, a situation which may lead to increased aggregate demand and heightened inflationary pressures.

3.1.2. Monetary Policy Rule in the ZQM

The model is closed by a Taylor rule type of policy reaction function. According to the policy reaction function, the Bank is assumed to respond to deviations of inflation from its target and to the output gap. Furthermore, the reaction function assumes that the central bank attempts to smoothen interest rates over the horizon in that the last period's policy stance may also affect the current policy stance. In the model, the monetary policy rule is specified as follows:

$i_t = \alpha\{\bar{\imath} + 1.1[\pi_t - \pi^*]_{t-1} + \beta y_t\} + (1-\alpha)i_{t-1} + \delta_t$, central bank responds.

Where i_t is the Policy Rate; π is year-on-year inflation; π^* is targeted year-on-year inflation; y_t is output gap, δ_t is a policy shock and □, □ and □ are policy-determined parameters. In addition to the Taylor type rule, the central bank also considers a wider set of information which holds key information on future price formation in its monetary policy formulation.

4. Use of extended ZQM in Forecasting and Policy Analysis

Just like its predecessor, the primary uses of the extended ZQM are forecasting macroeconomic variables and policy analysis. However, the extended ZQM is now able to perform fiscal policy analysis which is not available in the earlier model. In this section, we demonstrate the forecasting ability of the ZQM as well as policy analysis.

4.1. Forecasting with the Extended ZQM

In order to perform out of sample forecasting, three steps are involved. These include i) updating all the series in the model (endogenous and exogenous); ii) Set the forecast horizon, and; iii) Make assumptions about the evolution of exogenous variables over the forecast horizon.

Table 1: Variables in the Extended ZQM

Endogenous Variables	Exogenous Variables
Consumer Price Index	Copper Prices
Broad Money supply	Oil Prices
Average Lending Rate	Government Expenditure to Revenue and Grants
Nominal Kwacha/US$ exchange Rate	US Consumer Price Index
Excess Liquidity	South African Consumer Price Index
Output (GDP)	BOZ Policy Rate
5-Year Bond Yield Rate	

Once data has been updated to the most recent quarter, assumptions are then made. Assumption can be done in two ways:

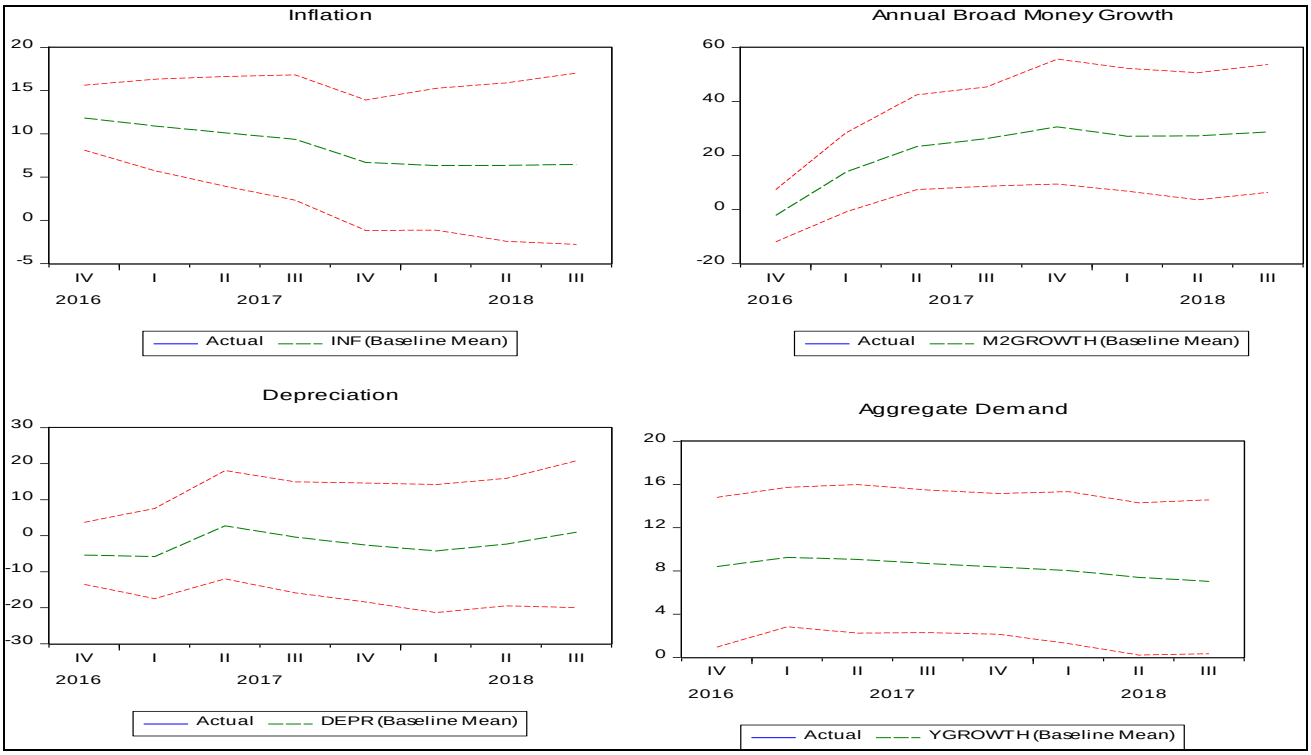
i) they can be made using the equations describing the evolution of exogenous variables over the forecast horizon; and,
ii) directly inputting the data from forecasts made by other organisations (FED, SARB, IMF, WORLD BANK, or other institutions).

