



**Strathmore**  
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**AN ASSESSMENT OF THE INTEREST RATE CHANNEL ON MONETARY POLICY  
TRANSMISSION IN KENYA 2006-2015**

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## LIST OF ABBREVIATIONS

CBK	Central Bank of Kenya
KNBS	Kenya National Bureau of Statistics
CBR	Central Bank Rate
CPI	Consumer Price Index
GDP	Gross Domestic Product
USD	United States Dollar
VAR	Vector Autoregressive Model
VECM	Vector Error Correction Model

## ABSTRACT

For the government to achieve its desired level of economic growth, appropriate monetary policy needs to be formulated and implemented. Theoretical and empirical literature highlights the importance of the interest rate channel. However in Kenya there have been inconclusive evidence on the effectiveness of this channel. This study attempts to investigate the effectiveness of the interest rate channel of monetary policy transmission in Kenya during the period 1996-2015. The study employed Vector Autoregressive Models. The paper also employs time series techniques namely Unit root tests, cointegration, impulse responses and variance decomposition. Cointegration tests showed the presence of 2 cointegrating equations and the study proceeded to use Vector error correction models (VECM). From the impulse response tests, the interest rate channel of monetary policy is proved to be effective since the Central bank rate (CBR) is able to transmit effects on output and prices but its effectiveness is with the four lags for CPI and three lags for GDP. The forecast error variance decomposition show that in forecasting CPI, all fluctuations were attributed to itself, with decreasing significant contribution from CBR in the long run. Forecasting GDP showed that GDP fluctuations were greatly denominated by itself, however in the long run there was significant contribution in the other variables. The results show that the interest rate channel of monetary policy transmission is effective in Kenya.

# 1. INTRODUCTION

## 1.1 BACKGROUND INFORMATION

The Economic Pillar of Vision 2030 seeks to improve the prosperity of all regions of the country and all Kenyans by achieving 10% gross domestic product (GDP) growth rate by 2017. However in 2015 the GDP grew by 5.6% compared to 5.3% in 2014. These rates are still far below the target of 10% per annum. One of the key foundations of the vision is macroeconomic stability for long-term development. In order to achieve this, the government must put in place appropriate policies such as the monetary policy whose role is to formulate and implement targets directed to achieve and maintain stability in the general price level.

Monetary policy involves changing the interest rate and influencing the money supply while the fiscal policy involves changing the levels of government spending, borrowing and tax rates. This paper mainly focuses on the monetary policies. In Kenya, the Central Bank of Kenya is the instituted fully charged with the responsibility of conducting monetary policy. According to the Central Bank of Kenya Act, the principal objective of the Central Bank is formulation and implementation of monetary policy directed at achieving and maintaining stability in the general level of price. The aim is to achieve stable prices, which includes the exchange rate. A stable exchange rate ensures that the value of the shilling versus other foreign currencies is maintained.

In making their decisions, most Central banks use an interest rate rule (similar to Taylor rule) which stipulates how much the central bank should change nominal interest rates in response to changes in inflation, output and other economic conditions. This rule states that for each one percent increase in inflation the central bank should raise the nominal interest rate by more than one percent point, but this is dependent to the weighting given to inflation versus economic growth which varies from one economy to another. However, most central banks don't follow this rule explicitly.

A dominant recent trend has been the empirical analysis of how monetary shock affects output, prices, exchange rates, as well as other key economic variables for example Munir (2010) Montiel (1991) and Komaan (2014). This is the monetary transmission mechanism and is important to policy formulators, decision making and implementing authorities.

There are a number of channels identified by literature that identify how monetary policy stance is transmitted into the economy, namely: the interest rate channel, asset channel, credit channel and expectations channel. However economists do not agree about how monetary policy affects the economy. There have been various empirical literature which weigh differently the various specific channels through which monetary policy works. The lack of consensus is evidenced by the many studies that have emphasized the importance of different channels through which policy shocks are transmitted to the economy.

This paper focuses on the interest rate channel of monetary policy. This is because first the monetary policy affects the economy mainly through the interest rate channel. This was the main channel in the Keynesian view and also other studies have argued this for example Kovaven (2011), Gitonga (2013) and Kalikeka and Sheefani (2013).

Over the past two decades, there have been a number of reforms and market developments in Kenya that have warranted a study on the transmission of monetary policy. For instance, there have been widespread deregulation of the financial system, modifications of the tools of monetary policy and emergence of financial innovations, such a mobile money, that have changed the structure and operations of the financial system, thus affecting the effectiveness of monetary policy, especially through the interest rate channel Misati (2010). In addition, the interest rate is argued to be strongly linked with other channels such as the exchange rate and credit channels of monetary policy transmission Mishkin (1996). For example, the credit channel where it is argued that interest rate changes also affect economic activity via its impact on firms' cash flow and supply of bank loans. As such, this study focuses on the interest rate channel

Moreover, there have been strong and widespread debates on interest rate spreads (lending rate-deposit rate). For instance, the spread between the average commercial banks' lending rate and deposit rate increased from 9.4 percent to 10.3 percent in December 2015. Large banks had the highest spread on average during the second half of 2015 due to comparably lower deposit rates. It has been argued that interest rate spread in Kenya is too wide compared to other countries and the Kenyan borrower continues to carry heavy burden of high interest rates as studied by Were and Wambua (2014). The spread between the average commercial banks' lending rate and deposit rate increased from 9.4% to 10.3% as of December 2015. Large banks had the highest spread on average during the second half of 2015 due to comparably lower deposit rates.

This study will use the Vector autoregressive models. Cheng' (2006) shows that there have been a significant number of studies that have employed the Vector autoregressive methods (VAR) to attempt to identify and measure the effects of monetary policy innovations on macroeconomic variables.

## 1.2 THE MONETARY POLICY FRAMEWORK AND INSTRUMENTS IN KENYA

CBK formulates and conducts monetary policy with the aim of keeping overall inflation at 5% with allowable deviation of 2.5% on either side. Achieving and maintaining a low and stable inflation rate together with adequate liquidity in the market facilitates higher levels of domestic savings and private investment and therefore leads to improved economic growth, higher real incomes and increased employment opportunities. CBK's monetary policy is therefore designed to support the Government's desired economic activity and growth as well as employment creation through achieving and maintaining a low and stable inflation.

The overall trends over the period covered by the study is that the overall rate of inflation dropped from 15.6% in December 2006 to 6.45 % in December 2015 which is within the governments margin of 2.5% on either side of 5% target. The Kenyan shilling against the US dollar moved from around 73 in 2006 to around 101 in 2016. The average yield rate for the 91-day Treasury bills, which is a benchmark for the general trend of interest rates, increased from 5.7% in December 2006 to 9.8% in December 2015. However, the inter-bank rate fell from 6.3\$ in December 2006 to 5.3 in December 2015. Broad money supply (M3), a key indicator for monetary policy formulation rose from 666.8 billion in December 2006 to 2658.2 billion in December 2015

The CBK formulates a policy to expand or contract money supply in the economy after detailed analysis and estimation of the demand for money in the economy. The major instruments used to implement monetary policy in Kenya include open market operations, discount window operation and reserve requirements.

Open market operations (OMO) are the actions by the CBK through purchase and sale of eligible securities to regulate money supply and the credit conditions in the economy. This is conducted using Repurchase agreements (Repos). Term Auction deposits (TAD) and Horizontal repos. Repos entail the sale of eligible securities by the CBK to reduce commercial banks, deposits held at CBK.

Term Auction deposits is used when the securities held by the CBK for repos are exhausted or when the CBK considers it desirable to offer long tenor options. The CBK seeks to acquire deposits through a transfer agreement from commercial banks at auction price but no exchange of security guarantee. The horizontal repo is an interbank Repo instrument which recognizes government securities as collateral for borrowing. The repo rate as of August 2015 was 11.5%.

As of discount window operations, the CBK as the lender of last resort provides short –term unsecured loans to commercial banks overnight at punitive rates when they run short of funds thus affecting the amount of money in circulation. This is anchored on the central bank rate.

Reserve requirements is where commercial banks are required to deposit a portion of their deposits with the CBK. This is used to influence the amount of loans that can be advanced to the public. The cash reserve ratio is currently 5.25 percent of the total of a bank’s domestic and foreign currency deposit liabilities as of December 2015 compared to 5% in December 2008. To facilitate commercial banks’ liquidity management, commercial banks are currently required to maintain their cash reserve ratio based on a daily average level from the 15th of the previous month to the 14th of the current month and not to fall below a CRR of 3 percent on any day.

