EFFECTIVENESS OF MONETARY POLICY ON INFLATION CONTROL AND ECONOMIC GROWTH IN KENYA: AN APPLICATION OF FACTOR AUGMENTED VECTOR AUTOREGRESSIVE MODEL

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DECLARATION

This research project is my original work and has not been presented for a degree in in any university or for any other award.

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Reg No: K102/37080/2016

This research project has been submitted for examination to the Department of Econometrics and Statistics, School of Economics, Kenyatta University, with my approval as the university supervisor.

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To my mentor and friend Dr. Jennifer Njaramba.

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ACRONYMS

ARDL	Autoregressive Distributed Lag Model
CB	Central Bank
CBK	Central Bank of Kenya
CBR	Central Bank Rate
CPI	Consumer Price Index
FAVAR	Factor Augmented Vector Autoregressive Model
GDP	Gross Domestic Product
IMF	International Monetary Fund
IT	Inflation Targeting
KNBS	Kenya National Bureau of Statistics
LICs	Low Income Countries
MAT	Monetary Aggregate Targeting
MP	Monetary Policy
MPC	Monetary Policy Committee
NDA	Net Domestic Assets
NFA	Net Foreign Assets
NKE	New Keynesian School
OMO	Open Market Operations
PCA	Principle Component Analysis
RBC	Real Business Cycle
REO	Regional Economic Outlook
RGDP	Real Gross Domestic Product
REPO	Repurchase Agreement
SSA	Sub-Saharan Africa
SVAR	Structural Vector Autoregressive Model
VAR	Vector Autoregressive Model

OPERATIONAL DEFINITION OF TERMS

Calvo Pricing: Is an exogenous, time-dependent strategy used for modelling price stickiness.

Central Bank Rate: It is the least rate of interest that is charged to commercial banks on loans by the Central Banks.

Interbank Overnight Lending: Refers to buying and selling of funds required in order to meet a reserve requirement as the trading day ends.

Monetary Policy: Refers to a set of measures and procedures taken by the monetary authorities to manage amount of money in circulation, interest rate and exchange.

Open Market Operation: They are actions taken by the monetary authorities through sale and purchase of securities with an aim of regulating money supply and the condition of credit.

Price Puzzle: Refers to a situation where tightening of monetary policy increases general price level instead of decreasing it contrary to theory.

Principle Component Analysis: It is a tool used to reduce a large set of variables to a small set but still containing most of the information in the large set

Repo Rate Innovations: Refers to changes in the rate at which the central bank lends money to commercial banks in the event of any shortfall of funds.

Reserve Requirement: It refers to the percentage of commercial bank's deposit liability deposited at Central Bank.

Vector Autoregressive Model: The VAR is an econometric model where all variables are treated as endogenous and regressed as a function of the lagged values of all endogenous variables in the model.

ABSTRACT

The question of the effectiveness of monetary policy (MP) on inflation control and economic growth is a long-standing issue in the literature of monetary policy. Despite immense research, most researchers and policy makers still remain divided on effectiveness of monetary policy and the appropriate choice of monetary policy instruments, targets and framework. This follows enormous divide in empirical findings on the subject in both developed as well as developing countries. This problem is more pronounced in developing countries which not only have underdeveloped financial markets but also lack appropriate tool to model their economies. This study seeks to complement existing literature by further examining effectiveness of monetary policy in Kenya using a Factor Augmented Vector Autoregressive Model (FAVAR) 1997 to 2015. The study examines the role of money supply, exchange rate and the repo rate in the inflation and real sector dynamics. The specific objectives were to determine the impact of repo rate innovations on price stability and Gross Domestic Product (GDP), the relationship between Money Supply, price stability and GDP and the effect of exchange rate fluctuations on price stability and GDP. A FAVAR model has several advantages; first it can handle poor quality data and is able to control for little information problem. The study found that repo rate has a negative effect on inflation. The response of inflation is instantaneous and the decrease in inflation only recover at seventh quarter. The study also found that money supply, price stability and GDP have a long run relationship. However, the study found that exchange rate fluctuations had insignificant effect on price stability and that the effect of exchange rate fluctuations on GDP was unstable, oscillating form negative to positive. The study concludes that repo rate is effective in controlling inflation but ineffective in stimulating economic growth. Therefore, the finding implies that Central Bank of Kenya (CBK) should use repo rate to control inflation. The study also shows that there exists a long run relationship between GDP, money supply and inflation implying that the Central Bank of Kenya should take into consideration the long run impact on GDP when designing tools to control inflation. The study findings also imply that exchange rate is not an effective monetary policy tools to control inflation and stimulate GDP growth. Hence, the CBK should not target exchange rate in the management of the economy.

CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Monetary policy (MP) refers to any action taken by the monetary authorities to vary the quantity of money available or the money cost (Shaw 1973). The Central Bank of Kenya's (CBK), monetary committee on the other hand describes monetary policy as actions undertaken by the monetary authorities to affect the amount of money to realize low and stable prices, full employment and economic growth (Central Bank of Kenya, 2012).

Most central banks' major goal is to maintain the internal and external value of the domestic currency. In the domestic economy, the aim is to keep inflation low and stable. Other monetary policy objectives include; the management of multiple monetary targets, promoting economic growth, attaining full employment, smoothing out business cycle, evading financial crises, stabilizing long-term interest rates and real exchange rate (Kahn, 2010).

Proper functioning of a market-based economy requires that prices should be stable since price stability encourages long-term investments and stability. To achieve its objectives, MP implementation focuses on use of operating targets, instruments and also policy goals. The variables which the Central Bank (CB) controls directly are called instruments. They include interest charges on cash borrowed from central bank by commercial banks, the reserve requirement ratio which determines the amount of reserve held by commercial banks against deposit and also the structure of the CB's own balance sheet. The instruments of MP are altered in order to achieve preferred values of an operating target (Walsh, 2010).

Globally, policy frameworks under which CBK's work in the recent decade have been subject to major changes. Monetary aggregate targets, Exchange rate pegs as well as inflation targets have at different times been preferred as the mainstream intermediate objective which has guided policymakers (Malcolm, 2006). Since the late 1980s, the leading framework for

monetary policy has been inflation targeting. Countries that have adopted explicit inflation targeting include Central banks in Canada, the United Kingdom, the euro area, the United Kingdom, New Zealand among others. Many developing countries are also transiting from monetary aggregate targeting towards an inflation targeting framework. (International Monetary Fund (IMF), 2018)

Generally, central banks use open market operations (OMO) as a tool to adjust the amount of money it supplies in its conduct of MP. The aim of OMO is to manipulate short term interest rates, that in return determines the long-term rates hence affecting overall economic activity. In majority of developing nations, the monetary transmission mechanism is not as effective as it is in developed economies. Developing nations should first develop a framework to enable the CB to target short-term interest rates before moving from monetary to inflation targeting. (IMF, 2018).

The CBK is assigned the role of formulating and implementing MP aimed at realising and sustaining stability in the general price levels to foster liquidity, soundness and proper working of a market based financial system. Kenya's MP main target variables include inflation and output (CBK,2012). CBK influences target variables indirectly using interest rates i.e. price of capital and reserve money i.e. quantity of money. To influence monetary targets, CB uses a several monetary tools among them Central Bank rate (CBR), open market operations (OMO), required reserves, overnight lending, foreign market operations licensing and regulation of commercial banks and communication of banks decisions (CBK, 2012).

Since the establishment of CBK in 1966, it has been actively using Monetary Aggregate Targeting (MAT) as a monetary policy framework where it controls quantities (money stock) to affect the prices in the economy. The framework is based on the presence of a stable and strong relationship between money aggregates and the monetary policy goals. Major assumptions in the implementation of the MAT framework are the stability of money demand

and money multiplier. These conditions enable the pass-through of changes in reserve money aggregates to monetary aggregates and target variables (price and GDP). In their absence, the framework becomes inconsequential.

The CBK formulates and conducts MP with the goal of maintaining general inflation at the government target of five per cent and an economic growth of ten percent and above (CBK, 2010). This however has not been the case. The Kenyan economy recorded real growth rate of 4.4percent in 2011, 4.6 per cent in 2012 and 4.1 per cent in 2013. In 2015, the economy grew at 5.6 per cent, a slight improvement from 5.3 per cent in 2014 (KNBS Economic Survey, 2015).

