EMPIRICAL ANALYSIS OF THE EFFECTIVENESS OF MONETARY POLICY IN ZAMBIA

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Abstract

This study provides empirical analyses of the effectiveness of monetary policy in Zambia by investigating the money demand function and the monetary transmission mechanisms (MTMs). The money demand function is investigated using the Autoregressive Distributed Lag (ARDL) approach while monetary transmission mechanisms are analysed through the Vector Autoregressive (VAR) framework. The money demand function is found to be determined by real income, the exchange rate and Treasury bill rates in the long-run while in addition to these factors, inflation plays a role in the determination of money demand in the short-run. The money demand function is also found to be stable, a result that points to the importance of monetary aggregates in the conduct of monetary policy. As regards monetary transmission mechanisms, the results found monetary aggregates (broad money) as being important in the transmission of monetary policy while interest rates were found to have no significant effects on output and prices. The exchange rate is also found to be an important channel for the transmission of monetary policy. The key proposition from these results is that monetary aggregates will still continue to play a role in the Bank of Zambia’s conduct of monetary policy even as the Bank moves toward the adoption of inflation targeting, where the policy rate is envisaged to be the key monetary policy tool.

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1.0 Introduction

The COMESA Committee of Central Bank Governors met at the 19th Meeting in Lilongwe, Malawi in November 2013 and considered a proposal from the Monetary and Exchange Rate Policies Sub-Committee on the appropriate monetary policy regime for the COMESA region. The proposal was in line with the regional block’s continued efforts aimed at enhancing monetary and financial integration in the region. The Governors welcomed the proposal, but noted shortcomings such as the lack of sufficient empirical analysis to support the conclusions contained in the proposal and inability to use recent information or data from member countries to analyse specific country experiences of member countries. In light of these shortcomings, the Governors directed the COMESA Monetary Institute (CMI) to undertake an in-depth empirical assessment of the effectiveness of monetary policies in selected member countries. Zambia is one such country identified for the study.

The conduct of monetary policies over the last two decades in most countries in the COMESA region have been based on the monetary aggregate targeting (MAT) framework\(^1\). The MAT framework is premised on the existence of a strong and stable relationship between monetary aggregates (broad money) and the ultimate monetary policy goals, inflation or output. In Zambia, monetary policy conduct was exclusively based on the MAT framework from the early 1990s to March 2012. During this period, monetary policy in Zambia helped to reduce inflation from the triple digits of the early 1990s to current single digits. Other member countries in the COMESA region using the similar framework have also managed to lower inflation from higher levels to relatively lower levels in recent times.

An assessment of the performance of monetary policy in Zambia under the MAT framework suggests that monetary policy has been effective, judging from the reduction in inflation rates from triple digits of the early 1990s to current single digits. However, firm conclusions about the effectiveness of monetary policy can only be deduced through a detailed empirical analysis that takes account of the underlying relationships between the monetary policy framework and monetary policy goals or objectives and outcomes. Such an analysis may also shed light on the motivation behind the Bank of Zambia’s recent move to consider alternative monetary policy frameworks for the conduct of monetary policy.

Hence, the main objective of this study is to empirically assess the effectiveness of monetary policy in the COMESA region, with particular reference to Zambia. This is accomplished through the empirical examination of the money demand function and empirical analysis of the monetary transmission mechanisms. The rationale behind the adopted approach is to assess whether the money demand function exhibits the characteristics required for the success of monetary policy under a MAT framework as well as to assess the channels through which monetary policy is transmitted under such a framework. Based on the empirical findings, the study makes recommendations for an appropriate monetary policy regime that can be implemented in Zambia, and by extension in the COMESA region over the medium to long-term.

\(^{1}\)Other COMESA member countries that at least used the MAT framework at one time include Kenya, Uganda, Rwanda, Burundi, Egypt, Mauritius, Madagascar and Zimbabwe.
The results from the empirical analysis of the money demand function suggest that in the long-run, demand for real money balances is determined by real income and opportunity cost variables (exchange rate and the Treasury bill rate). As regards the exchange rate, the negative and significant coefficient associated with the exchange rate demonstrates the presence of currency substitution in the estimated money demand function for Zambia. This result is not surprising given that residents are free to hold foreign currency-denominated accounts and may use such accounts to hedge the risks associated with inflation or the depreciation of the exchange rate. In the short-run, money demand is found to be significantly influenced by the exchange rate, short-term interest rates, inflation, and income dynamics. In terms of stability, the money demand function is found to be generally stable.

As regards the monetary transmission mechanisms, empirical evidence from this study suggests that the MTM is generally weak and more closely connected to monetary aggregates (broad money) than interest rates. In this regard, the money channel appears to be one of the important channels through which monetary policy is transmitted in Zambia, given its significant impact on output or inflation, in contrast to interest rates. Evidence also shows the importance of the exchange rate channel in monetary policy transmission in Zambia given the instantaneous response of the exchange rate following a monetary expansion. However, results from the interest rate pass-through suggest that market interest rates appear to be gaining in importance though their effect of output or prices remain insignificant.

The overall recommendation from this study is that as the process of modernising monetary policy framework, it is clear that in the case of Zambia monetary aggregates will still continue to play a role in monetary policy conduct. In this regard, it would be premature to abandon the traditional policy focus on monetary aggregates, given their influence on the key macroeconomic outcomes of output and prices. A key implication from this study is therefore that monetary policy in Zambia, and other COMESA member countries, should continue to consider developments in monetary aggregates while gradually transitioning to modern monetary policy frameworks. In addition, measures should be put in place that are aimed at enhancing monetary transmission mechanisms, particularly the interest rate channel, by promoting financial deepening and economic development more generally.

The paper is structured as follows: Section 2 discusses monetary policy implementation and economic performance in Zambia while the monetary policy framework is reviewed in Section 3. Theoretical literature review on the money demand function and monetary transmission mechanisms is presented in Section 4; empirical literature review on the money demand function and monetary transmission mechanisms is provided in Section 5. The empirical approaches used in the study are presented in Section 6 while Section 7 discusses the results of the estimated models. The paper ends with concluding remarks and recommendations in Section 8.
Prior to the 1990s, the conduct of monetary policy in Zambia was driven by multiple objectives, which included the provision of cheap credit mainly to state owned enterprises and promotion of economic growth through various initiatives and incentives. In addition, monetary policy was used to finance the government’s budget through borrowing from the central bank.

During this period, monetary policy relied mainly on the use of direct instruments such as interest rate controls, directed credit allocation as well as core liquid assets and statutory reserve ratios. Reliance on direct monetary policy instruments was partly based on the prevailing economic paradigm which was dominated by the state, and the realisation by the central bank that it had little control over money supply since the banking sector was dominated by foreign banks that tended to issue loans to mostly foreign owned companies without regard to prevailing economic and financial conditions (Kalyalya, 2001).

Partly due to monetary policy’s lack of clear focus, macroeconomic conditions deteriorated steadily during the period prior to the 1990s. The persistent use of the central bank to finance fiscal deficits as well as failure of the monetary authority to control money supply resulted in rising inflation (Bigstern and Mugerwa, 2000). The growing economic problems were compounded by internal and external imbalances as well as structural and institutional deficiencies. Domestically, price controls on most food items, widespread consumer subsidies, and the industrialisation strategy of import substitution coupled with weak public administration worsened the fiscal position and led to a highly inefficient allocation of resources. Externally, the country’s balance of payment position became unsustainable following the loss of international reserves due to growing foreign debt servicing and dwindling export earnings resulting from falling copper prices and production volumes.

The combined effect of the factors noted above pushed the economy to a state of stagnation and near hyperinflation (Table 1). Annual economic growth fell from an average of 3.9% during 1961-65 to 1.1% during 1981-90. At the same time, external debt as a percentage of gross domestic product (GDP) rose from 49 to 119%. Inflation reached an average of 76.9% during the 1980s, and with negative real interest rates, the banking system started to lose its intermediation role and credit to the private sector declined relative to GDP.

The worsening economic problems led to discontent among the citizenry that culminated in elections in 1991 and the ushering in of a new Government. 1992 marked a new chapter in the nation’s economy as the new government embarked on an agenda to restore economic growth through a series of economic reforms and policies aimed at creating a market-based economic system, driven by the private sector. Through the reforms, market forces were given a greater role in the allocation of resources as prices were decontrolled and most subsidies abolished. Other measures taken include the liberalisation of the foreign exchange market through the removal of exchange controls and the decontrolling of interest rates.
Changes in the economic environment carried through to the conduct of monetary policy. The Bank of Zambia (BoZ) Act was amended in 1996, narrowing the central bank’s objective to price and financial system stability. Consequently, monetary policy concentrated on creating a stable macroeconomic environment to support sustainable economic growth. The resultant institutional arrangement following the amendment of the BoZ Act was that the Bank was empowered to pursue appropriate monetary policy in support of sustainable economic growth. The inflation target was to be set by the Ministry of Finance in consultation with the Bank of Zambia. Once the inflation target has been set, BoZ had discretion to use monetary policy instruments at its disposal in managing liquidity conditions with the aim of achieving the inflation target. Under the new framework, BoZ started to target monetary aggregates, an approach premised on a strong and stable relationship between the ultimate target (inflation) and money supply.

The Bank also started to rely on indirect market-based monetary policy instruments in the conduct of monetary policy. These instruments included primary auctions of treasury bills and government bonds, as well as auctions of short-term credit and term deposits under open market operations (OMO). In addition, the Bank can use purchases and sales of foreign exchange as a tool of monetary policy as well as management of exchange rate policy. With these indirect instruments, the BoZ tried to influence the behavior of financial institutions and other market players through market mechanisms. This helped improve control of money supply and inflation and also promoted a more efficient allocation of credit and financial market development in general.