On the other hand is the central bank rate (CBR). The movement in the CBR both in direction and magnitude signal monetary policy stance. The CBR in Kenya is the base for all monetary policy operations in order to enhance clarity and certainty in monetary policy implementation. Whenever the central bank is injecting liquidity through a reverse repo, the CBR is the lowest acceptable rate by law. Also whenever the bank wishes to withdraw liquidity through a vertical repo the CBR is the highest rate that the CBK will pay on any bid received. However, to ensure flexibility and effectiveness of monetary policy operations in periods of volatility in the market, the CBK can raise the maximum acceptable interest rates on Term auction deposit (TAD) to above the CBR. Movements in the CBR are transmitted to changes in short-term interest rates. A reduction of the CBR signals an easing of monetary policy and a desire for market interest rates to move downwards. Lower interest rates encourage economic activity and thus growth. When interest rates decline, the quantity of credit demanded should increase.

The latest monetary statistics of Kenya published in the monetary policy statement (2015) states that the Monetary Policy Committee (MPC) tightened the policy stance by raising the Central Bank Rate (CBR) to 11.50 percent in July 2015 from 10.0 percent in order to anchor inflationary

expectations which were attributed largely to exchange rate depreciation compared to 10% in December 2006. In addition, the Kenya Banks' Reference Rate (KBRR) was raised to 9.87 percent in July, from 8.54 percent. The effectiveness of liquidity management instruments was enhanced through the introduction of a 3-day Repo, and by raising the maximum acceptable rate on the Term Auction Deposits (TAD) instrument to 250 basis points above the CBR. The money market was turbulent in September and October 2015 following pressures on the Government borrowing programme, and the placement of Imperial Bank Limited into receivership. The CBK used Reverse Repos to address the resultant temporary liquidity shortages in segments of the market. The Central bank rate increased from 10% in December 2006 to 11.5% in December 2015. The cash reserve also increased from 122.6 billion in December 2006 to 392.4 billion in December 2015

### 1.3 STATEMENT OF THE RESEARCH PROBLEM

For the government to achieve its desired level of economic growth, appropriate monetary policy needs to be formulated and implemented. It is argued that monetary policy transmission in low income countries is significantly weak than in advanced and emerging economies. This is usually attributed to weak institutional frameworks, shallow financial markets, oligopolistic banking structure and extensive central bank intervention in foreign exchange markets in low income countries. However, with the deregulation of financial markets and monetary policy more oriented towards market based operations in developing countries, especially in Sub-Saharan Africa, this can be subject to changes.

Theoretical and empirical literature highlights the importance of the interest rate channel (and its strong link with other channels of transmission). In this regard, this study focuses on Kenya and aims to analyze the effectiveness of the interest rate channel. There have been other studies in Kenya on the interest rate channel (see for instance, Cheng', 2006 and Misati, 2010). However they give inconclusive evidence on the effectiveness of this channel.

This study extends the period from previous studies to cover 2006-2015. This period incorporates new changes in the Kenyan economy that were not included in the previous studies. Some of the current changes are with regard to the conduct of monetary policy (reviews of policy instruments), enhanced risk-based banking supervision since 2014 that affected the way banks extend credit to

the private sector, and new prudential regulation on banks that the government has placed on commercial banks (example new capital requirements, and enhanced penalties for failure to meet banking Act requirements). The CBK continue to implement measures aimed at improving the efficiency of the banking sector as well as financial inclusion in order to enhance the monetary policy transmission mechanism.

There has also been an increased importance in mobile phones as a platform for financial services therefore reducing transaction costs. This points to the potential of technology-led delivery channels in increasing access to financial services. The conduct of monetary policy by CBK in order to achieve its price stability target is usually on the basis of the monetary aggregate targeting framework. The CBR has also been strengthened as a base for all subsequent monetary policy operations. The study also includes a period with economic turbulence characterized by increased volatilities in the money market in September -October 2015 following pressures on the Government borrowing programme, and the placement of one of the banks (Imperial Bank Limited) under receivership. This study seeks to capture these recent occurrences that have potentially impacted on the transmission of monetary policy actions on the economy.

#### 1.4 RESEARCH OBJECTIVES

The overall objective of this paper is to analyze the interest rate channel of monetary policy transmission mechanism in Kenya. The focus objectives include:

1. To estimate the effect of the interest rate channel on output
2. To estimate the effect of the interest rate channel on inflation

#### 1.5 RESEARCH QUESTIONS

This research paper seeks to answer the following questions:

1. How does output respond to variations in interest rates?
2. How does inflation respond to variations in interest rates?

## 1.6 JUSTIFICATION FOR THE STUDY

The aim of monetary policy is to achieve economic stability and growth. This study will provide an insight into monetary policy transmission mechanism and will help policy makers to address the issue of monetary policy effectiveness with focus on the interest rate channel.

This study will also contribute to academic debates on the monetary transmission mechanisms and in particular the effectiveness of the interest rate channel in developing countries with the focus in Kenya.

## 2. LITERATURE REVIEW

### 2.1 INTRODUCTION

This section views the theoretical literature of monetary policy transmission mechanisms and empirical literature that focus on effectiveness of the channels with more focus on the interest rate channel.

### 2.2 THEORETICAL LITERATURE

#### 2.2.1 KEYNESIAN VIEW

The Keynesians examine the effect of money on economic activity by building a structural model. This a description of how the economy operates using a collection of equations that describe the behavior of firms and consumers in many sectors of the economy. These equations then show the channels through which monetary and fiscal policy affect aggregate output and spending.

Keynes (1935) described the transmission mechanism of monetary policy such that money supply affects interest rates, which in turn affect investment spending, which in turn affects aggregate output or aggregate spending. The Keynesians examine the relationship between money supply and output by looking at empirical evidence on the specific channels of monetary influence, such as the link between interest rates and investment spending.

The early Keynesians also believed that money does not matter because they found weak links between interest rates and investment and because low interest rates on treasuries showed easy monetary policy during the great depression. They also based this arguments from early empirical studies that found no linkages between movements in nominal interest rates and investment spending.

#### 2.2.2 MONETARIST VIEW

They examine the effect of money on economic activity by looking at whether movements in output are tightly linked to movements in money supply. Using reduced-form evidence, monetarists analyze the effect of money supply on output as if the economy were a black box whose workings cannot be seen.

Friedman (1982) objected the Keynesian view on the grounds that focus on nominal rather than real interest rates may weaken the link between interest rates and investment. The monetarist also argued that interest rates may not be the only one of the many channels through which monetary

policy affect aggregate demand. They also stated that monetary policy was highly contractionary during the great depression by the standards of low interest rates and interest rates on lower grade bonds.

For example Bernanke and Gertler (1995) studied inside the black box, the credit channel of monetary policy transmission and argued that not only does the general level of interest rates affect monetary policy but also the size of the external finance premium. This is what explains the strength, timing and composition of monetary policy effects better than the interest rates alone.

### 2.2.3 CHANNELS OF MONETARY POLICY TRANSMISSION

Monetary policy works through its effects on aggregate demand in the economy. It does not have a direct effect but works through the various channels identified by literature. They include: the interest rate channel, the exchange rate channel, asset channel and the credit channel. These channels are not mutually exclusive, that is the economy's response to monetary policy will incorporate the impact of a variety of channels. In the long-run, monetary policy determines the value of money over time.

The interest rate channel is the key monetary transmission mechanism in the Keynesian textbook model. It works by impacting the short-term nominal interest rates which in turn impacts long-term interest rates. The monetary shock influences real interest rates and liquidity conditions which in turn affects investments and consumption which are influenced by interest rates. The traditional Keynesian view of how monetary tightening is transmitted to the economy can be summarized that a contractionary monetary policy leads to a rise in interest rates which in turn raises the cost of capital thereby causing a decline in investment spending which leads to a decline in aggregate demand and a fall in output. Taylor (2001) argued that there is a strong interest rate effect on consumer and investment spending and hence supporting existence of a strong interest rate channel. Mishkin (1996) however argued that the traditional interest rate channel is not that significant.

The exchange rate channel involves the interest rates effect through foreign direct investments from areas of low interest rates to areas of high interest rates. An increase in domestic interest rates relative to foreign interest rates leads to appreciation of the exchange rate, which lowers the price

of goods and services and therefore pushing down domestic inflation. A higher value of domestic currency makes domestic goods more expensive than foreign goods thereby causing a fall in net exports and hence a decrease in aggregate output. Taylor (2001) studied the effects of exchange rates on interest rates. He argued that indirect effects exist even if the central bank follow a policy rule without a direct exchange rate effect. Inertia combined with rational expectations cause this indirect effect. This indirect effect has advantages of direct in that it results in fewer and less erratic fluctuations in the interest rate.