After the several monetary target misses from the target inflation performance since early 1990, the CBK embarked on a more forward-looking MP framework revolving around the CBK's CBR set by a monetary policy committee (MPC). The policy targets to maintain inflation within the range of 2.5 per cent government's target on either side of the 5 per cent government target (MEFMI, 2015). The shift towards this forward-looking monetary framework was supported by several factors which include minimized fiscal deficits, flexible exchange rate regimes, and rigorous use of market-based monetary instruments. A feebler relationship between money and inflation was observed following a decline in average inflation rates to single digits, rapid financial innovation, greater integration with global economy, and deregulation of financial market.

Due to recurrent unfavourable food and energy price innovations, inflation is still within the upper half of the target range (5±2.5 percent) which reduces the reliability of the midpoint of the inflation target, (Monetary Policy Committee (MPC) report, 2017).Kenya has been through persistent and large variations of the overnight interbank rate from the CBR and this has impended the credibility of the policy rate. The median absolute deviance of the overnight rate from the CBR is about 185 basis points since October 2011. The difference is

not getting any smaller since the median absolute deviation of the spread stood at 210 basis points for the first nine months of 2015, (CBK, 2015). The ability to maintain market rates near the target plays a major role in guaranteeing effective monetary policy transmission. Market rates deviating steadily from the CBK's target creates uncertainty for money market.

This has resulted in the interrogation of the framework and its instruments on whether they are capable of delivering on central bank's price stability mandate. Due to the earlier mentioned challenges, Kenya is attempting to modernise its monetary policy framework. This modernisation process augments the framework with some Inflation Targeting (IT) features, (Republic of Kenya, 2012).

Literature available on monetary policy effectiveness still lacks synchrony. For example, while Mangani, (2012) finds evidence of Price puzzle, Mwabutwa et al., (2013) dispels this. Sims, (1992) argues that the counterintuitive price puzzle results can be blemished on methodological issues which arise from imperfectly controlling for some factors in the models.

Motivated by lack of synchrony in the available literature on how effective monetary policy is, this study used a Factor Augmented Vector Autoregressive Model (FAVAR) model following Bernanke et al., (2005) to provide further evidence on effectiveness of monetary policy on inflation control and rate of Kenyan economic growth by particularly examining the role of money supply, exchange rate and the repo rate in the inflation and real sector dynamics. FAVAR method is mainly suitable to examine monetary policy effectiveness in Kenya since the output and inflation are latent variables. Under the FAVAR method, large number of economic indicators are considered to estimate the unobserved variables that drive the systematic components of the economy. This method also minimizes ad hoc decisions about which data is to be included in a VAR and which should not.

1.1.1 Review of Kenya's Monetary Policy Profile

The conduct of MP in Kenya after independence may be described mainly as passive since no involvement was required in an economy of eight per cent GDP growth and less than two per cent inflation rate, (Kinyua, 2001). In 1973, Kenya experienced the first major macroeconomic imbalance with the oil shocks of 1973 followed by the coffee boom of 1977/78. The fixed exchange rate system had already collapsed with the Bretton Woods System in 1971. During this period of first two decades, direct tools were used in the conduct of monetary policy. These included cash reserve ratios, liquidity ratio, credit ceilings for commercial banks, and controls on interest rate. The 1990s witnessed a steady decline in development with reductions in development aid caused by perception of poor governance, embezzlement and mishandling of public resources (Putunoi & Mutuku, 2013).

In 1993, the Kenyan government started a major program of economic reform and financial liberalization. Some of the major reforms taken included elimination of price controls and imports licensing, removal of foreign exchange controls, privatization of a number of public companies, reduction of the number of civil servants, and introduction of conservative fiscal and monetary policies. This ushered in a new era in monetary policy with OMO becoming the main monetary tool. This period experienced high interest rates and expanding interest differential hence inhibiting the benefits of flexible interest rate policy which includes increased financial savings and reduction in cost of capital.