The change in the monetary policy framework and its implementation contributed to a marked improvement in Zambia’s macroeconomic environment. Money growth and inflation declined sharply, with the latter being held in the single digits since 2006. The liberalization of lending and deposit rates initially caused real interest rates to spike, but they subsequently stabilised at about 5%. Moreover, real GDP growth steadily increased to an average of 6.6% during the period 2001 to 2012 from an average of 0.8% during 1991 to 2000 (see Table 1 above).

| Table 1: Evolution of Key Monetary and Economic Variables |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 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 | 119.3 | 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 Database, and BoZ database. (Real Interest Rate is the lending interest rate adjusted for inflation as measured by the GDP deflator.)
3.0 Review of Monetary Policy Framework

The MAT framework employed by Bank of Zambia to conduct monetary policy is based on the existence of a strong and predictable relationship between monetary aggregates and the ultimate monetary policy target, inflation. Literature developed around the role of money in monetary policy suggests that money can be useful in the conduct of monetary policy if it is used as an “information variable” and or as a monetary policy instrument or target. In this regard, money is useful as an information variable “if fluctuations in money provide relevant information about the current or future fluctuations in key macroeconomic variables that monetary policy seeks to influence...while as a target or policy instrument, money is useful if a given rate of growth in money is consistent with the desired level of inflation or output’s rate of growth” (Friedman and Kuttner, 1982). From the foregoing, it should be noted that for money to be useful as an information variable, it must provide important and systematic information about the future paths of key variables for monetary policy. Similarly, for money to be useful as a monetary policy target or instrument, it must have some relation with key macroeconomic variables such as inflation or output. The implication of this is that for a monetary policy framework based on money to be successful, there has to be a strong and reliable relationship between the monetary aggregate selected as the target or instrument and the ultimate target, which could be inflation or output.

In the case of Zambia, base money or reserve money has been used as the operational target in the conduct of monetary policy while broad money has been used as the intermediate target with inflation being the ultimate target. Reserve money represents the liability of the central bank, and its choice as the operational target is premised on the central bank’s ability to control this liability. Reserve money is in turn linked to broad money through the money multiplier, which is assumed to be stable and predictable. In this regard, if the money multiplier is stable and predictable, the central bank could control the overall monetary conditions in the economy by keeping reserve money at a level that is consistent with desired broad money growth. The desired expansion of broad money should in turn be consistent with the inflation target.

A review of the money multiplier for Zambia depicted in the Figure 1 suggests that the money multiplier has not been particularly stable during the period of the MAT framework. Prior to 2000, the economy was characterized by general instability with relatively high growth rates in money supply and high inflation rates. This is partly reflected in the relatively high instability of the money multiplier. However, from about 2001 to around 2007, the money multiplier exhibits some relative stability. From around 2008 to the end of the sample period (February 2014), the stability of the money multiplier seems to be questionable.
Another important requirement for successful implementation of monetary policy under the MAT framework is the existence of a strong and predictable relationship between the monetary aggregate selected as the intermediate target and the ultimate target of inflation. In the Zambian case, this entails that growth in broad money should be consistent with inflation. In other words, there has to be a strong positive relationship between growth in broad money and inflation for monetary policy to achieve the inflation objective.

Figure 2 depicts the relationship between growth in broad money and inflation. From the Figure, it can be noted that prior to 1995, the relationship between growth in broad money and inflation was relatively stronger than during the post-1995 era. The weakening of the strength of the relationship between growth in broad money and inflation as reflected in the lower correlation coefficient in the post-1995 era entails that broad money has become a less reliable indicator of future developments in inflation and this presents a challenge to the conduct of monetary policy under the monetary aggregate targeting framework.
The relative instability of the money multiplier and the weakening relationship between broad money and inflation partly motivated the Bank of Zambia’s recent move toward an alternative monetary policy framework. To this effect, the Bank embarked on modernising its monetary policy framework with the ultimate objective of adopting an inflation targeting monetary policy framework. The first step in the modernisation of the monetary policy framework was the introduction of the policy rate in April 2012.

One of the motivations for the introduction of the policy rate was to enhance market participants understanding of the monetary policy stance. Under a monetary aggregate targeting framework, it is usually difficult for market participants and other economic agents to understand the central bank’s monetary policy stance as the monetary aggregates (reserve and broad money) used in conducting monetary policy may convey opaque signals. Hence, one of the main objectives for the introduction of the policy rate was to help the market understand the Bank’s monetary policy stance. This is because price signals (interest rates) are better understood by the market than monetary aggregates. In this case, an increase in the policy rate is a clear indication of the tightening of monetary policy while a reduction in the policy rate signals the loosening of monetary policy.

Other motivations behind the need to modernise the monetary policy framework include strengthening of the monetary policy transmission channel, particularly the interest rate channel; reducing interest rate volatility, which tends to characterise monetary aggregate targeting frameworks; anchoring market expectations with regard to interest rates and inflation; and,
promoting transparency in the way banks set the lending rates by making the policy rate the reference rate for pricing of credit products.

However, it should be noted that despite the weakening of the relationship between broad money and inflation, relative money multiplier instability and the need to modernise the monetary policy framework, monetary aggregates will continue to play a role in the conduct of monetary policy in Zambia.

4.0 Literature Review on Money Demand and Monetary Transmission Mechanisms

4.1 Theoretical Perspectives on the Demand for Money

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. 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 as shown below;

\[ M^D = f(Y^+, P^+, r^-) \] ... ... 1

In real terms, the money demand function is often denoted as;

\[ \frac{M}{P} = f(Y, r) \] ... ... 2

Equation (2) is viewed as the liquidity preference and represents the desired level or long run real money demand function and assumes a unit elasticity of the nominal cash balances with respect to the price level. The unitary elasticity of the demand for money portrays the common argument in the monetarist literature that “inflation is everywhere and always a monetary phenomenon in the long-run” (Friedman, 1968). In this regard, monetary policy will only be effective in controlling inflation if there is a stable money demand function in the long-run. If money demand is stable, changes in money supply are closely related to prices and income, and hence it is possible for the central bank to control inflation through appropriate changes to money supply. On the other hand, if the demand for money function is unstable, changes in money supply are
not closely related to prices and income and it becomes difficult to control inflation using adjustments in money supply.

4.2 Theoretical Perspectives on Monetary Policy Transmission Mechanisms

Monetary policy transmission is a process through which central bank actions are transmitted to real sector variables of inflation, output and employment (Taylor, 1995). Although the long-run neutrality of money view of the classical tradition is widely accepted, monetary policy is at least assumed to affect real variables in the short-run due to the Keynesian view of nominal sticky prices or due to wealth, income, liquidity and expectations effects (Dabla-Norris and Floerkemeier, 2006). Although there have been several channels of monetary policy transmission, literature seems to converge on five main channels namely; interest rate, exchange rate, bank lending, asset price, and expectations channels (Bank of England, 1999; Horvath et al., 2006; Loayza et al., 2002; Mishkin, 1995; Obstfeld et al., 1995; Taylor, 1995). The monetary policy transmission mechanism can be graphically presented in the following manner;

**Figure 3: Monetary Policy Transmission Channels**

Source: Adapted from Loayza et al. (2002) and Bank of England (1999).

4.2.1 The Traditional Interest Rate Channel

According to the traditional interest channel, an increase in the money supply leads to a decrease in the real interest rate due to the Keynesian assumption of sticky prices. In earlier works of the
Keynesian approach, this channel was thought to mainly operate through the investment channel but later theoretical and research works recognised that consumers’ decisions about real estate and durable expenditure (spending on cars, own house construction and other durable goods) are also influenced by the real interest rate (Mishkin, 1995). Changes in the real interest rates induce economic agents to change their investment and consumption expenditure and thereby changing economic activity. This channel implicitly assumes that the central bank is able to influence long-term real interest rates through manipulation of short-term real interest rates. Mishkin (1995) notes that this suggests the expectation hypothesis of the term structure of interest rates holds true. The expectation hypothesis of the term structure states that the long-term interest rate is an average of expected future short-term interest rates, suggesting that lower real short-term interest rate leads to a fall in the real long-term interest rate. Özsuca (2009) also notes that theoretically the interest rate channel also circumvent the zero interest bound. Expansionary monetary policy increases expected prices of goods and services and therefore lowers real interest rates, hence lower interest rates stimulates consumer spending. The Interest rate channel is often referred to as the hallmark of the “Money View”.

4.2.2 The credit channel
The credit channel came into being as a result of dissatisfaction over the effects of monetary policy explained through interest rate effects on durables expenditure and investment. The credit channel explains the impact of monetary policy via the effects of informational asymmetry between the lender and the borrower (Mishkin, 1995). The credit view proposes that as a result of these informational asymmetries, two channels of monetary transmission arise: those that operate through the effects on bank lending as well those that affect the firms’ and households balance sheets. The bank lending channel is based on the assumption that financial intermediaries are best suited to solve problems of informational asymmetry in credit markets while the balance sheet channel is based on the effects of monetary policy on the net worth of firms and hence their collateral (Simatele, 2004).

The bank lending channel operates through the quantity of loans supplied by the commercial banks to firms and households. As Dabla-Norris and Floerkemeier (2006) notes “The bank lending channel operates via the influence of monetary policy on the supply of bank loans, that is, the quantity rather than the price of credit”. An expansionary monetary policy increases excess reserves in the banking system. This makes loans available to bank dependent economic agents to increase. Increased supply of loans makes it possible for bank dependent economic agents to increase investment as well as consumption spending which result in increased economic activity. This channel is likely to be more effective in economies where there are many small firms with little capacity to raise capital on stock markets. Further, an under-developed capital markets as is the case in most developing or underdeveloped economies makes the bank lending channel stronger.

Due to asymmetric information in financial markets, the role played by commercial banks as financial intermediaries becomes important and thus comes in the balance sheet channel (Tahir, 2012). Existence of asymmetric information gives rise to moral hazard and adverse selection. As Mishkin (1995), Tahir, (2012) and Bernanke and Gertler (1995) emphasis that banks have a comparative advantage in assessing the balance sheets of borrowers and hence help in mitigating adverse selection as well as moral hazard. Under the balance sheet channel, there are several
ways through which monetary policy affect the balance sheets of economic agents and hence the occurrence of moral hazard and adverse selection.

Expansionary monetary policy affects the net-worth of firm through an increase in stock prices as described earlier. Further, expansionary monetary policy which reduces interest rates reduces the debt servicing burden of firms and households. This improves the cash flow of firms and thereby enhances their chance of accessing loans from banks. The improvement in the balance sheets of households and firms due to expansionary policy reduces the possibility of moral hazard and adverse selection. All this brings about an increase in borrowing resulting in increased consumer spending and investment, and consequently economic activity. It is important to emphasise here that all the other channels operate mostly through the credit channel.

4.2.3 The Exchange Rate Channel

The exchange rate channel is one of the primary transmission channels of monetary policy in open economies, especially those with flexible exchange rate regimes. Monetary policy can influence the exchange rate through interest rates (the popular uncovered interest rate parity condition), direct intervention in foreign exchange markets or through inflationary expectations (Dabla-Norris et al., 2006). In this channel, monetary policy affects economic activity (output) through net exports.