The credit channel work through the response of credit aggregates to interest rates and other monetary policy instruments. The channel works through the balance sheet channel and the lending channel. The balance sheet channel is where policy changes affects interest rates and the financial position of borrowers. An increase in interest rates increases the interest rate expenses, thus reducing the net cash flow and weakening the financial position of borrowers. Increasing interest rates are also associated with declining asset and equity prices leading to shrinking of households and firms balance sheet.

The lending channel is based on the view that as the net worth of borrowers reduce banks have to screen borrowers to avoid adverse selection and they have to monitor the borrowers to reduce moral hazard. This process reduces the amount of loans given by the bank. In an expansionary monetary policy, there is an increase in deposits which stimulate an increase in loans, investments and output while in a contractionary there is decrease in loans, investments and eventually output. Mishkin (1996) provided an overview of the transmission mechanisms of monetary policy. He argued that the credit channel provides additional ways in which changes in interest rate can have an important impact on aggregate demand.

He gives three reasons for the importance of the credit channel in monetary transmission. First, there is a lot of evidence which supports the view that the credit market imperfections, the type crucial to credit channels, indeed affect firm's employments and spending decisions. Second there is evidence that show that small firms which are more likely to be credit constrained are hurt more by tight monetary policy than large firms. Third, the asymmetric information view of credit market imperfections at the core of credit channel analysis is a theoretical construct that has proven to be highly useful in explaining many other phenomena.

However Bernanke and Gertler (1995) argued that the credit channel is not a distinct free-standing alternative to the traditional monetary transmission mechanisms but a set of factors that amplify and propagate conventional interest rate effects. It was found difficult to explain the magnitude, timing and composition of the economy's response to monetary policy shocks solely in terms of conventional interest rate effects and the credit channel comes in to fill the gaps in the traditional mechanism. In the credit channel not only does the general level of interest rates affect monetary policy but also the size of the external finance premium. This is what explains the strength, timing and composition of monetary policy effects better than the interest rates alone.

According to Meltzer (1995), the Keynesian view of monetary policy focused on only one relative asset price through interest rate channel. Therefore there have been studies on how monetary policy affect the world of asset prices and real wealth. Tobin (1969) explains how monetary policy can affect the economy through its effects on the valuation of equity. Tobin defines  $q$  as the ratio between the market value of a firm and the replacement cost of capital. If  $q$  is high, the market price is high relative to the replacement cost of capital, and the new plant and equipment capital is cheap relative to market value of firms. Companies can then issue stock and get a high price for it relative to the cost of the facilities and equipment they are buying. Investment spending will rise, because firms can buy a lot of new investment goods with only a small issue of stock. In an expansionary monetary policy, the public spends more.

There will be increased spending in the stock market, increasing demand for stocks and consequently raising their prices. High stock prices ( $P$ ) will lead to a higher  $q$  and thus higher investment spending  $I$  leading to an increase in output. Mishkin (1996) supported the existence of the asset price channel arguing that other asset prices besides those of long term debt instruments are important channels of monetary policy transmission. This is because they contain important information which is used in the credit channel to determine the value of collaterals that firms and customers present to obtain a loan

### 2.3 EMPIRICAL LITERATURE REVIEW

This section looks at views on the effectiveness of various channels in developed and then developing countries outlining the argued differences in their transmission mechanisms. It later on focuses on empirical views on the interest rate channel in some developing countries in Africa then with particular interest in the Kenyan economy.

There have been a number of literature that focus on developed and emerging economies looking at the transmission mechanisms and sectorial effects of the monetary policy. It is argued that monetary policy transmission in low income countries is significantly weak than in advanced and emerging economies .According to Kamaan (2014) the most distinguishing characteristic of monetary transmission mechanism in developed countries is the focus on prices (asset prices, interest rates and exchange rates) rather than quantities (money, credit, base money, bonds and foreign assets). In contrast, the common analysis of monetary transmission mechanism in low-income countries has been its focus on quantities rather than prices. This difference is often attributed to weak institutional frameworks, shallow financial markets, oligopolistic banking structure and extensive central bank intervention in foreign exchange markets in low income countries. The financial structure of such countries would suggest that the bank lending channel is likely to be the dominant channel but according to Prachi Mishra and Peter Montiel it is problematic because of the domestic institutional context, the structure of the banking system in the country and the intrinsic stability of the domestic macroeconomic environment.

Bhuiyan (2012) studied monetary policy transmission in Canada, a small open economy. He used a Bayesian structural VAR model to estimate the effects of monetary policy shocks, using the overnight rates target as the policy instrument for the period 1994 to 2008. The key findings were that monetary policy affects the real economy through both the exchange rates and market interest rates. An expansionary policy shock almost immediately lowers the market interest rate and depreciates the Canadian dollar: the policy shock then increases output with a lag and pries with a further lag. The paper also found that Bank of Canada responds to both foreign and home variables that embodies information about future inflation and external shocks are an important source of output fluctuations.

Chow (2014) studied the monetary transmission mechanism in Singapore using the VAR model. His findings were different from that of Bhuiyan (2012) as he found out that the interest rate

channel is not a strong channel for transmitting exchange rate disturbances at least over the same period. He also found out that output reacts immediately and significantly to a contractionary monetary policy shock, and that the exchange rate innovation is quite persistent. In the model, the variance decompositions showed that the exchange rate innovation is a more important source of output fluctuations, compared with the interest rate shock.

Kuttner and Mosser (2002) argued that the monetary policy has less of an impact on real activity than it once had. Some of the reason given for this change is that the transmission mechanism may have changed over time as a result of financial innovation. Bernanke and Gertler (1995) also agreed with this argument that with financial deregulation and innovation, the lending channel has most likely diminished over time. An example of changes include introduction of Basel two and three which introduce new regulations in the financial sector.

In support of this view, The European Central Bank (2010) also studied the monetary policy transmission in the euro area, a decade after the introduction of the Euro. The article argues that there are a number of changes in the financial sector which have affected the properties of monetary policy transmission in the euro area. Recently, the monetary policy has coincided with intense progress in financial innovation. It argues that the fact that banks could easily securitize part of their loan portfolios and have proven increasingly capable of obtaining financing directly from financial markets has rendered the bank lending channel of monetary policy less effective in normal times. Another probable reason for the change in the effectiveness is the change in conduct of monetary policy. Lastly fundamental structural changes affecting the economy's stability.

However, with the deregulation of financial markets and monetary policy more oriented towards market based operations in developing countries, especially in Sub-Saharan Africa, there has been an increased interest in understanding how developing economies respond to monetary shocks. Montiel (1991) studied the transmission mechanism for monetary policy in developing countries. He analyzed how changes in monetary policy instrument are transmitted to domestic aggregate demand in a financially repressed economy using partial and general equilibrium models. He identified additional channels than the primary interest rate channel that play important role in monetary transmission mechanism in developing countries. These include the wealth effects induced by changes in the degree of financial repression, as well as effects on the free exchange

market, through changes in the expectations of future inflation, and through changes in the economy's net foreign asset.

Another example of a study done on a developing country is Muhammad and Munir (2010) investigating the effects of monetary policy shocks on prices and other macroeconomic variables in Pakistan. The authors used a structural vector autoregressive (SVAR) model approach to study the period 1992 to 2008. The macroeconomic variables used in the study included output, inflation, exchange rates and monetary supply. They found out that a contractionary monetary policy leads to a persistent rise in prices. We would expect tightening of monetary policy to reduce the price level and not increase it but this is not the case for the 48 month period. Their findings also suggest that monetary policy shocks are not the main cause of fluctuations of output in Pakistan. On the other hand, they found out that contractionary monetary policy over the period studied was associated with persistent depreciation of the domestic currency value relative to the US dollar. They concluded that monetary policy stance should not be the only solution to inflation but also include fiscal policies as their monetary stances are not transmitted effectively to the economy.

Many studies have been carried out to investigate the effectiveness of various channels in different countries. This study focuses on the interest rate channel. There are different views on the effectiveness of the interest rate channel. An examples of a studies done on the interest rate channel is Kalikeka and Sheefani(2013) and Kovanen (2011).