Here we demonstrate forecasts for a two-year period using the first method. Specifically, the forecasts are made under the following assumptions:

- LOG(G2RAG) = LOG(G2RAG(-1))
- LOG(CPIUS) = LOG(CPIUS(-4))+ 0.02
- LOG(CPISA) = LOG(CPISA(-4))+ 0.04
- LOG(POIL) =LOG(POIL(-1))
- LOG(PCOP) = LOG(PCOP(-1))
- FFR = FFR(-1)
- BoZR = BoZR(-1)

The above assumptions state that US inflation will be 2% over the forecast horizon which is the medium term target of the USA Federal Reserve System; Inflation in South Africa will be 4% which is the middle of the South African medium target range of 3-6%; the deficit in the previous quarter will continue at the same level over the medium term; Oil prices will remain flat (that is, at the previous quarters levels) over the medium-term, similar to copper prices. Finally, we assume that the US Federal Funds Rate will be maintained at its current level while Bank of Zambia will not change its policy rate.

Figure 2: Projections of Inflation, Broad Money Growth, Depreciation and Aggregate Demand



Given the above assumptions, Figure 2 gives the forecasts of the endogenous over the forecast horizon. Figure 3 indicates inflation will average 11.6% in Q4 2016 falling to 6.7% by end of 2017 while annual broad money growth will shrink by 2% in Q4 2016 then grow by 26% in Q4 2017. Further, the Figure shows that the exchange rate will post some minimal appreciation in Q4 2016 and Q1 2017, then start depreciation in Q2 2017 though rate of the depreciation will be low.

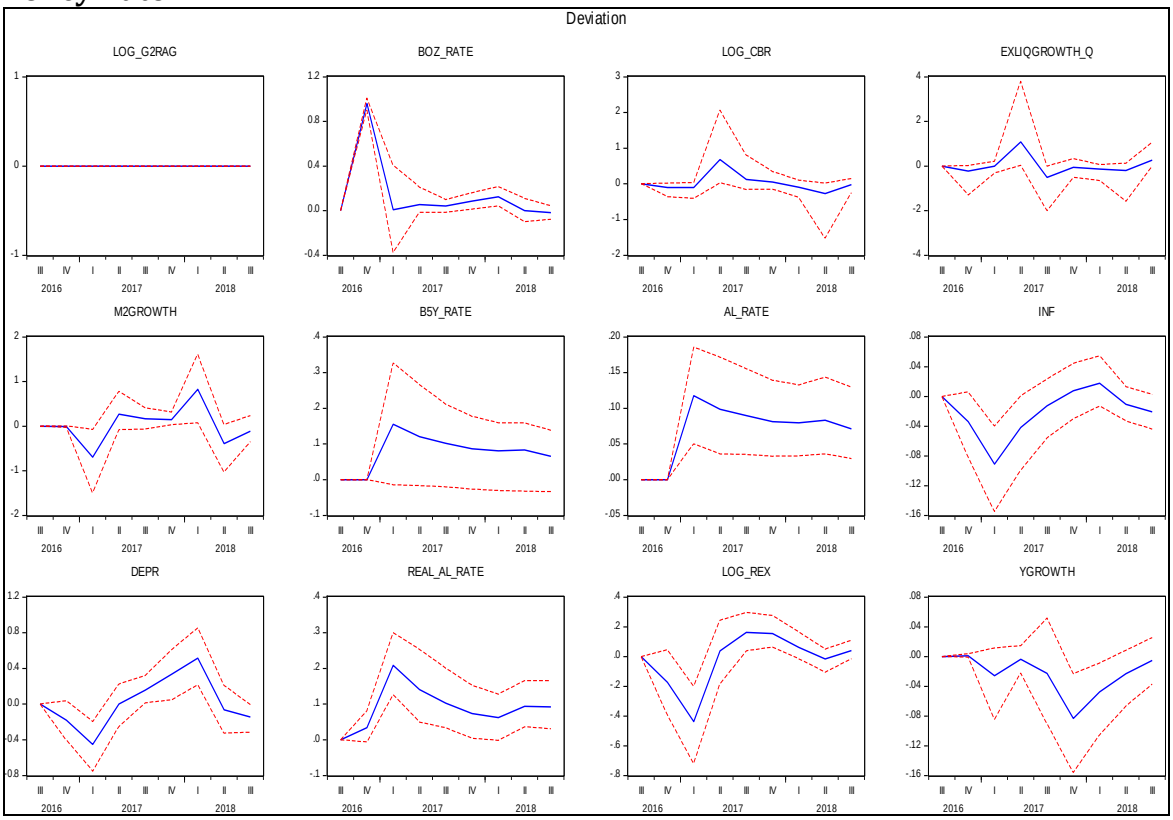
4.2. Policy Analysis in the Extended ZQM