This link between monetary policy and exchange rate under the uncovered interest parity (UIP) condition were popularised by the open macroeconomic models developed independently by Fleming (1962), Mundell (1963), and Dornbusch (1976). Under the UIP assumptions, the difference between interest on domestic financial assets and foreign assets is equal to the expected change in exchange rates. The change in exchange rate as a result of monetary policy action in these models affects both aggregate demand and aggregate supply. On the demand side, expansionary monetary policy which reduces interest rates makes the local currency to depreciate as investors divest from the local market to invest in foreign markets. The real depreciation of the currency makes the country’s exports cheaper compared to foreign produced goods. This results into an increase in the net exports and hence stronger aggregate demand leading to an increase in output (Obstfeld and Rogoff, 1996; Taylor, 1993; Mishkin (1995, 2001); Loazya and Schmidt-Hebbel, 2002). However, on the supply side a real depreciation of the currency raises the domestic prices of imported goods, which directly increases domestic inflationary pressure through the so-called exchange rate pass through (Ozdogan, 2009; Loazya and Schmidt-Hebbel, 2002; Alper 2003; Campa and Goldberg, 2004; Kara et al., 2005). Moreover, the higher prices of imported inputs contracts output and increases prices (Loazya and Schmidt-Hebbel, 2002). The extent of the exchange pass-through to domestic price, hence overall inflation, depends on the level of the country’s dependence on imported consumer and intermediate goods, the magnitude and timing of the appreciation, as well as macroeconomic environmental (Alper, 2003; Campa and Goldberg, 2004; Kara et al., 2005).

The exchange rate channel also operates through the effect of monetary policy on the international competitiveness of exports and import competing goods (Dabla-Norris and Floerkermeier, 2006). Expansionary monetary policy which lowers interest rates leads to a real currency depreciation making domestically produced exports cheaper on international markets resulting in increased demand for them and more output and vice versa. Furthermore, the effects
of monetary policy on the exchange rate may exert significant effect on the balance sheets of households and firms which change the net-worth and debt-service ratio. These changes affect the borrowing and spending patterns of economic agents, especially for highly dollarized countries (Dabla-Norris and Floerkermeier, 2006; Kamin \textit{et al.}, 1998).

The strength of the exchange rate channel is affected by several factors such as the exchange rate regime, sensitivity of the interest rates, the size and openness of the economy, degree of capital mobility and the degree of expenditure switching between domestic and imported goods (Boivin \textit{et al.}, 2010; Mishra \textit{et al.}, 2010; Tahir, 2012).

4.2.4 The Asset Price Channel

Monetary policy affects asset prices such as bonds, equity and real estate, changing firms’ stock market values and household wealth. Changes in stock market values and household wealth in turn affect aggregate demand. The asset price channel of monetary policy transmission is assumed to operate through two mechanisms namely; the Tobin’s (1969) Q-theory of investment and Ando-Modigliani (1963) life cycle theory of consumption. Although monetarists and Keynesians arrive at the same conclusion of how these views work, they disagree on how monetary policy affects equity prices (Afandi, 2005). The Keynesians argue that the fall in interest rates following monetary expansion makes bonds less attractive to investors relative to equities, thereby making the prices of equities to increase and vice versa. On the other hand, the monetarists believe that expansionary monetary policy affects equity prices through an increase in the demand for equities as economic agents find themselves with excess liquidity which they can use to invest in equities, given their short-run supply, prices increase (Mishkin, 1995).

The asset price channel that works through the Tobin’s Q (1969) theory of investment relies on the effect of monetary induced changes in equity prices on the Tobin’s Q. James Tobin (1969) defined the Q as the ratio of the market value of a firm to the replacement cost of capital owned by that firm. This ratio is a summary measure of one important impact of financial markets on purchases of goods and services (Afandi, 2005). Tobin (1969) argues that although in equilibrium the Q has a normal value equal to one, which sustains capital replacement and expansion at the natural rate of economic growth, in reality the Q often exceeds one by the capitalised value of monopoly profits and rents. In the short-run, the Q changes as a result of random events, policies and expectations which create or destroy incentives for capital investment. Amongst these is monetary policy.

Thus, the Tobin’s view of the asset channel works as follows. Expansionary monetary policy increases the demand for equities (either by the Keynesian or Monetarist argument), raising equity prices and thereby boost market value of firms relative to the replacement cost of capital. This will result in increased investment and therefore output. Furthermore, higher equity prices also raise the net-worth of firms and households and hence improve their credit worthiness and access to funds, the effects of which would partly reflect the balance sheet channel of monetary policy (Afandi, 2005).

On the other hand, in the Ando-Modigliani life cycle model of consumption monetary policy changes affect the economic agents’ long-term wealth and therefore, alters their consumption pattern. The basic premise of Ando-Modigliani theory is that consumers smooth out their consumption over time and this consumption depends on lifetime resources and not only current consumption (Mishkin, 1995). Expansionary monetary policy which lowers interest rates
changes consumers’ portfolio composition in accordance with the risk of each asset class. In this case, a decrease in the interest rates encourages people to reduce their holding of interest earning deposits and bonds and substitute them with equity/stocks, thereby increasing stock prices (Afandi, 2005). Given that a major component of wealth is in common stocks, the increase in stock prices increases their wealth resulting in higher consumption expenditure and hence output.

Although Tobin’s Q theory of investment and Ando-Modigliani assume that monetary policy affects the prices of stocks and bonds, Meltzer (1995) takes a wider view of the impact of monetary policy on various asset prices. He contends that the short-term nominal interest rate is not the only mechanism affected directly by monetary policies. Monetary policy actions affect the markets for durable goods, real estate, equities, and financial assets along with interest rates. Changes in all of these asset prices affect aggregate demand and output.

Tahir (2012) notes the following factors as the key determinants of the asset price channel: the participation of households in the capital market; the generation of funds by firms through issuance of shares; and the level of development of the national stock market. This is confirmed by Kamin et al. (1998) and Butkiewicz and Ozdogan (2008) who notes that the asset price channel in developing and emerging markets is weak and more unpredictable compared to developed economies due to shallower and uncompetitive markets as well as highly unstable macroeconomic environments.

4.2.5 The Expectations Channel

Since the early years of modern macroeconomics, expectations have been acknowledged to influence the behaviour of economic agents. For example, Keynes (1936) in his General Theory comments “…the behaviour of each individual firm in deciding its daily output will be determined by its short-term expectations — expectations as to the cost of output on various possible scales and expectations as to the sale-proceeds of this output; though, in the case of additions to capital equipment and even of sales to distributors, these short-term expectations will largely depend on the long-term (or medium-term) expectations of other parties”. Economists generally agree that expectations are important in influencing economic activity, but they differ on how these expectations are generated. Friedman and other monetarists, postulate adaptive expectations while the new classical school lead by Lucas and the New Keynesian School argue for rational expectations.

Since economic agents are forward looking and rational, the expectation channel is in effect fundamental to the working of all channels of monetary policy transmission. Empirically, this channel is mainly operational in developed economies with well-functioning and deep financial markets (Davoodi et al., 2013). For example, if economic agents expect future changes in the policy rate, this can immediately affect medium and long-term interest rates. Further, monetary policy can be used to influence expectations of future inflation and thus influence price developments. Inflation expectations matter in two important areas. First, they influence the level of the real interest rate and thus determine the impact of any specific nominal interest rate. Second, they influence price and money wage-setting behaviour and feed through into actual inflation in subsequent periods. Similarly, changes in the monetary policy stance can influence expectations about the future course of real economic activities by affecting inflationary expectations and the ex-ante real interest rate and guiding the future course of economic activities.
5.0 Empirical Review

5.1 Empirical Literature on the Demand for Money

Empirical literature on the money demand function has been in existence for long time, elsewhere. However, in the sub-Saharan Africa region empirical studies on the demand for money started to emerge following significant economic reforms undertaken in these countries focusing on establishing the impact of the financial sector reforms on the stability of the money demand function. Generally, it is argued that economic reforms especially those focusing on the financial sector have significant impact on the money demand function with important consequences for monetary policy effectiveness under a monetary targeting framework.

In a monetary aggregate policy framework, the stability of the demand for money function is crucial for the for monetary policy formulation. This is because it enables a policy driven change in a monetary aggregate to have a forecastable influence on aggregate demand, interest rates and prices (Sriram, 1999). Thus, any reforms with fundamental impact on money demand will affect the effectiveness of monetary policy. In this regard, a number of studies have been done to ascertain the impact of financial reforms on the stability of the demand function with varied results; a few of these studies are reviewed.

Ogunsakin and Awe (2014) investigates the impact of financial sector reforms on the stability of the money demand function in Nigeria. They estimate a parsimonious error correction model (ECM) which include real broad money balances; inflation; exchange rate; foreign interest rates; savings deposit rate; treasury bill, and a dummy for post-liberalisation era. They find that the significant determinants for money demand in Nigeria are inflation, foreign interest rates, Treasury bill rate, savings deposit rate and real GDP. A test for the stability shows that the demand for money function remained stable despite the reforms, implying using of monetary targets is still relevant.

Dagher and Kovanen (2011) analyses the stability of the money demand function in Ghana using bounds testing procedure developed by Pesaren (2001). They estimate an Auto-Regressive Distributive Lag (ARDL) model which includes changes in broad money, its own lags, current and lagged values of the explanatory variables. The explanatory variables include income, exchange rate, deposit rate, TB rate, US TB rate, and the US libor rate. They find that the TB rate, US TB rate and the Libor rate have no significant impact on the demand while income and exchange rate were found to have significant effects. Specifically, they find that a depreciation increases money demand as is the increase in incomes. Furthermore, they find a faster convergence of the ECM to equilibrium once there is a misalignment. Using a CUSUM and CUSUM squares test on the residuals of the ECM model they find that the money demand is stable.

Lungu et al. (2012) examines the behaviour of the demand for money in Malawi for the period 1985 to 2010. Specifically, they seek to tackle two objectives: i) to estimate a demand for money function; and ii) to test for the stability of the money demand function. Their model include real money balances, real GDP, inflation, TB rate, exchange rate, and a measure of financial depth. The model estimates show that short-run dynamics are mainly driven by lagged money balances, prices, and financial innovation. However, their results show that the exchange rate, income and TB rate are not significant. The error correction term is negative and significant, implying that
variables return to equilibrium after a shock. Using characteristic roots they find that the estimated VECM is stable.