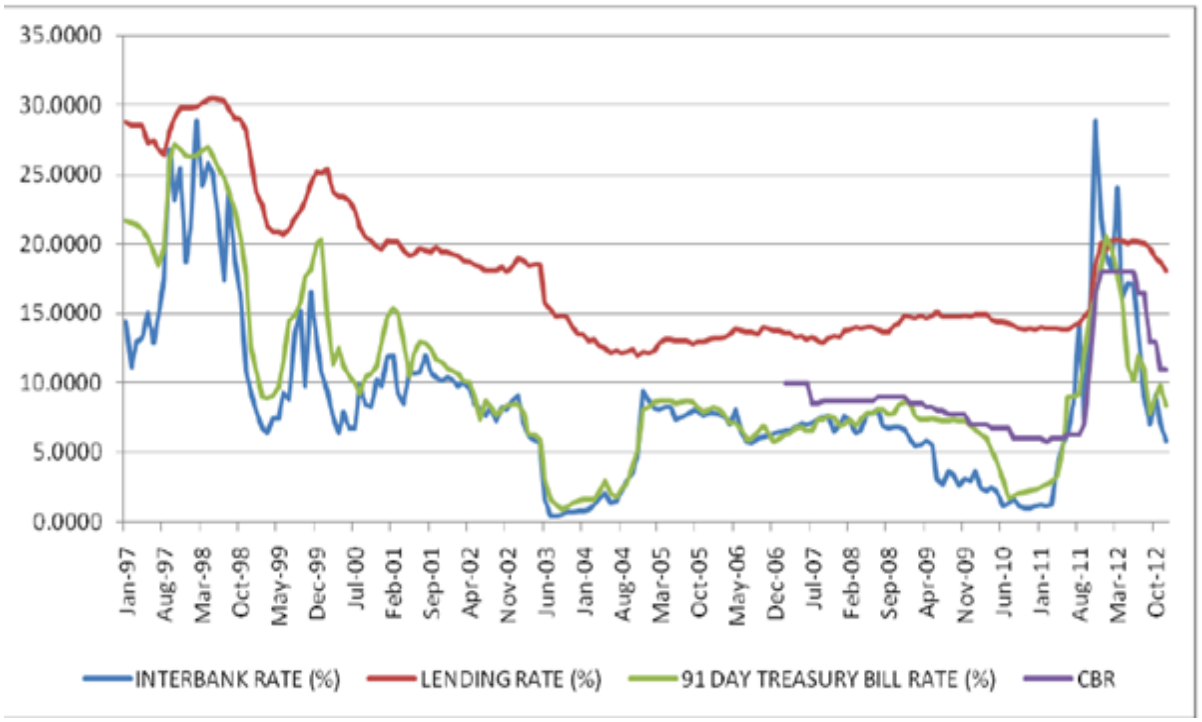
The CBK Act was amended in 1996 allowing the CBK to move from targeting broad money M3 to targeting broader money M3x as the principal concept of quantity of money (Kenya,2001). In the same year, Kenya introduced repurchase agreements (repos) for purposes of monetary policy implementation. On a daily basis, the bank determines the excess or shortfall in the banking system. Depending on the outcome for the day, the bank sells Government securities to commercial banks at an agreed rate and repurchases the same

on maturity plus interest. In 2007, Kenya experienced several crises among them, political turmoil from a disputed election, the world economic and financial crises as well as severe draught. This negatively affected the economy and growth dropped from 7.1 per cent in 2007 to 1.6 per cent in 2008. The same year, the CBK Act was amended to allow the creation of the Monetary Policy Committee (MPC). The Committee is tasked with the responsibility of formulating monetary policy. Again, in 2011 the Kenya shilling depreciated to its lowest point ever against the US dollar at Kes107 which was attributed to the drought situations in 2011 and the political turmoil in Middle East and North Africa regions, which was reflected in world oil prices.

The turmoil in the world financial markets was aggravated by the US debt crisis, which led to the decline in US credit ratings in the second quarter of 2011. The situation was however corrected through monetary policy tightening, moral suasion and intervention on the foreign exchange market. Kenya ushered the year 2013 on an improving macroeconomic position with inflation being contained within single digit and the exchange rate stabilized. The Kenyan GDP growth rate target according to vision 2030 was 10 per cent per annum starting 2012.

Figure 1.1 shows short-term interest rates in the Kenyan economy from 1997 to Jan 2012. The 91-day Treasury bill rate, interbank rate and Repo rate track movements of the CBR. The interbank rate is an overnight rate for uncollateralized lending obligation among commercial banks.