The other use of the ZQM is policy analysis aimed at understanding the response of key macroeconomic variables to domestic and external shocks. The model can be used to trace how inflation, for instance, responds to a shock, such as the decline in the price of copper, increase in the price of crude oil or the increase in the BOZ Policy Rate and fiscal deterioration. In this demonstration, policy analysis is undertaken using two shocks namely: i) monetary policy; ii) and external shocks.

4.2.1. Monetary Policy Shocks

Here we demonstrate the effects of a hike in the policy rate by 100 basis points or 1 percent in the fourth quarter of 2016. Figure 3 illustrates the response of the key variables to such a shock.

Figure 3: Response of key Macroeconomic Variables - 100 bps increase in Policy Rate

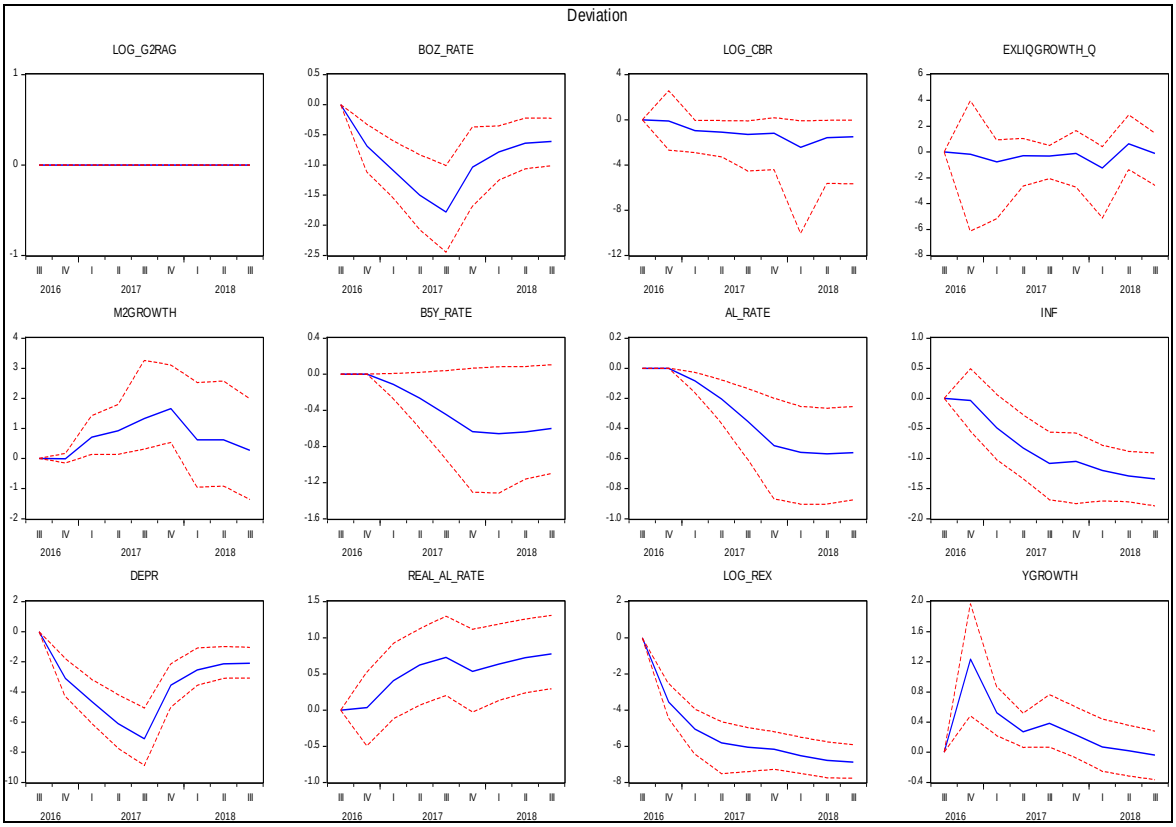


A 100 basis points increase in the Policy Rate will result in inflation falling by a maximum of 40 bps in Q1 2017 and then slowly returning to equilibrium by Q3 2017. This effect occurs through three main transmission channels. Initially, an increase in the Policy Rate will lead to an increase in long-term interest rates (5-year Bond Yield Rates and Average lending Rates). An increase in nominal interest rates will in turn lead to higher real interest rates which will negatively impact money supply and ultimately aggregate demand. Secondly, a hike in the Policy Rate resulting in a rise on interest rates on Zambian securities which will cause an inflow of foreign capital, leading to the appreciation of the domestic currency. Appreciation of the domestic currency will make the price of imported goods cheaper leading to a fall in inflation. In addition, the appreciation of the exchange rate will cause the net exports to decline, lowering aggregate demand and ultimately inflation.

4.2.2. External Shocks - 15 % positive shock to copper prices

Here we consider a 15% positive shock to copper prices is considered. Figure 4 below illustrates the response of other variables to a 15% rise in copper prices starting in Q4 2016.

Figure 4: Response of Macroeconomic variables to a 15% rise in copper prices



A 15% rise in copper prices from Q4 2016 will result in sharp decline in inflation, levelling off in Q1 2018 as well as a rise in economic activity with a peak in Q2 2017. The effects of a rise in copper prices occur primarily through its stronger effects on the exchange rate. Figure 5 shows that an increase in copper prices will lead to the appreciation of the nominal and real exchange rate. The