Kalikeka and Sheefani (2013) studied the interest rate channel and monetary transmission in Zambia with particular focus on the interest rate channel. The study used a VAR approach to analyze annual data for the period 1980 to 2011. The variables used were GDP, CPI and interest rates. The study also employed other time series techniques namely the unit root tests, co-integration, Granger causality tests, and impulse response and forecast error variance decomposition. The results for the co-integration tests showed that co-integration exists therefore he they used error correction model (VECM). The granger causality tests showed that the lending rate and CPI can predict each other. The GDP is able to predict the interest rates and not the interest rates predicting GDP. Looking at the impulse response, output responded negative to monetary policy and the rate of inflation had an inverse relationship with interest rates. However this effects are not permanents and the GDP converges to the steady state in the long run. The forecast error variance showed that CPI was attributable to itself and while GDP was largely attributable to itself

with a significant contribution to CPI and no contribution to the rate of interest. On the other hand in forecasting the rate of interest, it was found out that the rate of interest was largely attributable to itself, with a successive increase in CPI and GDP. The results from this study provides evidence of the interest rate channel existence in Zambia. Their findings are similar to that of. Abayomi and Toyin (2014)

Abayomi and Toyin (2014) studied the impact of the Interest rate channel of monetary policy on output and prices in Nigeria. They used an unrestricted VAR approach on two periods 1986Q1-1999Q1 and 1999Q2-2012Q4. They found out that the interest rate channel exists in Nigeria in both periods but was more effective in the latter period. They concluded that the use of monetary policy to control real output and domestic prices is evolving in a developing country like Nigeria. This implies an improvement in the interest rate channel as a measure of monetary policy because it enhances the management and integration of the Nigerian financial system.

On the other hand, Kovanen (2011) studies monetary transmission in Ghana mainly focusing on the interest rate channel. The author used time series and bank specific data to highlight the linkage between policy, wholesale market (interbank and Treasury bill rates) and the retail market interest rates. They found out that responses to changes in the policy interest rate are gradual in the whole sale market. Prolonged deviations in the interbank interest rate from the prime rate would weaken the effectiveness of Bank of Ghana's monetary policy implementation. They concluded that asymmetries in the wholesale market adjustment possibly relate to monetary policy signaling, weak policy credibility, and liquidity management. Their results showed that banks retail interest rates adjust to changes in the wholesale market rate but the speed in slower and the adjustment is slower in the long-run.

Since this study focuses on the Kenyan economy, this section looks at studies done in the region. Davoodi, Dixit and Pinter (2013) investigated monetary policy transmission in the East African Community which include Kenya, Tanzania, Uganda, Burundi and Rwanda. They studied the data using the VAR model investigating the period 1999 to 2013. The study sought to find if monetary policy stances is transmitted to the economy by affecting inflation and output. The found out that monetary policy transmission tends to be generally weak when it comes to standard statistical inferences but somehow strong when using non statistical inference methods. They found out that monetary transmission mechanisms are present in the EAC but the precise transmission channels

and their importance differ across countries, The monetary policy instruments mostly used, the reserve requirements and the policy rates sometimes exert offsetting expansionary and contractionary effects on inflation posing challenges to harmonization of policies across the EAC and transition future East African Monetary Union.

In Kenya, Cheng' (2006) examined the impact of monetary policy shock on real output, price and the nominal effective exchange rate. He sought to find out how the monetary policy shocks affect the variables and how much variations in the short-term interest rates account for their fluctuations. The author used vector auto regression techniques (VAR) to analyze the monetary policy transmission mechanism in Kenya for the period 1997-2005. He found out that there is a weak transmission mechanism from monetary stance to real variables showing a weakness in the financial markets. The findings suggest that an exogenous, unexpected and rise in the CBK's REPO rate tends to be followed by nominal appreciation and falling prices, with impact on output being insignificant. The weaknesses included inadequate financial infrastructure and weak legal framework. He explained that in a contractionary monetary stance, a rise in interest rates makes domestic assets more profitable compared to foreign assets resulting to capital inflows thus exerting appreciating pressure on the exchange rate. The domestic currency becomes stronger making imports cheaper, thus easing inflation.

Following the weaknesses raised in Kenya's financial sector raised, Misati (2010) studied the effects on financial innovation on the monetary policy transmission mechanism focusing on the interest rate channel through which the central bank implements monetary policy. The paper used Two stage least squares (2SLS) and monthly data covering the period 1996-2007. Using banking assets to GDP ratio and M3/M1 as indicators of financial innovation, he established that financial innovation has implications for monetary policy and thus for output. Normally interest rates have a negative effect on output but with financial innovation this is reversed implying that the Central banks actions through the interest rate channel is weakened. The paper concludes that financial innovation poses a challenge to the conduct of monetary policy which would raise need for constant revision of the policy and instruments, targeting frameworks and operating procedures to enhance monetary policy effectiveness.

Gitonga (2013) studied the impact of interest rate channel of monetary transmission mechanism in executing monetary policies in Kenya during the period 2005-2013. The study employed a VAR

methodology using impulse response graphs and variance decomposition to test the relative impact of the different variables. The variables used were repo rate, nominal effective exchange rate (NEER), M3, Consumer price index (CPI), GDP and savings, which data sets were quarterly. He found out that there is a long run relationship between the nominal effective exchange rate and GDP although savings, M3 and CPI are not as strong. The study suggests that the interest rate channel is effective in the long run. His results differ with Cheng' (2006) whose results suggested that there is insignificant influence of the monetary transmission shock to the GDP of Kenya.

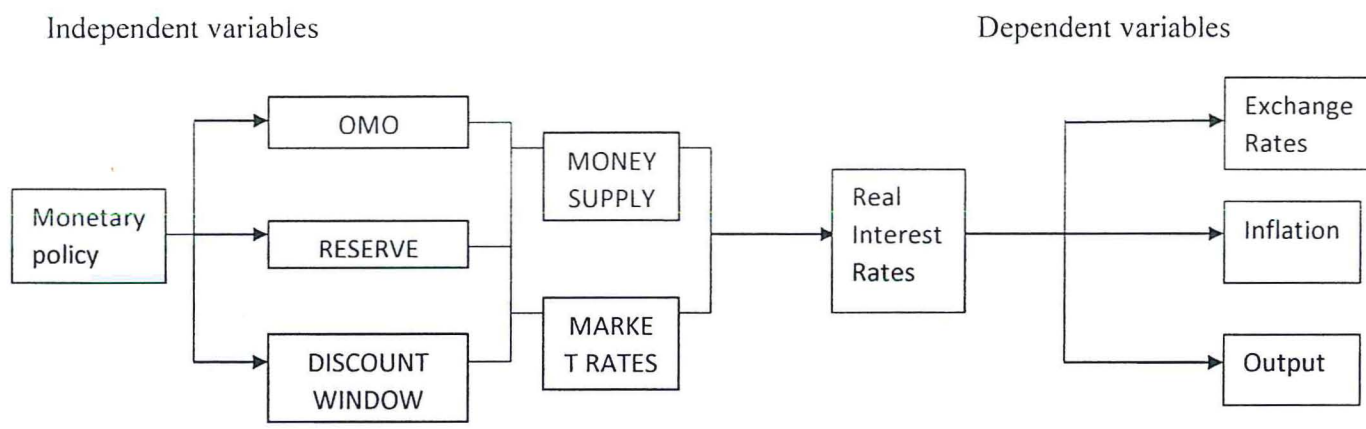
#### 2.4 RESEARCH GAP

Literature show that different instruments have a different effect on output and inflation, most of it contradicts expectations derived from theory. There is lack of consensus as to the channels through which some of macroeconomic policy actions affect economic growth. This section has discussed some of those studies in Kenya. Some of which argue that there is insignificant effect on output thus this study aims to bridge this gap with focus on the interest rate channel. There is also limited literature on the long-run effects of financial innovations on the interest rate channel as the Kenyan economy grows more dynamic and diversified.

#### 2.5 THEORETICAL FRAMEWORK

The aim of monetary policy is to create price stability, stable exchange rates and increase output. This study uses a framework similar to that of Mishkin (1996). It illustrates steps in which of the interest rate channel in monetary policy transmission. The first step of the interest rate channel is the impact of policy interest rates on market interest rates, then the market interest rates affect the real rates and the real sector (prices and output).

Policy actions of the monetary authorities in the current period cause changes in the money market rates. Changes in these rates in turn affect investment decisions (goods and labour markets) and ultimately the aggregate output and general price level.