In Zambia, there are not many studies that have been undertaken on the impact of financial reforms on the stability of the money demand function. Mutoti, Zgambo and Kapembwa (2012) estimate a money demand function for the Zambia for the period 1994 to 2008. Their model includes real money balances, real GDP, exchange rate, and TB rate. Their results indicate that real money balances is positively influenced by incomes, the exchange rate has a negative relationship while the TB rate negatively affects the demand for real money balances. To incorporate the financial sector reforms, they include a time trend as a proxy for financial liberalisation and they find that it is positively related to the demand for money. To check for the stability of the money demand function they plot the residuals from both the regression with a time trend and one without. They find that generally the demand for money function is stable.

Another study by Adam (1999) looks at the impact of monetary policy reforms in Zambia. He estimates the money demand function with portfolio shifts to evaluate whether there have been any changes in the stability of the demand function since the reforms. His model includes the Treasury bill rate, deposit rates, changes in the parallel exchange rate, inflation, currency in circulation and the real Gross National Income. His results indicate that there is evidence of a stable long-run money demand function with a policy induced structural break. In addition, he finds that there is an increased underlying variations in the money demand from about 1989, which begins to reduce around 1994. The results from this study suggest that because of the observed short-run forecast variance around the money demand function, stabilization policy based on controlling reserve money is likely to have an imprecise link to inflation in the short to medium-term despite the long-run correspondence between the two.

5.2 Empirical Literature on Monetary Policy Transmission

Although the monetary policy transmission mechanism has been a subject of intense empirical research for over three decades in developed and emerging economies, it is only now that interest is being paid to it in the developing countries such as Zambia. This increase in interest can be attributed to several factors; notably the economic reforms undertaken in these countries since the early 1980’s as well as the increased availability of longer time series data which are critical in carrying out those investigations. In Zambia, although there have been numerous studies on the effects of money supply on real variables and output, very few focus on monetary policy. Notable among these includes Mwansa (1999), Simatele (2004), Mutoti (2006), Mwenda (1993), Adam (1999) and Bova (2009). In actual sense only Simatele (2004), Mutoti (2006) and Bova (2009) specifically deal with monetary policy transmission to the best of our knowledge. In this section, we present a survey of available literature on monetary policy transmission mechanism in Zambia.

Early studies on monetary policy in Zambia in the early and late 1990s focussed on the effect of financial and economic liberalisation that took place after the new government was ushered into office in 1991 (Mwenda, 1993; Adam, 1999; and Mwansa, 1999). A study by Mwenda in 1993 looked at the impact on the effectiveness of monetary policy of switching to indirect monetary policy instruments from direct instruments, with a special focus on growth and variability in broad money and in inflation. He estimates Auto Regressive models to evaluate whether there
has been a change in the growth of money supply and inflation since the switch to indirect instruments. He also looks at the variability in the two variables to observe if there has been any change in the instability over the period. The study finds that the move to indirect instruments for policy has indeed reduced the variability in broad money and inflation. However, he finds that the growth in money supply has not changed.

One of most recent and comprehensive analysis is one done by Mutoti (2006) in which the short and long-term dynamics are investigated. The author uses a cointegrated structural VAR, in which restrictions are imposed according to a priori information on the relationships between the variables. The model is framed in an IS-LM-AS theoretical structure and uses monthly data on domestic 91-day TB rate, foreign (South African) interest rate, money supply (as broad money), real GDP, domestic CPI, foreign CPI (South Africa) and the nominal exchange rate Kwacha to the South African Rand. Estimating the model for the period 1992-2003, the results indicate that there is a stable money demand relationship, implying that money growth has a predictable impact on the economic activity and also that money demand is sensitive to the interest rate; inflation appears to be associated with excess demand and disequilibrium in the exchange rate. The impulse responses to expansionary monetary policy shocks makes interest rates to significantly fall for a period lasting one year, with domestic interest rate falling below the foreign interest rate by 0.5 basis points. This induces a depreciation of the exchange rate reaching a peak of 1.7% after 4 months. Further, expansionary monetary policy shocks appear to strongly affect domestic prices only in the first period, suggesting that the link between money supply and inflation may be weak. However, monetary policy shocks where found to have no significant effect on real economic activity as output fluctuations are mostly accounted for by aggregate supply shocks. The results of this study seems to confirm literature from other small open developing countries where the exchange rate channel is seen to be a strong mechanism through which monetary policy is transmitted to real sector.

Another comprehensive study of monetary policy transmission is done by Simatele (2004). The study examines the impact of financial liberalization on the monetary transmission mechanism using two different models for the period prior and the period after the reforms. The analysis adopted a VAR using the Choleski decomposition to impose restrictions, thus, relying on the assumption that policy does not respond contemporaneously to macro-shocks and that this may be due to information lags. The VAR model uses monthly data on the following variables real GDP, CPI, monetary aggregates (M2, base money), TB-rate (a measure of monetary policy stance), weighted saving rate (a measure of policy stance), lending rate, liquidity asset ratio, the exchange rate (a measure of policy stance), and commercial bank loans to private sector. Using the variance decompositions, it was found that in the pre-reform period innovations to policy variables contributes very little to variations in output and prices while their contributions increases after the reforms. Using impulse responses, a positive shock to base money reduces prices while a shock to interest rates leads to price increase, a result commonly referred to as the “price puzzle”. Furthermore, as expected, contractionary monetary policy dampens output in both periods. In addition, they find that the response of the variables to shocks is faster and larger in the post-reform period. The study also finds the existence of bank lending channel after the reforms as well as an enhanced exchange rate channel. Thus, the study illustrates that the potency of monetary policy has increased with the reforms, since prices are more responsive to monetary policy shocks. The study also illustrates that the exchange rate seems to be an important variable in the explanation of prices in Zambia.
Bova (2009) takes a similar approach to Mutoti (2006) to test how sensitive Zambian food and non-food inflation is to changes in the money supply and in the exchange rate. They estimate a six variable cointegrated structural VAR with monthly time series data for the period April 1996 to April 2008. The model includes broad money, nominal exchange rate (ZMK/USD), non-food inflation and food inflation as endogenous variables while copper and oil prices are exogenous variables in the model. Broad money and the nominal exchange rate are used as indicators of monetary policy. The results indicate that expansionary monetary policy (or increase in money supply by 0.2 percent) depreciates the exchange rate by 1 percent in the long-run. In the long-run, money supply is found to affect food inflation and non-food inflation, but has no effect on the exchange rate. Further, it is found that in the short-run broad money is very sensitive to changes in food inflation and the exchange rate. At the same time, the exchange rate adjusts to changes in the money supply and in copper prices in the short-run. The study concludes that the monetary transmission mechanism is weak and only effective for non-food prices, while the exchange rate channel is stronger, especially for food prices. These results also confirm the finding by Mutoti (2006) regarding the existence of a strong exchange rate channel in Zambia as is the case with other developing small open economies.

6.0 Empirical Analysis

6.1 Data
In this study, we employ quarterly data to estimate the demand for money function and analyse monetary policy transmission. In Zambia, there is no quarterly data for GDP hence we use the Index of Industrial Production to obtain quarterly GDP series. The data for this study was obtained from the Bank of Zambia, IMF, World Bank and the Central Statistical Office.

6.2 Empirical Approach

6.2.1 Empirical Model of the Money Demand Function
This study will borrow from common practice in the literature in which the error correction model (ECM) is increasingly becoming the model of choice (Lungu et al., 2012; Ogunsakin et al., 2014). This is because this technique is capable of revealing more information on the long- and short-run behaviour of the economic variables. In this study, we will employ Autoregressive Distributive Lag (ARDL) approach to testing for co-integration. This approach is partly settled for due to its advantage of avoiding the classification of variables into stationary or non-stationary, and hence no need for pre-testing of unit roots in the variables (Sharifi-Renani, 2007).

Empirical literature surveyed seems to converge on a particular real money demand function in which real money balances is a function of a scale variable (income, wealth or expenditure); own rate of return on money, the opportunity cost of holding money (domestic interest rates and expected inflation). In addition, with increasing globalization and flexible exchange rate regimes, an exchange rate has been added as a potential explanatory variable.

Therefore, to analyse the factors that influence the demand for money in Zambia, we will borrow from Bahmani-Oskooee (1996); Anwar et al., (2012); and Lungu et al., (2012) and estimate the following:

\[
\ln m_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln E_t + \alpha_3 TBrate_t + \alpha_4 \ln \inf_t + \varepsilon_t \ldots \ldots 3
\]
Where: \( Y \) is real GDP, \( E_t \) is the nominal exchange rate (K/USD), \( TBrate_t \) is the 91-day Treasury bill rate, \( m_t \) is the real money balances, and \( \text{inf} \) is the annual inflation rate.

The error correction version of the Autoregressive Distributive Lag (ARDL) model pertaining to the money demand equation given above is specified as follows:

\[
\Delta \ln m_t = \alpha_0 + \sum_{i=1}^{n_1} \alpha_1 \Delta \ln m_{t-i} + \sum_{i=0}^{n_2} \alpha_3 \Delta \ln Y_{t-i} + \sum_{i=0}^{n_3} \alpha_4 \Delta TBrate_{t-i} + \sum_{i=0}^{n_4} \alpha_5 \Delta \text{inf}_{t-i} + \gamma_1 \ln m_{t-1} + \gamma_2 \ln Y_{t-1} + \gamma_3 \ln E_{t-1} + \gamma_4 TBrate_{t-1} + \gamma_5 \text{inf}_{t-1} + \varepsilon_t \ldots \ldots 4
\]

The ARDL formulation specified above is very suitable for estimating an error correction model in which variables are either stationary such as inflation or non-stationary such as income or money. In this regard, the approach does not need unit root pre-testing. However, in this study unit root tests are undertaken for all the variables under consideration.

We expect that based on the conventional theory the income elasticity coefficient (\( \alpha_1 \)) is positive; \( \alpha_2 \) can either be positive or negative, it can be positive if the depreciation of the exchange rate is perceived as the increase in wealth leading to an increase in the demand for money, on the contrary it can be negative if the depreciation leads to a substitution of the domestic currency for the foreign currency as a store of value; \( \alpha_3 \) is expected to be negative; and, finally, \( \alpha_5 \) is expected to be negative since during inflationary periods, economic agents tend to hold less of the assets in monetary terms in preference for physical assets such as real estate.