appreciation of the exchange rate leads to a fall in prices of imported consumer goods and raw materials. On the other hand, the rise in copper prices will spur economic activity since copper mining is an important sector with significant linkages to other sectors of the economy. In addition, the fall in the interest rates following a decline in inflation will cause the borrowing from the financial system to increase, resulting in more economic activity.

5. Conclusion

The main objective of this paper is to document the extended ZQM, which is an aggregate macroeconomic model for Zambia. The model has been developed with a view to provide short to medium-term forecasting and policy analysis to guide monetary policy formulation

and implementation at Bank of Zambia. The model is based on a simple econometric modelling strategy using relevant economic theories to support the various components of the model. The level of exogeneity is quite high with model users required to provide assumptions on seven exogenous variables to be able to use it successfully.

Equations in the model were estimated on a sample size covering the period from late 1990s to the fourth quarter of 2014. This period covers the era of numerous economic policy reforms by the government that moved the economy from a command or centralised one to market-based. Overall, the performance of the model is reasonable and acceptable. The paper demonstrated how to perform forecasting and policy analysis. In policy analysis, two demonstrations are done involving a monetary policy shock and an external shock. The analysis presented in the previous section shows that the response of other variables to monetary policy and external shocks are consistent with expectations. In addition, the results presented in this paper indicate that tightening monetary policy through increasing the Policy Rate leads to fall in economic activity and inflation as expected. Furthermore, the results indicate that a positive shock to copper prices leads to an increase in economic activity and a fall in inflation.

The model documented here is not without limitations. The model still suffers from lack of quarterly data. Although the Central Statistical Office (CSO) has started releasing quarterly GDP the series is still short for purposes of econometric estimations. To keep the model relevant and usable, period updating may be required including the re-estimation of the model once a longer series of quarterly GDP data from CSO is available.

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