## 2.6 RESEARCH HYPOTHESIS

The research hypothesis are:

H<sub>01</sub>: There is an effect of the interest rate channel on output

H<sub>A1</sub>: There is no effect of interest rate channel on output

H<sub>02</sub>: There is effect of interest rate channel to inflation

H<sub>A2</sub>: There is no effect of interest rate channel on inflation

### 3. METHODOLOGY

#### 3.1 RESEARCH DESIGN

This study employs an exploratory research design in order to assess the effectiveness of the interest rate channel as a monetary transmission mechanism in Kenya. This is in line with the main objective of the study. Vector autoregressive models (VAR) are used to capture linear interdependencies among multiple time series. Most empirical studies covering the monetary policy transmission have used the VAR model. Chow (2014) argued that the use of the VAR approach gives two main advantages. First, the VAR model explicitly allows for the endogeneity of variables, thereby accommodating the interdependence between monetary policy and economic developments. Second, as opposed to a large-scale fully specified structural model, the VAR analysis focuses on reduced form relationships and thus only requires a simple model with a small number of variables. Lutkepohl and Kratzig (2004)

#### 3.2 DATA SOURCES AND COLLECTION

This study is dependent on secondary data which include the time series data of CPI, output (GDP), central bank rate (CBR), Treasury bill rates and the exchange rates. All these data was collected from the central bank of Kenya (CBK) and Kenya national bureau of statistics (KNBS).

The study will use monthly data covering the period between 1996 and 2015 with 80 observations.

The table below shows a detailed description of each variable.

Table 1: Detailed description of each variable

VARIABLE	DESCRIPTION / MEASUREMENT	SOURCE
Gross domestic product (GDP)	This represents the monetary value of goods and services produced in an economy within a specific period of time. It is usually quarterly but this study will	Kenya National Bureau of statistics (KNBS) website on Facts and figures (2015).

	<p>adjust/interpolate it into monthly data sets.</p> <p>It will be expressed in logarithm form.</p>	
Central Bank rate (CBR)	<p>The CBR in Kenya is the base for all monetary policy operations in order to enhance clarity and certainty in monetary policy implementation. Whenever the central bank is injecting liquidity through a reverse repo, the CBR is the lowest acceptable rate by law. Also whenever the bank wishes to withdraw liquidity through a vertical repo the CBR is the highest rate that the CBK will pay on any bid received. This will be in monthly frequency</p>	Central Bank of Kenya (CBK) website
Consumer Price index (CPI)	<p>This is used to measure inflation, whereby inflation refers to the changes in price level over time. Interest rates generally have a direct relationship with inflation affecting both consumption and investments. This study will use monthly CPI indices with 2009 as the base year It</p>	Central Bank of Kenya (CBK) website on Macroeconomic statistics.

	will be expressed in logarithmic form	
91-day treasury bill rate	It is used as the short term interest rate and money market rate.	Central bank of Kenya (CBK) website.
United States Dollar (US\$)/ Kenya shilling exchange rate	This is the world currency and most international trade (over 65% of Kenya's trade with rest of world) is transacted using the US \$.  This will be adjusted to be monthly at the beginning of each period. It will be expressed in logarithmic form	Central bank of Kenya (CBK) Website on macroeconomic statistics.

### 3.3 MODEL SPECIFICATION

This study adopts a multivariate time series analysis, in particular Vector autoregressive model used by Kalikeka and Shefeni (2013) where the author examines the interest rate channel of monetary policy transmission in the case of Zambia. A VAR model describes the evolution of a set of k variables over the same sample period as a linear function of only their past values. Consider k- dimensional time series:

$$\alpha_0 Y_t = \alpha_1 Y_{t-1} + \dots + \alpha_k Y_{t-k} + \varepsilon_t$$

Where  $Y_t$  denotes  $k \times 1$  vector of endogenous variables.  $\varepsilon_t$  is a vector of exogenous variables.  $\alpha_0, \alpha_1, \dots, \alpha_k$  represents  $k \times k$  matrices of the structural VAR form. The model can be written more compactly with the lag operator L:

$$\alpha(L)Y_t = \varepsilon_t$$

Where  $\alpha(L)Y_t = \alpha_0 - \alpha_1 L - \alpha_2 L^2 - \dots - \alpha_k L^k$  is the autoregressive lag or polynomial. The variance-covariance matrix of the structural error term  $\varepsilon_t$  is normalized:

$$E(\varepsilon_t \varepsilon_t') = \sum \varepsilon = I_k$$

This shows that the model includes as many shocks as the variables.  $\sum \varepsilon$  is a diagonal matrix meaning that the structural shocks are not correlated with each other within the same period. The equation also shows that the variance of the structural shocks are normalized to 1. In order to estimate the structural model, it is necessary to derive the reduced form representation by expressing  $Y_t$  as a function of its own lags only.

Multiply both sides of the original equation by  $\alpha_0^{-1}$  which results to:

$$\alpha_0^{-1} \alpha_0 Y_t = \alpha_0^{-1} \alpha_1 Y_{t-1} + \dots + \alpha_0^{-1} \alpha_p Y_{t-k} + \alpha_0^{-1} \varepsilon_t$$

Thus, we obtain the reduced form of the VAR:

$$Y_t = \varphi_1 Y_{t-1} + \dots + \varphi_k Y_{t-k} + e_t$$

Where  $\varphi_t = \alpha_0^{-1} \alpha_t$   $t=1, 2, \dots, k$ ;  $e_t = \alpha_0^{-1} \varepsilon_t$

The model can be written as

$$\varphi(L)Y_t = e_t$$

Where,  $\varphi(L) = \varphi_0 - \varphi_1 L - \varphi_2 L^2 - \dots - \varphi_k L^k$ , is the autoregressive lag polynomial.

The main aim is to derive the impulse response function (IRF) for each of the structural shocks  $\varepsilon_t$ . Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. The standard evaluations methods facilitate calculation of the reduced form parameters:  $A_t$   $t = 1, 2, \dots, k$ , errors  $e_t$  and the covariance matrix. Though  $e_t$  represents a linear combination of structural shocks  $\varepsilon_t$  and there is no economic content behind them. In order to compute the structural parameters, we need to know  $\alpha_t$ .

The expression  $\varphi(L)Y_t = e_t$  is a common VAR specification because many macroeconomic time series appear to have a unit root.. Each variable is a function of lagged values of variables, which makes the VAR a general dynamic specification. This generality, however, comes at a cost. Because each equation has many lags of each variable, the set of variables must not be too large.

Otherwise, the model would exhaust the available data. If all shocks have unit roots,  $\varphi(L)Y_t = e_t$  is estimated.

Under the assumption that  $Y_t$  is stationary, the reduced form model polynomial can be inverted:

$$Y_t = \varphi(L)^{-1}e_t$$

Thus we get the infinite-order moving average representation for vector auto-regression:

$$\sum_{i=1}^{\infty} \tau_i \varepsilon_{t-i}$$

Matrices  $\tau_i$  represent the impulse response functions and can be written as:

$$\tau_i = \frac{\partial y_t}{\partial \varepsilon_{t-i}}$$

Identification of structural shocks is based on the introduction of restrictions of the matrix  $\alpha_0$ . We accept the diagonal elements of the matrix  $\alpha_0$  in the equation  $e_t = \alpha_0^{-1} \varepsilon_t$  equal unity. In this case  $\alpha_0$  is a lower triangular matrix and hence  $\alpha_0^{-1}$  is a lower triangular matrix as well.

The study will also carry out variance decompositions. It apportions variance of one variable to variations in other variables as well as itself.. A shock to the  $i$  the variable will directly affect that variable, but it will also be transmitted to all of the other variables in the system through the dynamic structure of the VAR. Variance decompositions determine how much of the  $s$  - step-ahead forecast error variance of a given variable is explained by innovations to each explanatory variable for  $s = 1, 2, \dots$

The focus of this study is to estimate the effectiveness of the interest rate channel of monetary policy transmission. In order to assess the monetary transmission process, the empirical model for interest rate channel is constructed. The vector of endogenous variables for the interest rate channel model includes:

$$Y_t = (\Delta GDP_t \Delta CP_t IR)$$

Where  $\Delta GDP_t$  –output growth,  $\Delta CP_t$  is the rate of inflation,  $IR$  is the short term interest rate, represented by the central bank rate.

### 3.3.1 COINTEGRATION ANALYSIS.

Before estimation of the VAR model we need to identify if the variables have a true long run causal relationships, and if so their behavior over time will be systematically related. Cointegration would then be useful to VAR by identifying long run properties thus will need to differentiate the long run properties from the short dynamic process of adjustment to equilibrium by use of error correction models.