6.2.1.1 Econometric Methodology

6.2.1.1.1 Unit root tests

Non-stationarity is a common feature in time series data. Estimating a regression with differently integrated series could result in spurious correlation in the estimated equation. In this regard, there is need to test for stationarity or non-stationarity in the time series data before proceeding to estimation. Normally, the Augmented Dickey Fuller (ADF) test is used to determine the order of integration of the data. However, literature has shown ADF test has lower power in the presence of structural breaks; it is biased towards non-rejection of a unit root. Hence, the Phillip Peron (PP) Test is also used in addition to the ARDF to test for the presence or absence of unit roots in the data series.

6.2.1.1.2 Co-integration Test

In the presence of non-stationarity in the variables, it has become standard to check for the existence of co-integrating relationship among the variables. For example, if real money balances, income and interest rates are non-stationary variables with unit roots and a linear combination of these variables is stationary, then any deviation from the relation is temporary and the relationship holds in the long-run. If this is the case, then the variables are said to be co-integrated. In this study, we will employ the ADL approach to co-integration which is based the bounds testing approach developed by Pesaran et al. (2001).
In the ARDL set up given in Equation 4 above, the null hypothesis for no co-integration is defined by $H_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ against the alternative hypothesis that $H_0 \neq \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$. The Wald test statistic is used to carry out this test.

### 6.2.1.1.3 Test for Stability in the Money Demand Function

To check for the stability of the demand for money function, we will use the CUSUM and CUSUM squared tests. In this regard, if the estimated coefficients of the money demand function are found to lie within the defined confidence bands (critical values), the money demand function is said to exhibit stability. However, if the estimated coefficients breach the defined confidence bands, the money demand function is considered to be unstable.

### 6.2.1.1.4 Test for the Non-Serial Correlation in the residuals of the ARDL Model

A key assumption in the ARDL / Bounds Testing methodology of Pesaran et al. (2001) is that the errors must be serially independent. In this regard, it is important to test for the existence of serial correlation as it is a requirement for the selection of the number of lags (Pesaran et al., 2001).

In order to test for serial correlation of the residual, the LM test is used to test the null hypothesis that the errors are serially independent against the alternative hypothesis that they are either moving average [MA(m)] or autoregressive [AR(m)], where m is 1,2,3,…, is the lag length.

### 6.2.2 Econometric Approaches for Monetary Policy Transmission

Monetary policy transmission is a process through which central bank actions are transmitted to real sector variables of inflation, output and employment (Taylor, 1995). Monetary policy transmission involves two stages (Demchuk et al., 2012). The first one looks at the effects of monetary policy-induced changes on the prices of the financial sector assets while the second one looks at the effects of monetary policy induced changes on aggregate demand and consequently output and prices. In this study, we investigate both stages of the monetary policy transmission.

#### 6.2.2.1 Interest rate Pass-through

The first stage in the monetary policy transmission involves the effect of monetary policy actions on the prices of financial market variables such as short-term interest rates, commercial banks’ lending rates, deposit rates, stock prices and exchange rates. The effect of monetary policy actions on financial market prices can be quantified through the interest rate pass-through. In this study, we use a method similar to Mishra et al. (2010); Westelius (2011); and Espinoza et al. (2012) to quantify the short-run and long-run effects. The model is adapted as follows;
Where, \( lr \) is lending rates and \( ibr \) stands for interbank rate. The coefficient \( \gamma \) provides the short-term effects and the long-term effects are provided by \( (\gamma + \tau + \omega)/(1 - \alpha - \beta) \).

6.2.2.2 VAR Model of the Monetary Policy Transmission

A review of empirical literature on monetary policy transmission (see Mishra et al. (2010); Davoodi et al. (2013); Mishra and Montiel (2013); Espinoza and Prasad (2012); Cheng (2006) reveal that Vector Auto regression (VAR) is widely used to investigate the effects of monetary policy shocks on real economic activity and the price level in low income countries. Thus, following this literature, we assume that the Zambian economy can be described by the following structural model:

\[
\Delta lr_t = a\Delta lr_{t-1} + \beta\Delta lr_{t-2} + \gamma\Delta ibr_t + \tau\Delta ibr_{t-1} + \omega\Delta ibr_{t-2} \ldots \ldots 5
\]

In Equation 6, \( Y_t \) represents an \( nx1 \) vector of endogenous variables while \( X_t \) is a \( mx1 \) vector of exogenous variables, and \( \varepsilon_t \) is a \( nx1 \) vector of structural disturbances with a zero mean and constant variance, \( \Lambda \). In the specification given in (6), \( A \) is an \( nxn \) matrix of contemporaneous coefficients of the interaction of variables in \( Y_t \) while \( B \) is the matrix of lagged coefficients of interactions in \( Y_t \).

However, since the structural model given in (6) cannot be estimated directly due to inadequate information, the existence of the inverse of the matrix \( A \), \( A^{-1} \) allows us to have a reduced-form of the structural model, which can be specified as follows (Maturu, 2014):

\[
AY_t = B(L)Y_{t-1} + C(L)X_t + \varepsilon_t; \varepsilon_t \sim iid (0, \Lambda) \ldots \ldots 6
\]

Or

\[
Y_t = D(L)Y_{t-1} + \delta X_t + \mu_t; \mu_t \sim iid (0, \Sigma) \ldots \ldots 7
\]

Where: \( D(L) = A^{-1}B(L); \delta = A^{-1}C(L); \mu = A^{-1}u_t \)

Given that \( A \) is a matrix of contemporaneous coefficients in the structural model and \( B(L) \) is matrix of lagged coefficients in the structural model, we can define \( G(L) \) as the matrix of both contemporaneous and lagged coefficients as follows:

\[
G(L) = A + B(L) \ldots \ldots \ldots 8
\]

Following Cheng (2006) and using equation (6), structural and reduced-form equations can be related by:
\[ D(L) = -A^{-1}B(L) \text{ and } \delta = -A^{-1}C(L) \ldots \ldots 10 \]

and the disturbance terms through:

\[ \mu_t = A^{-1}\varepsilon_t \text{ or } \varepsilon_t = A\mu_t, \]

which implies,

\[ \Sigma = A^{-1}AA^{-1} \ldots \ldots \ldots 11 \]

In VAR analysis of the MTM, the important issue is to investigate how a shock to a monetary policy variable impacts on other variables, particularly real sector variables such as inflation and output. Impulse responses are used in this regard. The impulse responses of interest are usually those associated with a structural model, but since the structural model cannot be directly estimated, convention requires the estimation of the reduced-form model from which the covariance matrix, \( \Sigma \) can be obtained. The results are then exploited to recover structural shocks from reduced-form shocks (Maturu, 2014).

Before estimating a VAR, there is need to identify the system through the imposition of \( a \text{ priori} \) restrictions. Due to the symmetric nature of the covariance matrix, \( \Sigma \), the number of independent equations to be estimated is usually less than the number of unknown elements in \( A \), giving rise to the identification problem. To identify the system, a minimum number of values of the elements of the \( A \) matrix must be assigned \( a \text{ priori} \) to allow the estimation of the remaining part of the restricted version of Equation (8). When the diagonal elements of the \( A \) matrix are normalized to unity, the remaining additional restrictions will be determined by \( n \times (n - 1)/2 \); where \( n \) is the number of endogenous variables. The additional restrictions can be motivated by economic theory.

In VAR studies of the MTM, the Choleski approach is used to impose identifying restrictions. This approach imposes a recursive ordering of the endogenous variables, resulting in a lower-triangular matrix \( A \) and a just identified system.

In this paper, the endogenous vector \( Y_t \) is assumed to include real GDP, consumer price index (CPI), broad money (M2), short-term interest rates (91-day TB rate and the interbank rate) and the nominal exchange rate of the Kwacha to the US dollar (EXR). Hence,

\[ Y_t = [\text{RealGDP}, CPI, M2, TBrate, EXR] \ldots \ldots 12 \]

The exogenous vector, \( X_t \) is assumed to contain copper prices (\( Cupr \)), crude oil prices (\( Oilpr \)) and the US Federal Funds rate (\( FFR \)). These variables are considered to be important to the Zambian economy and are aimed at capturing the global economic environment. Copper is the main export commodity and major foreign exchange earner in Zambia while crude oil is an important input in almost all sectors of the economy and one of the main imports. Sims (1992) argues that including such variables may help to reduce the likelihood of having empirical puzzles such as the “price puzzle”. Therefore, the vector of exogenous variables is given by;

\[ X_t = [\text{Cupr}, \text{Oilpr}, \text{FFR}] \ldots \ldots \ldots 13 \]
The ordering determines the level of exogeneity of the variables, so that the most exogenous variables are ordered first as given in Equation 12. Real GDP is ordered first on the assumption that real economic activity responds sluggishly to policy and economic shocks; Consumer price index (CPI) comes second in the ordering on the assumption that prices have no immediate effects on output. Broad money is ordered after CPI to indicate that money stock has no contemporaneous effect on prices while the Treasury bill rate (which may represent a monetary policy shock) is ordered after broad money to indicate that it has no immediate effect on the money stock. Finally, the EXR is ordered last to reflect that the exchange rate responds contemporaneously to all relevant economic variables. This ordering is akin to estimating the reduced-form and computing the Choleski factorization of the reduced-form VAR covariance matrix.

7.0 Results of the Estimated Models

7.1 Unit Root and Co-integration Tests
It is common practice to check for the existence of unit roots in time series data. The importance of checking for unit roots in the data is to avoid spurious results that may arise from the regressing of differently integrated time series. Furthermore, for us to apply the Auto-Regressive Distributive Lag co-integration technique, there is need to determine the degree of integration in each variable. For this purpose, we utilise the Augmented Dickey Fuller (ADF) and the Phillip-Perron (PP) tests whose results are presented in Table A1 in the Appendix.

The results from the ADF and PP tests presented in Table A1 in the Appendix suggest that with an exception of inflation, which is stationary or I(0), all the variables are integrated of order one I(1) since they are non-stationary in levels but stationary in first differences. This justifies the estimation of the money demand function using the ARDL approach and interest rate pass-through model using variables in differences without encountering possibility of spurious correlation. Furthermore, co-integration tests results using ARDL bound test presented in the Table A2 in the Appendix shows that the F-value of the M2 equation exceeds the upper bound value at any of the confidence intervals, which is an indication of the existence of co-integration in the money demand function in Zambia. As a result of the existence of co-integration in the variables of the money demand function, an error correction model is estimated. The main aim is to capture the short-run and long-run dynamics of the money demand function in Zambia.