Let  $Y_t = (y_{1t}, \dots, y_{nt})'$  denote an  $(n \times 1)$  vector of  $I(1)$  time series.  $Y_t$  is co-integrated if there exists an  $(n \times 1)$  vector  $\beta = (\beta_1 \dots \beta_n)'$  such that

$$\beta' Y_t = \beta_1 y_{1t} + \dots + \beta_n y_{nt} \sim I(0)$$

Therefore the non-stationary time series in  $Y_t$  are co-integrated if there is a linear combination of them that is stationary or  $I(0)$ . If some elements of  $\beta$  are equal to zero then only the subset of the time series in  $Y_t$  with non-zero coefficients is co-integrated. If we have non-stationary data where there exists a true causal long run relationship between variables, then over time their behavior must somehow be systematically related. For two series to be co-integrated they must have comparable long run properties. Thus two series of different orders cannot be co-integrated. However in models with more than 2 variables, the requirement that the variables be integrated of the same order is modified. This is because the two series with higher orders of integration, may have a linear combination which is co-integrated of lower order that applies to the third series of the model.

If the  $(n \times 1)$  vector  $Y_t$  is co-integrated there may be  $0 < r < n$  linearly independent co-integrating vectors. For a model with  $n$  variables you can have  $n-1$  co-integrating relationships. Only for  $n=2$  will any co-integrating relationship be unique. Enders (2004)

This model uses Johansen test. This test permits more than one co-integrating relationship so it is more generally applicable than the Engle Granger test which is based on the Dickey-Fuller test for unit root in the residual from a single estimated co-integrating relationship. There are two types of Johansen test, either with trace or with eigenvalues (Enders, 2004). The null hypothesis for the trace test is the number of co-integrating vectors

$$H_0: \text{rank}(\Pi) = r_0$$

$$H1: r_0 < \text{rank}(\Pi) \leq n$$

The first non-rejection is taken as the estimate of  $r$ .

The test of maximum eigenvalue is a likelihood ratio test. The test statistic is

$$LR(r_0; r_0 + 1) = -T \ln(1 - \lambda_{r_0+1})$$

The null hypothesis for the maximum eigenvalue test is

$$H_0: \text{rank}(\Pi) = r_0$$

$$\text{rank}(\Pi) = r_0 + 1$$

If co-integrating relations are present in the system of variables, the VAR form is not the most convenient model setup. Thus it would be useful to consider specific parameterization that support the analysis of the co-integrating structure such as Vector Error correction models (VECM) Lutkepohl and Kratzig (2004). It is of the form

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \dots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t$$

Here  $\Pi = -(I_K - \alpha_1 - \dots - \alpha_p)$  and  $\Gamma_i = -(\alpha_{i+1} + \dots + \alpha_p)$ .

## 4. EMPIRICAL ANALYSIS AND RESULTS

### 4.1 INTRODUCTION

This chapter covers the analysis of the secondary data presentation and interpretation; the results from an unrestricted VAR analysis are also presented. In this chapter, the data was tested for stationarity of the variables and cointegration. This was followed by running of the VECM, the Impulse Response Function and Variance Decomposition

### 4.2 DESCRIPTIVE STATISTICS

Before the estimation of econometrics models it is necessary to view a summary for the series. The descriptive statistics of the variables in this study are presented in the table below.

	91DAY_TBILL	CBR	LN_CPI	LN_GDP	LN_USD
Mean	10.56162	0.126774	4.273535	5.733522	4.319806
Median	8.621667	0.104694	4.320655	5.713482	4.347209
Maximum	26.71000	0.297358	5.099925	6.153653	4.570234
Minimum	1.036667	0.038296	2.659176	5.384287	3.994371
Std. Dev.	6.306340	0.067699	0.582115	0.233341	0.131863
Skewness	1.014608	1.197992	-0.743190	0.248899	-0.732403
Kurtosis	3.406772	3.471180	3.257062	1.750746	2.891781
Jarque-Bera	14.27728	19.87584	7.584682	6.028126	7.191235
Probability	0.000794	0.000048	0.022543	0.049092	0.027444
Sum	844.9300	10.14192	341.8828	458.6817	345.5845
Sum Sq. Dev.	3141.824	0.362073	26.76973	4.301411	1.373632
Observations	80	80	80	80	80

Table 2: Descriptive statistics of the series

The positive skewness of the 91 day T-bill, CBR and LNGDP means that the distribution has a long right tail while the negative skewness of LN CPI and LN USD implies the distribution has a long left tail. The kurtosis of 91 day T-bill, CBR and LN CPI are greater than 3 implying that the distribution is peaked (leptokurtic) relative to the normal while LN GDP and LN USD are less than 3 implying that the distribution is flat (platykurtic) relative to the normal.

The Jarque-Bera on the other hand is a test for whether the series is normally distributed. This follows the rejection of the null hypothesis that the variables are normally distributed and conclude that the data is not normally distributed since Jarque-Bera probability is less than 5% p-value.

The graph below shows the trend of the variables between 1996 and 2015

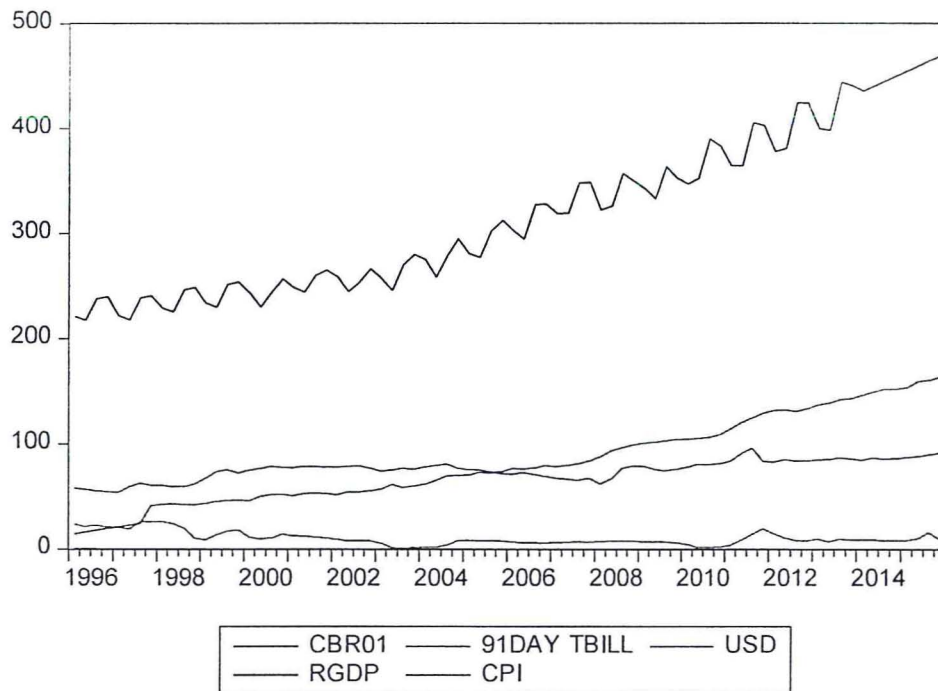


Figure 1: graph of trends of the series

### 4.3 UNIT ROOT

When estimating a model that includes time series it is important to ensure that the time series variables are stationary. This study uses a host of unit root test to test for stationarity conditions of the variables i.e to find the order of integration. Non-stationarity implies that the mean, variance and covariance are not constant over time. When data contains unit root it means any result accrue to such data will be spurious or nonsensical. This study will employ the Augmented Dickey Fuller (ADF) statistic for unit root in testing for stationarity and non-stationarity of the variables and determining their order of integration. The Augmented Dick Fuller (ADF) statistic involves estimating the following regression:

$$\Delta Y_t = \psi Y_{t-1} + \sum_{i=1}^m \alpha_i \Delta Y_{t-i} + u_t$$

Where  $u_t$  is a pure white noise error term and where  $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$  and  $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$  e.t.c. The number of lagged difference terms to include is usually determined empirically,

the idea being to include enough terms so that the error term is serially uncorrelated. The null and the alternative hypothesis will be:

$$H_0: \psi = 0$$

$$H_1: \psi < 0$$

The test statistic defined as

$$\text{test statistic} = \frac{\psi}{SE(\psi)}$$

If the test statistic is less than the critical value for the dickey fuller test, then the null hypothesis  $H_0: \psi = 0$  is rejected and no unit root is present. It can be concluded that the series is stationary.

If the data sets being used are non-stationary, then tests for co-integration will be applied.

To determine VAR in level form, it has to be stable, which means all the roots have to lie within the unit circle. However if it is not stable, VAR is estimated in first difference.

## CBR

### LEVEL FORM

Table 3: Unit root tests of all Variables

Null Hypothesis: CBR has a unit root  
 Exogenous: Constant, Linear Trend  
 Lag Length: 1 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.733830	0.2264
Test critical values: 1% level	-4.080021	
5% level	-3.468459	
10% level	-3.161067	

\*MacKinnon (1996) one-sided p-values.

### FIRST DIFFERENCE

Null Hypothesis: D(CBR) has a unit root  
 Exogenous: Constant, Linear Trend  
 Lag Length: 2 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.111827	0.0000
Test critical values: 1% level	-4.083355	
5% level	-3.470032	
10% level	-3.161982	

\*MacKinnon (1996) one-sided p-values.

### LN CPI

#### LEVEL FORM

Null Hypothesis: LN\_CPI\_ has a unit root  
 Exogenous: Constant, Linear Trend  
 Lag Length: 0 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.572683	0.0022
Test critical values: 1% level	-4.078420	
5% level	-3.467703	
10% level	-3.160627	

\*MacKinnon (1996) one-sided p-values.

### LN GDP

#### LEVEL FORM

Null Hypothesis: LN\_GDP\_ has a unit root  
 Exogenous: Constant, Linear Trend  
 Lag Length: 4 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.204300	0.4801
Test critical values: 1% level	-4.085092	
5% level	-3.470851	
10% level	-3.162458	

\*MacKinnon (1996) one-sided p-values.

#### FIRST DIFFERENCE

Null Hypothesis: D(LN\_GDP\_) has a unit root  
 Exogenous: Constant, Linear Trend  
 Lag Length: 3 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.235461	0.0003
Test critical values: 1% level	-4.085092	
5% level	-3.470851	
10% level	-3.162458	

\*MacKinnon (1996) one-sided p-values.

### LN USD

#### LEVEL FORM

Null Hypothesis: LN\_USD\_ has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.709171	0.2360
Test critical values: 1% level	-4.080021	
5% level	-3.468459	
10% level	-3.161067	

\*MacKinnon (1996) one-sided p-values.

#### FIRST DIFFERENCE

Null Hypothesis: D(LN\_USD\_) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.355661	0.0000
Test critical values: 1% level	-4.081666	
5% level	-3.469235	
10% level	-3.161518	

\*MacKinnon (1996) one-sided p-values.

### 91 DAY TBILL

#### LEVEL FORM

Null Hypothesis: \_91DAY\_TBILL has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.028714	0.1312
Test critical values: 1% level	-4.080021	
5% level	-3.468459	
10% level	-3.161067	

\*MacKinnon (1996) one-sided p-values.

#### FIRST DIFFERENCE

Null Hypothesis: D(\_91DAY\_TBILL) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 2 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.000624	0.0000
Test critical values: 1% level	-4.083355	
5% level	-3.470032	
10% level	-3.161982	

\*MacKinnon (1996) one-sided p-values.

The tables shows that CBR, 91 day T-bill, LN GDP and LN USD were found to be non-stationary in level form while LN CPI was stationary in level form. After differencing them the series became stationary. Therefore 91 day T-bill, CBR, LNGDP and LN USD are integrated of degree one I (1) while LN CPI is integrated of order I(0)

This is different from the results of Kalikeka and Sheefeni (2013) where their series were found to be non-stationary in level form. After differencing them, the test statistic showed that the Interest Rate (IR) and Consumer Price Index (CPI) became stationary. However, their study proceeds to the second difference for Gross Domestic Product (GDP) to become stationary.

#### 4.4 CO-INTEGRATION TEST

Co-integration is defined as the concept that mimics the long-run equilibrium relationship among variables.

Before estimation of the VAR model we need to identify if the variables have a true long run causal relationships, and if so their behavior over time will be systematically related. The Johansen approach recognizes both the importance of relationships between the variables included in the system in levels, thereby allowing us to obtain an intimation of the equilibrium relationship between the variables and the evolution of the system of variables over subsequent time periods thereby allowing us to capture the characteristics of the short run dynamics of the system at the same time as estimating a long run equilibrium relationship. If there is co-integration in the relationship among the variables, it can be re-parameterized as an Error-Correction Model (ECM) which will contain both short and long-run effects.

The results for Johansen co-integration test based on trace and maximum Eigenvalue test statistics are presented below.

Table 4: Johansen cointegration test on eviews

Date: 11/22/16 Time: 23:04  
 Sample (adjusted): 1997Q2 2015Q4  
 Included observations: 75 after adjustments  
 Trend assumption: Linear deterministic trend (restricted)  
 Series: \_91DAY\_TBILL CBR LN\_GDP\_LN\_USD\_  
 Exogenous series: LN\_CPI\_  
 Warning: Critical values assume no exogenous series  
 Lags interval (in first differences): 1 to 4

##### Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.411490	81.81351	63.87610	0.0008
At most 1	0.300373	42.05146	42.91525	0.0609
At most 2	0.123104	15.26090	25.87211	0.5529
At most 3	0.069573	5.408359	12.51798	0.5388

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.411490	39.76204	32.11832	0.0048
At most 1 *	0.300373	26.79057	25.82321	0.0372
At most 2	0.123104	9.852539	19.38704	0.6346
At most 3	0.069573	5.408359	12.51798	0.5388

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

The results for maximum Eigen values test statistics show at least two test statistics which are greater than 95% critical value indicating that there are two cointegrating equations. On the other hand, the results for trace test statistics indicate 1 co-integrating equations. This follows rejecting the null hypothesis of no cointegration of variables at 5%. The trace test statistic is used in this case because it is termed to be specific and not general. After determining that cointegration is present the study proceeds by estimating data with Vector Error Correction Model (VECM) in order to help isolate the long run effects into the error correction term so that the coefficients generated would only capture short run effects.

This results are different to that of Mbewe Kalikeka (2013) as they found 3 co-integrating equations from the trace tests while the max Eigen values indicated 1 co-integrating equation. They preferred the trace tests to the maximum Eigen valued as it is termed to be more specific and not general. On the other hand Gichuki (2012) found in their model there exists at least one co-integrating relationship at 5% level of significance between monetary aggregates, GDP, and overdraft rates. Both studies also proceeded to use the Vector error correction model.

#### 4.5 VAR ANALYSIS

Vector autoregressive models (VAR) are used to capture linear interdependencies among multiple time series. However, given large number of variables it may be difficult to interpret thus the use of impulse responses and variance decompositions

#### 4.5.1 IMPULSE RESPONSE FUNCTION

Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to the error term. A unit shock is applied to each variable and its effects are noted. The response of GDP and CPI to changes in CBR in the short run is presented in the graphs below.

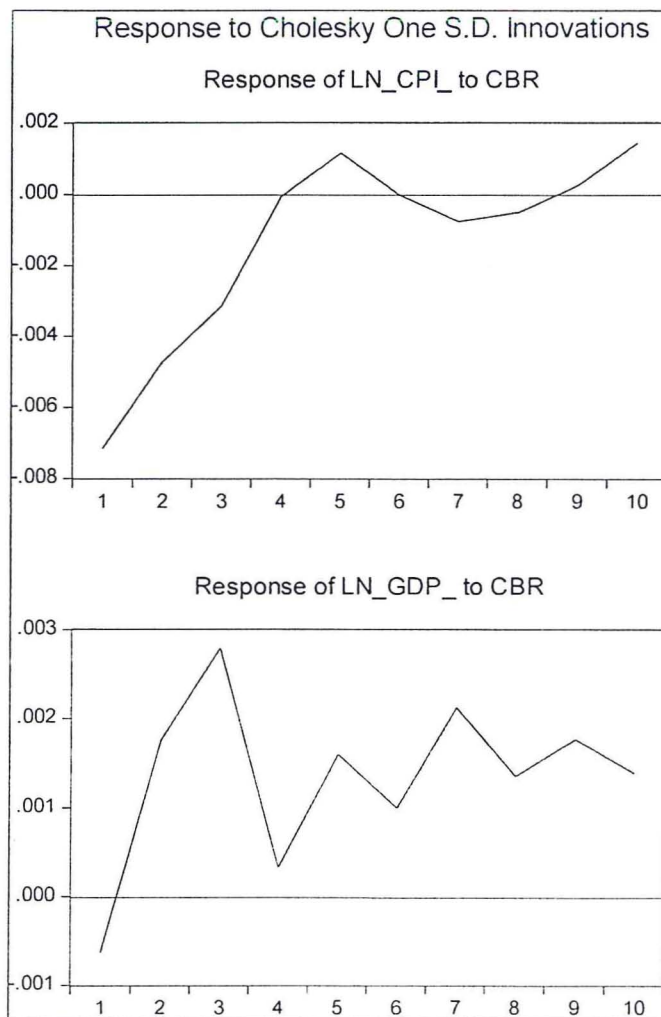


Figure 1 Impulse response tests results on eviews

CPI responds negatively to CBR, but the impact decays gradually to the fourth term. The impulse response test for GDP indicates it responds positively to CBR which is seen after the third time period. An upward adjustment in CBR starts to significantly constrain growth only after three quarters but this impact is not sustained beyond the fourth quarter. In this case, the interest rate

channel of monetary policy is proving to be effective since the Central bank rate (CBR) is able to transmit effects on output and prices but its effectiveness is with the lags above.