7.2 Estimated Results of the Money Demand Function
One of the important steps in estimating a model using the ARDL approach is to choose the optimal lag length to use in the estimation. In this regard, the lag length selection criteria is used to select the optimal lag length. The results presented in Table A3 in the Appendix indicate that the optimal lag length is three lags using the Likelihood Ratio (LR) test, the FPE, and the Akaike Information Criterion (AIC). However, the Schwarz Criterion (SC) and HQ suggest one lag and four lags, respectively. In this regard, we settle for three lags to estimate the ARDL model.

The results of the estimated long-run and short-run money demand function using three lags are presented in Tables 2 and 3 below.
Table 2: ARDL Long-Run Coefficient Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECT&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.174874</td>
<td>0.064801</td>
<td>-1.155443</td>
<td>0.0525</td>
</tr>
<tr>
<td>Constant</td>
<td>-13.50136</td>
<td>0.766827</td>
<td>-17.60680</td>
<td>0.0000</td>
</tr>
<tr>
<td>LOG(GDP)</td>
<td>1.586269</td>
<td>0.087881</td>
<td>26.77846</td>
<td>0.0044</td>
</tr>
<tr>
<td>LOG(USD)</td>
<td>-0.053179</td>
<td>0.010241</td>
<td>2.097354</td>
<td>0.0382</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.005402</td>
<td>0.003265</td>
<td>-0.668207</td>
<td>0.5077</td>
</tr>
<tr>
<td>TB'91</td>
<td>-0.885609</td>
<td>0.186722</td>
<td>-1.915680</td>
<td>0.0624</td>
</tr>
</tbody>
</table>

The coefficients reported in Table 2 above represents $\delta_1 - \delta_5$ from the ARDL model specified in Equation 4. According to literature, the long-run elasticities are normalised by dividing them by $-\delta_1$. This yields a significant long-run income elasticity of the real money balances of 1.586269. The inflation elasticity is negative (-0.005402) though it is insignificant. The negative coefficient supports our theoretical expectation that as inflation accelerates, economic agents reduces their demand for real money balances as economic agents prefer physical assets to holding money. In addition, the exchange rate coefficient is negative and significant (-0.053179). This result is similar to those obtained by others such as Anwar (2010) and Bhamani-Oskoe and Pourhedrian (1990). The negative coefficient on the exchange rate demonstrates the presence of currency substitution in the estimated money demand function for Zambia. In an environment of currency substitution, a depreciation in the exchange rate may induce economic agents to substitute foreign currency-denominated assets for domestic currency-denominated assets as they perceive a depreciation as indicative of loss of wealthy. In addition, Bhamani-Oskoe et al., (1990) argues that a foreign currency represents an avenue which economic agents can use to hedge their risks. The sign on the short-term interest rate is negative, but only significant at 10 percent level of significance. In this regard, an increase in interest rates reduced the demand for real money balances, in line with the speculative motive of the demand for money. Finally, although the lagged error correction term ($ECT$) is insignificant, it is correctly signed implying that real money demand is co-integrated with its determinants.

Table 3 presents the estimated short-run coefficients of the ARDL model. The 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.
As already mentioned, one critical aspect in the application of the ARDL models to cointegration is the confirmation that residuals of the estimated equation are not serially correlated. In this regard, the test for the presence or absence of serial correlation in the residuals was undertaken using the LM test. The results of the LM test suggest the absence of serial correlation in the residuals (see Table A4 in the Appendix).

The stability of the estimated real money demand function is investigated through the use of the CUSUM and CUSUM Square tests proposed by Brown, Durbin and Evans (1975). The advantage of the CUSUM and CUSUMSQ tests is that it does not require the specification of the break points, but uses the cumulative sum of recursive residuals based on the first \(n\) observations and is updated recursively and plotted against the break point (Sharifi-Renani, 2007). Figure 4 presents the stability test based on the CUSUM test, which suggests that the real money demand function is stable. However, the CUSUM test has been criticized because it only tests for the instability in the intercept alone and not the whole range of estimated coefficients (Ploberger and Kramer, 1990). In this case, we also utilise the CUSUM Square test, whose results are presented in Figure 5. The test indicates that the CUSUM Square plot crosses below the critical value for a while. However, since the CUSUM Square plot gets back above the critical line it can be argued that the real money demand function is generally stable even in the parameters over time.

### Table 3: ARDL Short-run Coefficient Estimates

Dependent Variable: DLOG(REALM2)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.054310</td>
<td>0.022747</td>
<td>2.387583</td>
<td>0.0201</td>
</tr>
<tr>
<td>(\Delta)log(Real Money)_{t-1}</td>
<td>-0.256843</td>
<td>0.089468</td>
<td>-2.870794</td>
<td>0.0056</td>
</tr>
<tr>
<td>(\Delta)log(gdp)_{t-1}</td>
<td>0.264940</td>
<td>0.241412</td>
<td>1.097459</td>
<td>0.2768</td>
</tr>
<tr>
<td>(\Delta)log(gdp)_{t-2}</td>
<td>0.650475</td>
<td>0.228999</td>
<td>2.840518</td>
<td>0.0061</td>
</tr>
<tr>
<td>(\Delta)log(gdp)_{t-3}</td>
<td>0.276273</td>
<td>0.235095</td>
<td>1.175157</td>
<td>0.2446</td>
</tr>
<tr>
<td>(\Delta)log(usd)</td>
<td>0.383827</td>
<td>0.094476</td>
<td>4.062712</td>
<td>0.0001</td>
</tr>
<tr>
<td>(\Delta)log(TB91)</td>
<td>-0.355775</td>
<td>0.131410</td>
<td>-2.707361</td>
<td>0.0088</td>
</tr>
<tr>
<td>(\Delta)Inflation</td>
<td>-0.002178</td>
<td>0.000839</td>
<td>-2.596422</td>
<td>0.0118</td>
</tr>
<tr>
<td>Seasonal Dummy</td>
<td>-0.107650</td>
<td>0.017356</td>
<td>-6.202544</td>
<td>0.0000</td>
</tr>
<tr>
<td>Step Dummy</td>
<td>-0.008990</td>
<td>0.018988</td>
<td>-0.473434</td>
<td>0.6376</td>
</tr>
</tbody>
</table>

- R-squared 0.675272
- Mean dependent var 0.016517
- Adjusted R-squared 0.615738
- S.D. dependent var 0.077722
- S.E. of regression 0.048179
- Akaike info criterion -3.076776
- Sum squared resid 0.139273
- Schwarz criterion -2.697332
- Log likelihood 122.7639
- Hannan-Quinn criter. -2.925718
- F-statistic 11.34273
- Durbin-Watson stat 2.016581
- Prob(F-statistic) 0.000000
Figure 4: CUSUM Test for the Money Demand Function

Figure 5: CUSUM SQ test for residuals of the Money Demand Function
7.3 Estimated Results of the MTM

7.3.1 Interest Rate Pass-through

One of the most important aspects of monetary policy is the ability of central bank to influence market interest rates through influencing short-term money market rates. Ability to influence the market interest rates is crucial in influencing aggregate demand and consequently inflation. With the introduction of the Policy Rate in April 2012, the Bank of Zambia started to target the overnight interbank rate in its conduct of monetary policy. Thus, we estimate the interest rate pass-through in the short and long-run horizons. Table 4 below presents the short- and long-run effects of the interest rate pass-through from the interbank interest rate to commercial banks’ lending rates computed from the estimation of Equation 5 above.

Table 4: Interest Rates Pass-through from Interbank Rates to Lending Rates

<table>
<thead>
<tr>
<th>Description</th>
<th>Short-run Effects</th>
<th>Long-run Effects</th>
<th>R-Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample (1995Q1-2014Q1)</td>
<td>0.21</td>
<td>0.45</td>
<td>0.26</td>
</tr>
<tr>
<td>1995Q1-2000Q4</td>
<td>0.05</td>
<td>0.29</td>
<td>0.31</td>
</tr>
<tr>
<td>2001Q1-2014Q1</td>
<td>0.29</td>
<td>0.66</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Source: Authors Computations

The results from the computations indicate that for the full sample, a one percent increase in the interbank rate leads to 0.21 percentage points increase in average lending rates in the short-run and 0.45 percent increase in the long-run. This result is similar to those obtained for emerging economies (see Westelius, 2011). The results further indicate that in the 1990s interest rate pass-through was lower compared to the time after 2001. Specifically, in the period 1995 quarter one to the fourth quarter of 2000 the short-run interest rate pass-through was 0.05% for every one percent increase in the interbank rate while for the later period it is 0.29%. This suggests that overtime the interest rate pass-through is improving though it remains low.

7.3.2 Estimated VAR Model of the MTM

We estimate two VAR models to investigate the MTM in Zambia using quarterly data spanning the period 1995 quarter 2 to 2013 quarter 3. The models are estimated in levels with the constant, endogenous variables and exogenous variables noted in Section 6. The difference between the two estimated models is that the Treasury bill rate is included in one of the models (Model A) while in the other model (Model B), the interbank rate is included.

An important aspect in the estimation of VAR models is the selection of an appropriate lag length that ensures the absence of serial correlation in the estimated models and well behaved residuals. In this regard, the lag length selection criteria are used to select an appropriate lag length. Lag length selection criteria results presented in Table A4 in the Appendix suggests different lag lengths for the two models. However, we use the principle of parsimony in the selection of the lag length, which entails that if two or more models explain the same phenomena but have different lag lengths, choose the model with lower lags in order not to lose information when higher lags are included and to preserve the degrees of freedom. Hence, based on the Schwarz information criterion, we select models with one lag length.
The next important step in the estimation of VAR models is to test for the stability of the VAR once estimated with the selected lag length. The results of stability tests presented in Table A5 in the Appendix suggests that the estimated VARs for both models are stable as all the roots lie within the unit circle. The importance of the stability a VAR is to ensure that although a particular variable may increase or decrease following a shock, the variable will eventually return to its equilibrium position in the long-run as the shock gradually dissipates or “dies”.

To analyse the monetary transmission mechanism, impulse response functions are used of a one-standard deviation of a monetary policy shock to trace the response of real GDP and prices as well as other relevant variables. A monetary policy shock in this regard is defined as an exogenous, unexpected temporary increase in the interest rate or money supply. In addition, we examine the relative importance of the monetary policy shock to fluctuations in output and prices through the forecast error variance decompositions. Forecast error variance decompositions indicate the forecast error of relevant variables at different forecast horizons that can be attributed to a monetary policy shock.