This is similar to the results of Kalikeka (2013) who found the interest rate channel to be effective, since interest rate is able to transmit effects on output and prices. Their impulse response tests showed that the effects of shocks are transitory on GDP and die out in the short run. CPI decreased as interest rate increased and the short term effects die out sooner compared to permanent price effects which remain relentless in the long run. Bhuiyan (2012) found that monetary policy in Canada affects the real economy through both the market interest rate and the exchange rate: a contractionary policy shock almost immediately increases the market interest rate and appreciates the Canadian dollar; the policy shock then lowers output with a lag and prices with a further lag.

#### 4.5.2 VARIANCE DECOMPOSITION

On the other hand variance decomposition examines dynamics by giving the proportion of the movements in the dependent variables that are due to their “own” shocks, versus shocks to the other variables. The table below shows results for variance decomposition which are presented over a 10 quarters forecasting horizon. This provides the relative importance of random innovation in affecting the variables in the VAR.

Table 5 Variance decomposition results on Eviews

Variance Decomposition of LN_CPI_:						
Period	S.E.	_91DAY_TBILL	CBR	LN_CPI_	LN_GDP_	LN_USD_
1	2.127702	0.501298	1.845610	97.65309	0.000000	0.000000
2	2.921337	4.208530	1.755363	93.21702	0.030743	0.788339
3	3.580852	3.725706	1.678263	86.10551	0.027129	8.463392
4	4.060274	3.689157	1.608394	83.77494	0.063227	10.86428
5	4.693235	3.707054	1.582199	81.29100	0.078434	13.34131
6	5.131081	3.890515	1.564268	80.36961	0.416215	13.75939
7	5.447188	3.918859	1.564771	80.01905	0.708170	13.78915
8	5.692253	3.892983	1.551605	79.32845	1.074709	14.15225
9	5.934816	3.840058	1.531718	78.64161	1.447743	14.53887
10	6.133622	3.801849	1.528155	77.00647	2.455393	15.20814

Variance Decomposition of LN_GDP_:						
Period	S.E.	_91DAY_TBILL	CBR	LN_CPI_	LN_GDP_	LN_USD_
1	0.020035	2.832122	0.084262	0.594530	96.48909	0.000000
2	0.029599	2.935660	0.576247	0.599407	95.88603	0.002657
3	0.038702	7.230521	1.693451	1.425996	89.53458	0.115451
4	0.044392	13.36323	1.456987	5.600496	79.00439	0.574895
5	0.050523	10.66851	1.108152	3.707809	81.85858	2.656949
6	0.054568	10.35995	1.045323	3.332438	82.11655	3.145739
7	0.058323	13.06183	1.296554	3.204382	79.33854	3.098692
8	0.061196	17.03714	1.302279	4.063172	74.66854	2.928870
9	0.064070	15.28864	1.184433	3.519088	76.91017	3.097672
10	0.066544	14.72561	1.175226	3.269163	77.74413	3.085874

Cholesky  
Ordering:  
\_91DAY\_TBILL  
L CBR  
LN\_CPI\_  
LN\_GDP\_  
LN\_USD\_

The results that of all variations in CPI, own variations account for up to 97.7% and up to 77% in tenth quarter. CBR accounts for 1.84% in the first quarter and gradually decreases in the other periods to 1.53% in the tenth quarter.

The variance decomposition for GDP showed that out of all variations in GDP, own variations account for up to 96.48% in the first quarter, and up to 79.00% in the fourth quarter. CBR accounts for 0.08% in the first quarter but this grows to 1.69% by the third quarter

This is similar to what Kalikeka (2013) study in Zambia where he found that fluctuations in forecasting CPI are mostly attributed to itself which tend to be persistent even after 10 years with insignificant contributions by GDP and Interest rates. The error in the forecast of GDP in the first period was greatly dominated by itself but with a significant contribution attributed to CPI of 19.8% but no contribution from IR.

This is different from the results of Bhuiyan (2012) in the variance decomposition of the Canadian GDP. He found out that monetary policy shock is not the dominant source of output fluctuations in Canada at any horizon. Among domestic shocks, those from the exchange rate and from domestic GDP itself are the primary sources of output fluctuations. On the other hand, external shocks become the dominant source of output fluctuations after twelve months. For Davoodi, Dixit and Pinter (2013) in variance decomposition of the East African economies found that changes in output are more due to shocks to reserve money than to the interest rate. This is mostly seen in Uganda and Rwanda. Inflation is more due to shocks to the interest rate than shocks to reserve money. This is mostly seen Tanzania and Uganda.

## 5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

### 5.1 SUMMARY OF FINDINGS

From the impulse response tests, the interest rate channel of monetary policy is proved to be effective since the Central bank rate (CBR) is able to transmit effects on output and prices but its effectiveness is with the four lags for CPI and three lags for GDP.

The forecast error variance decomposition show that in forecasting CPI, all fluctuations were attributed to itself, with decreasing significant contribution from CBR in the long run. Forecasting GDP showed that GDP fluctuations were greatly denominated by itself, however in the long run there was significant contribution in the other variables.

### 5.2 CONCLUSION

The objective of this study was to determine if the interest rate channel was effective in transmitting shocks to prices and output. The variables used in the study were GDP, CPI and CBR for the periods 1996 to 2015. The study employed VECM because co-integration was found to be present among the variables.

From the findings it follows the failure to reject the first null hypothesis that there is an effect of the interest rate channel on output. This is seen from the impulse response test where the CBR is able to transmit an effect but its effectiveness is with 3 lags however the variance decomposition shows that CBR contributes 0.08% in the first quarter but grows to 1.69% in the third quarter

We also fail to reject the second null hypothesis that there is effect of the interest rate channel on inflation. This is seen from the impulse response tests where CBR is able to transmit an effect on inflation but its effectiveness being on the fourth lag however the variance decomposition shows that the CBR accounts for 1.84% in the first quarter but decreases up to 1.53% in the tenth quarter.

Therefore the interest rate channel of monetary policy is proving to be effective since the Central Bank Rate is able to transmit effects on output and prices but its effectiveness is with the lags above. In general, the results show that the interest rate channel of monetary policy transmission is effective in Kenya.

### 5.3 RECOMMENDATIONS

Based on the empirical finding of this paper, recommendations to the Central Bank of Kenya is that it should continue to use interest rates as a monetary policy tool since interest rates are able to transmit effects to the general price level.

There is need for the CBK harmonize and combine the functionality of all channels to achieve optimum output goals of monetary transmission mechanism. These channels include the asset channel, the credit channel and the exchange rate channel. This could be complemented with adoption of one policy rate used to signal the market and by so doing will reduce on duplication of activities by different rates and lead to optimum outcomes of monetary policy goals.

In response to financial innovation, the CBK should combine other transmission channels of monetary policy to achieve optimum policy outcome as opposed to concentrating on single channel. By so doing, financial innovation may dampen the interest rate channel as argues by previous literature but through other channels it might be responsive.

The CBK can also use other factors that can be used to control inflation and output other than monetary tools. For example diversification of energy sources, mechanization of agriculture and engaging in hedging activities so as to prevent the economy from price shocks resulting from fluctuation in oil prices. These could help in maintaining inflationary levels at a rate below the government recommended rate.

There is also need for constant revision of policy and instruments targeting framework and operating procedure in order to enhance monetary policy effectiveness in keeping inflation levels at the generally recommended rate.

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