Figure 6 shows the impulse responses of real GDP, CPI, Treasury bill rate and nominal exchange rate to the shock to money supply. In this case, a monetary policy shock leads to statistically significant effects for real GDP, CPI and the exchange rate which tends to persist for a long period of time. An expansionary monetary policy results in an increase in real GDP with the maximum effect coming through after 6 or 7 quarters (about one and half years). However, the effect on real GDP becomes insignificant after 24 quarters. Similarly, an expansionary monetary policy results in an increase in CPI and a depreciation in the exchange rate. The response of prices to a monetary policy shock seems to peak at about 7 to 8 quarters though the response becomes insignificant after about 22 to 23 quarters. The response of the exchange rate to a monetary policy shock is rather instantaneous with the exchange rate depreciating immediately following a monetary expansion. However, the response of the exchange rate to a monetary policy shock becomes insignificant after about 9 to 10 quarters. This result demonstrates the importance of the exchange rate in the monetary policy transmission mechanism in Zambia, and is in line with other studies on the monetary transmission mechanism in Zambia. Similar results are obtained when Model B is used to analyse the MTM (see Figure 7).

However, when the interest rate is used as a policy variable, impulse response functions suggest statistically insignificant effects on all the relevant variables (see Figures A1 and A2 in the Appendix). These results show that the use of interest rates as a policy variable in the conduct of monetary policy in Zambia is rather ineffective in influencing the key variables of real GDP and inflation. This result may be an indication of the underdeveloped nature of the money market in Zambia as well as lack of financial depending, which is partly reflected in sticky and wide interest rate spreads between the lending and deposit rates.

Variance decompositions for real GDP and CPI presented in Table 5 shows that shocks to broad money explain about 31 percent of the variations in real GDP after three years, that is 12 quarters, while shocks to the interest rate (TB rate) explain around 9 percent of the variation in real GDP over the same period. As regards variation in prices, shocks to broad money explain around 30 percent of variations after three years while shocks to interest rates explain about 22 percent of the variation. These results demonstrate the importance of broad money in inflation and real GDP outcomes in Zambia. However, interest rates also seem to be important in explaining variations in prices.
Figure 6: Impulse Responses of Model A to Shock to M2

Response to Cholesky One S.D. Innovations ± 2 S.E.
Figure 7: Impulse Responses of Model B to Shock to M2

Response to Cholesky One S.D. Innovations ± 2 S.E.
### Table 5: Variance Decompositions of Real GDP and CPI

#### Variance Decomposition of LOG(RGDP):

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>LOG(RGDP)</th>
<th>LOG(CPI)</th>
<th>LOG(M2)</th>
<th>TB91</th>
<th>LOG(EXR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.034049</td>
<td>100.0000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
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<tr>
<td>2</td>
<td>0.039651</td>
<td>94.62520</td>
<td>0.884602</td>
<td>3.663672</td>
<td>0.114626</td>
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<tr>
<td>3</td>
<td>0.043161</td>
<td>87.98011</td>
<td>1.782628</td>
<td>8.201239</td>
<td>0.592042</td>
<td>1.443977</td>
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<tr>
<td>4</td>
<td>0.045998</td>
<td>81.86510</td>
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<tr>
<td>5</td>
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<td>71.91798</td>
<td>3.151875</td>
<td>18.98716</td>
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</tr>
<tr>
<td>7</td>
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<td>8</td>
<td>0.054554</td>
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<td>10</td>
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<td>3.575763</td>
<td>30.98750</td>
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<td>11</td>
<td>0.059230</td>
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<td>30.98750</td>
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<tr>
<td>12</td>
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<td>3.593807</td>
<td>30.98750</td>
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<td>2.202896</td>
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#### Variance Decomposition of LOG(CPI):

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<th>Period</th>
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<th>LOG(CPI)</th>
<th>LOG(M2)</th>
<th>TB91</th>
<th>LOG(EXR)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
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<td>91.61816</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
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<tr>
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<td>6.111333</td>
<td>88.71083</td>
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<td>3</td>
<td>0.030951</td>
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<td>10.48247</td>
<td>0.021134</td>
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<tr>
<td>4</td>
<td>0.035531</td>
<td>9.221363</td>
<td>75.97225</td>
<td>14.71135</td>
<td>0.053837</td>
<td>0.041201</td>
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<tr>
<td>5</td>
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<td>71.37939</td>
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<tr>
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<td>67.80033</td>
<td>20.67301</td>
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<tr>
<td>7</td>
<td>0.046455</td>
<td>11.79582</td>
<td>64.95962</td>
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<tr>
<td>8</td>
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<td>62.65910</td>
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<td>0.309356</td>
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<tr>
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<td>56.62693</td>
<td>30.04676</td>
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<td>0.494694</td>
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### 8.0 Conclusion and Policy Recommendations

The conduct and success of monetary policy in any economy is crucially dependent of the monetary policy framework used as well as the structure of the economy. However, evolving economies such as those in the COMESA region, including Zambia, present challenges that may render monetary policy less effective in the achievement of the monetary policy goals. In this regard, empirical analyses of the monetary policy frameworks in place is important in order to
assess the effectiveness of the frameworks and to design frameworks that will yield the desired goals, if existing frameworks are found to be ineffective.

The empirical analyses undertaken in this study regarding the money demand function in Zambia suggest a generally stable money demand function. This result implies that monetary aggregates can still play a critical role in monetary policy implementation in Zambia, and possibly in other COMESA member countries that have been using a similar framework. The results from the VAR analysis of the monetary transmission mechanism also support the importance of monetary aggregates in the conduct of monetary policy given the significant effects that monetary aggregates have on output and prices.

However, the weakening link between consumer prices and monetary aggregates would naturally require that the Bank of Zambia—along with many other central banks in similar situations—starts the search for a policy framework that will be more effective in the future conduct of monetary policy, such as inflation targeting which focuses on targeting inflation through a policy rate instead of focusing on maintaining a certain growth rate in money aggregates.

The overall recommendation from this study is that as the process of modernising monetary policy frameworks gets underway to address the emerging economic challenges, it is clear that in the case of Zambia monetary aggregates will still continue to play a role in monetary policy conduct. In this regard, it would be premature to abandon the traditional policy focus on monetary aggregates, given their influence on the key macroeconomic outcomes of output and prices. A key implication from this study is therefore that monetary policy in Zambia, and other COMESA member countries, should continue to consider developments in monetary aggregates while gradually transitioning to modern monetary policy frameworks. In addition, measures should be put in place that are aimed at enhancing monetary transmission mechanisms, particularly the interest rate channel, by promoting financial deepening and economic development more generally.
Appendix

Table A1: Unit Root Test Results

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>ADF TEST</th>
<th>PP test</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td></td>
<td>t-statistic</td>
<td>P-value</td>
<td>t-statistic</td>
<td>P-value</td>
</tr>
<tr>
<td>Variables in levels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Lending rate</td>
<td>-0.41</td>
<td>0.90</td>
<td>-0.68</td>
<td>0.85</td>
</tr>
<tr>
<td>Interbank Rate</td>
<td>-2.65</td>
<td>0.09</td>
<td>-2.49</td>
<td>0.12</td>
</tr>
<tr>
<td>TBrate</td>
<td>-2.15</td>
<td>0.22</td>
<td>-1.20</td>
<td>0.67</td>
</tr>
<tr>
<td>Inflation</td>
<td>-5.47</td>
<td>0.00</td>
<td>-5.16</td>
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<tr>
<td>FFR</td>
<td>-1.93</td>
<td>0.32</td>
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</tr>
<tr>
<td>Ln(GDP)</td>
<td>2.52</td>
<td>0.99</td>
<td>1.78</td>
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</tr>
<tr>
<td>Ln(CPI)</td>
<td>-2.24</td>
<td>0.99</td>
<td>-2.45</td>
<td>0.39</td>
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<tr>
<td>Ln(real M2)</td>
<td>0.93</td>
<td>1.00</td>
<td>1.17</td>
<td>0.97</td>
</tr>
<tr>
<td>Ln(M2)</td>
<td>-1.73</td>
<td>0.41</td>
<td>-4.49</td>
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</tr>
<tr>
<td>Ln(USD)</td>
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<td>-1.06</td>
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<tr>
<td>Ln(Cupr)</td>
<td>-0.56</td>
<td>0.87</td>
<td>-0.69</td>
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<tr>
<td>Ln(Oilpr)</td>
<td>-0.56</td>
<td>0.87</td>
<td>-0.61</td>
<td>0.86</td>
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Variables in First Differences

<table>
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<th>P-value</th>
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<tbody>
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<td>D(Average Lending rate)</td>
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<td>-7.38</td>
<td>0.00</td>
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<tr>
<td>D(Interbank Rate)</td>
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<td>D(TBrate)</td>
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<td>D(FFR)</td>
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</tr>
<tr>
<td>D(Ln(GDP))</td>
<td>-9.71</td>
<td>0.00</td>
<td>-11.85</td>
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</tr>
<tr>
<td>D(Ln(CPI))</td>
<td>-5.29</td>
<td>0.00</td>
<td>-8.91</td>
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</tr>
<tr>
<td>D(In(real m2))</td>
<td>-4.36</td>
<td>0.00</td>
<td>-11.64</td>
<td>0.00</td>
</tr>
<tr>
<td>D(In(m2))</td>
<td>-4.44</td>
<td>0.00</td>
<td>-8.82</td>
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</tr>
<tr>
<td>D(log(USD))</td>
<td>-7.74</td>
<td>0.00</td>
<td>-5.69</td>
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</tr>
<tr>
<td>D(Ln(Cupr))</td>
<td>-6.58</td>
<td>0.00</td>
<td>-5.98</td>
<td>0.00</td>
</tr>
<tr>
<td>D(Ln(Oilpr))</td>
<td>-7.33</td>
<td>0.00</td>
<td>-6.73</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Table A2: ARDL Bound Testing for Co-integration

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>F-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(Real M2)</td>
<td>Lag(4,4,4,4,4) 5.8790671</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Critical Value</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>3.29</td>
<td>4.37</td>
</tr>
<tr>
<td>5%</td>
<td>2.56</td>
<td>3.49</td>
</tr>
<tr>
<td>10%</td>
<td>2.20</td>
<td>3.09</td>
</tr>
</tbody>
</table>

Pesaran et al (2001)

Table A3: Lag Length Selection Criteria for the ARDL Model

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>91.89003</td>
<td>NA</td>
<td>0.003713</td>
<td>-2.758414</td>
<td>-2.588324</td>
<td>-2.691516</td>
</tr>
<tr>
<td>1</td>
<td>92.78365</td>
<td>1.617016</td>
<td>0.003726</td>
<td>-2.755036</td>
<td>-2.550928*</td>
<td>-2.674760</td>
</tr>
<tr>
<td>2</td>
<td>93.49760</td>
<td>1.269252</td>
<td>0.003762</td>
<td>-2.745956</td>
<td>-2.507829</td>
<td>-2.652299</td>
</tr>
<tr>
<td>3</td>
<td>96.92783</td>
<td>5.989297*</td>
<td>0.003484*</td>
<td>-2.823106*</td>
<td>-2.550962</td>
<td>-2.716070</td>
</tr>
<tr>
<td>4</td>
<td>100.0255</td>
<td>5.310351</td>
<td>0.003261</td>
<td>-2.889700</td>
<td>-2.583538</td>
<td>-2.769285*</td>
</tr>
<tr>
<td>5</td>
<td>100.1034</td>
<td>0.130978</td>
<td>0.003361</td>
<td>-2.860425</td>
<td>-2.520245</td>
<td>-2.726630</td>
</tr>
<tr>
<td>6</td>
<td>100.1999</td>
<td>0.159303</td>
<td>0.003462</td>
<td>-2.831742</td>
<td>-2.457544</td>
<td>-2.684568</td>
</tr>
<tr>
<td>7</td>
<td>101.7187</td>
<td>2.459083</td>
<td>0.003409</td>
<td>-2.848214</td>
<td>-2.439998</td>
<td>-2.687660</td>
</tr>
<tr>
<td>8</td>
<td>101.9811</td>
<td>0.416407</td>
<td>0.003494</td>
<td>-2.824796</td>
<td>-2.382562</td>
<td>-2.650863</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion
Table A4: Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

<table>
<thead>
<tr>
<th></th>
<th>F-statistic</th>
<th>Prob. F(2, 58)</th>
<th>Observations-R-squared</th>
<th>Prob. Chi-Square(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F-statistic</strong></td>
<td>0.880856</td>
<td>0.4199</td>
<td><strong>Observations-R-squared</strong></td>
<td>2.122485</td>
</tr>
</tbody>
</table>

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 11/18/14  Time: 16:03
Sample: 1996Q1 2013Q4
Included observations: 72
Presample missing value lagged residuals set to zero.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(1)</td>
<td>-0.036514</td>
<td>0.074061</td>
<td>-0.493024</td>
<td>0.6239</td>
</tr>
<tr>
<td>C(2)</td>
<td>0.023481</td>
<td>0.243342</td>
<td>0.096492</td>
<td>0.9235</td>
</tr>
<tr>
<td>C(3)</td>
<td>-0.052418</td>
<td>0.252798</td>
<td>-0.207350</td>
<td>0.8365</td>
</tr>
<tr>
<td>C(4)</td>
<td>-0.029383</td>
<td>0.230747</td>
<td>-0.127340</td>
<td>0.8991</td>
</tr>
<tr>
<td>C(5)</td>
<td>-0.021293</td>
<td>0.243145</td>
<td>-0.087574</td>
<td>0.9305</td>
</tr>
<tr>
<td>C(6)</td>
<td>0.015015</td>
<td>0.096297</td>
<td>0.15923</td>
<td>0.8766</td>
</tr>
<tr>
<td>C(7)</td>
<td>-0.018500</td>
<td>0.132960</td>
<td>-0.139143</td>
<td>0.8898</td>
</tr>
<tr>
<td>C(8)</td>
<td>-0.000217</td>
<td>0.000895</td>
<td>-0.242162</td>
<td>0.8095</td>
</tr>
<tr>
<td>C(11)</td>
<td>0.000156</td>
<td>0.017832</td>
<td>0.008741</td>
<td>0.9931</td>
</tr>
<tr>
<td>C(12)</td>
<td>0.005260</td>
<td>0.023671</td>
<td>0.222200</td>
<td>0.8249</td>
</tr>
<tr>
<td>C(13)</td>
<td>-0.004442</td>
<td>0.019693</td>
<td>-0.225560</td>
<td>0.8223</td>
</tr>
<tr>
<td>C(14)</td>
<td>0.014705</td>
<td>0.119087</td>
<td>0.123481</td>
<td>0.9022</td>
</tr>
<tr>
<td>RESID(-1)</td>
<td>0.037259</td>
<td>0.189315</td>
<td>0.196808</td>
<td>0.8447</td>
</tr>
<tr>
<td>RESID(-2)</td>
<td>0.187281</td>
<td>0.144534</td>
<td>1.295759</td>
<td>0.2002</td>
</tr>
</tbody>
</table>

R-squared: 0.029479
Adjusted R-squared: -0.188052
S.E. of regression: 0.048275
Sum squared resid: 0.135167
Log likelihood: 123.8411

Prob(F-statistic): 0.999833
Table A5: Lag Length Selection

Model A

Endogenous variables: LOG(RGDP) LOG(CPI) LOG(M2) TB91 LOG(EXR)
Exogenous variables: C LOG(CUPR) LOG(OILPR) FFR

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-55.13370</td>
<td>NA</td>
<td>4.55e-06</td>
<td>1.887933</td>
<td>2.211717</td>
<td>2.016389</td>
</tr>
<tr>
<td>1</td>
<td>362.3121</td>
<td>750.1924</td>
<td>5.23e-11</td>
<td>-9.487307</td>
<td>-8.354064*</td>
<td>-9.037712</td>
</tr>
<tr>
<td>2</td>
<td>399.2225</td>
<td>60.98239</td>
<td>3.76e-11</td>
<td>-9.832536</td>
<td>-7.889834</td>
<td>-9.061801</td>
</tr>
<tr>
<td>3</td>
<td>436.5134</td>
<td>56.20654</td>
<td>2.72e-11</td>
<td>-10.18879</td>
<td>-7.436633</td>
<td>-9.096919*</td>
</tr>
<tr>
<td>4</td>
<td>464.5660</td>
<td>38.21666</td>
<td>2.66e-11</td>
<td>-10.27728</td>
<td>-6.715656</td>
<td>-8.864262</td>
</tr>
<tr>
<td>5</td>
<td>497.6092</td>
<td>40.22651*</td>
<td>2.34e-11*</td>
<td>-10.51041</td>
<td>-6.139334</td>
<td>-8.776259</td>
</tr>
<tr>
<td>6</td>
<td>527.7520</td>
<td>32.32708</td>
<td>2.37e-11</td>
<td>-10.65948*</td>
<td>-5.478942</td>
<td>-8.604187</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Model B

Endogenous variables: LOG(RGDP) LOG(CPI) LOG(M2) INTRT LOG(EXR)
Exogenous variables: C LOG(CUPR) LOG(OILPR) FFR

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25.72429</td>
<td>NA</td>
<td>5.83e-07</td>
<td>-0.165922</td>
<td>0.481646</td>
<td>0.090990</td>
</tr>
<tr>
<td>1</td>
<td>356.7117</td>
<td>575.6303</td>
<td>8.26e-11</td>
<td>-9.035122</td>
<td>-7.578096*</td>
<td>-8.457071*</td>
</tr>
<tr>
<td>3</td>
<td>425.8998</td>
<td>67.97676</td>
<td>5.06e-11</td>
<td>-9.591297</td>
<td>-6.515354</td>
<td>-8.370968</td>
</tr>
<tr>
<td>4</td>
<td>451.0373</td>
<td>32.78815</td>
<td>5.45e-11</td>
<td>-9.595285</td>
<td>-5.709883</td>
<td>-8.053816</td>
</tr>
<tr>
<td>5</td>
<td>486.2160</td>
<td>40.78686*</td>
<td>4.60e-11*</td>
<td>-9.890319</td>
<td>-5.195458</td>
<td>-8.027711</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
### Table A6: Stability of Estimated VAR Models

**Model A**

Roots of Characteristic Polynomial
Endogenous variables: LOG(RGDP) LOG(CPI) LOG(M2) TB91 LOG(EXR)
Exogenous variables: C LOG(CUPR) LOG(OILPR) FFR
Lag specification: 1 1

<table>
<thead>
<tr>
<th>Root</th>
<th>Modulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.984141</td>
<td>0.984141</td>
</tr>
<tr>
<td>0.954145</td>
<td>0.954145</td>
</tr>
<tr>
<td>0.699060 - 0.104744i</td>
<td>0.706863</td>
</tr>
<tr>
<td>0.699060 + 0.104744i</td>
<td>0.706863</td>
</tr>
<tr>
<td>0.291164</td>
<td>0.291164</td>
</tr>
</tbody>
</table>

No root lies outside the unit circle.
VAR satisfies the stability condition.

**Model B**

Roots of Characteristic Polynomial
Endogenous variables: LOG(RGDP) LOG(CPI) LOG(M2) INTRT LOG(EXR)
Exogenous variables: C LOG(CUPR) LOG(OILPR) FFR
Lag specification: 1 1

<table>
<thead>
<tr>
<th>Root</th>
<th>Modulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.980766</td>
<td>0.980766</td>
</tr>
<tr>
<td>0.921399</td>
<td>0.921399</td>
</tr>
<tr>
<td>0.598007 - 0.094020i</td>
<td>0.605353</td>
</tr>
<tr>
<td>0.598007 + 0.094020i</td>
<td>0.605353</td>
</tr>
<tr>
<td>0.305875</td>
<td>0.305875</td>
</tr>
</tbody>
</table>

No root lies outside the unit circle.
VAR satisfies the stability condition.
Figure A1: Impulse Responses of Model A to Shock to TB91

Response to Cholesky One S.D. Innovations ± 2 S.E.

Response of LOG(RGDP) to TB91

Response of LOG(CPI) to TB91

Response of LOG(M2) to TB91

Response of TB91 to TB91

Response of LOG(EXR) to TB91
Figure A2: Impulse Responses of Model B to Shock to Interbank Rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

Response of LOG(RGDP) to INTRT

Response of LOG(CPI) to INTRT

Response of LOG(M2) to INTRT

Response of INTRT to INTRT

Response of LOG(EXR) to INTRT
References


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Bernanke B. and A. Blinder. 1992. “The Federal Funds Rate and the Channels of