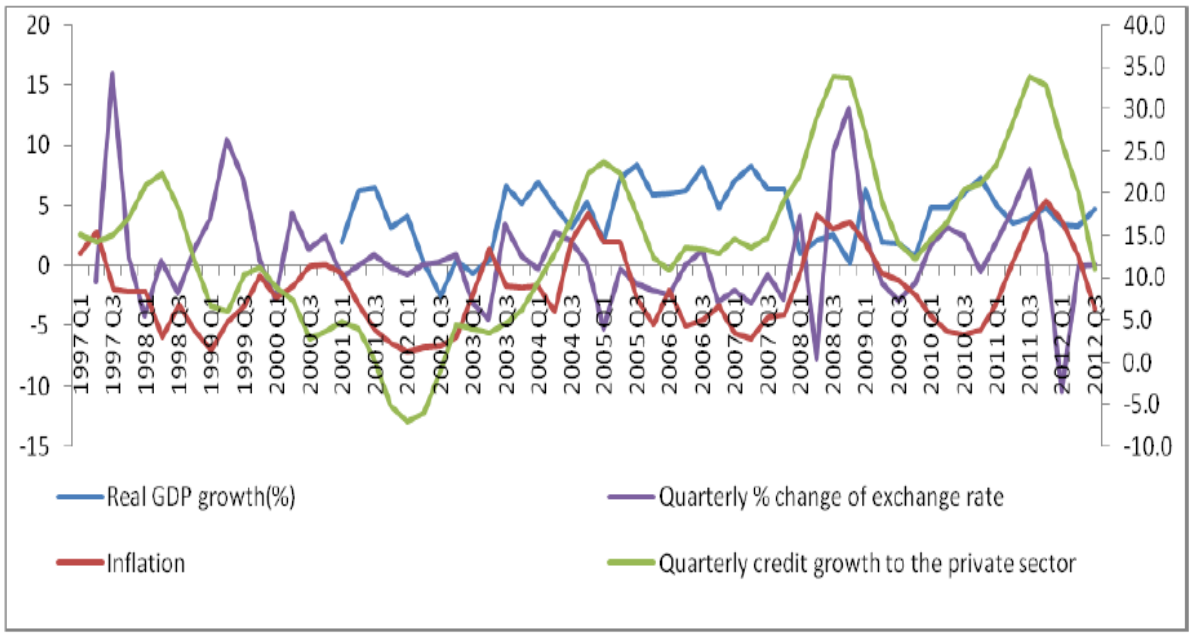
Figure 1.1: Short term interest rates in Kenya 1997 – 2012



Source: CBK, www.centralbank.go.ke

For the period 1998- 2012, the CBR was successful in influencing short term rates but not the retail rates like the lending rate. Between 1997 -2000, the average rate for the interbank was 14.04 per cent, 91-day Treasury bill was 17.79 per cent and the lending rate was 25.63 per cent. In the following period between 2001-2004 the interbank rate, 91-day Treasury bill and lending rate reduced to 6.33 per cent rate, 6.33 per cent and 16.77 per cent respectively. Between the year 2009 and 2011, the average of the CBR reduced to 7.64 per cent causing a decrease in the interbank rate to an average to 5.19 per cent and the 91-day Treasury bills average rate declined to 6.57 per cent. However, the lending rate remained sticky suggesting the anticipated effect of monetary policy to impact credit given to the private sector and hence economic growth may have not been attained.

Figure 1.2: GDP, Growth of Credit to the Private Sector, Exchange Rate and Inflation



Source: KNBS, www.knbs.or.ke

During the period 1997-2002, economic growth averaged at 2.4 per cent while inflation averaged at 12.7 per cent as shown in Figure 1.2. Several factors accounted for high inflation including; increased money supply, erratic weather conditions, depreciation of the Kenya shilling, and price decontrols. In the period 2003-2012, the economy reported positive improvement as shown in figure 1.2 where the economy grew at an average of 4.6 per cent while inflation eased to an average of 9.5 per cent. The structural reforms undertaken during the period 1997-2002 is among the reasons for the positive outlook of the economy (Kinyua, 2001).

1.1.2 Monetary Policy Framework and Instruments in Kenya

A MP framework represents institutional arrangement within which monetary policy is formulated and implemented. There are four major types of frameworks; namely, direct targeting of interest rates, credit or prices; monetary aggregates targeting; exchange rate targeting, and inflation targeting. Theory and empirical evidence show that the choice of any framework for particular economy is a function of diverse factors. Kasekende, (2010)

observes that in Africa, there are 18 countries pursuing monetary aggregate targeting (MAT), 23 countries pursuing exchange rate targeting while about 6 are either actively pursuing or seriously considering migrating to inflation targeting.

To achieve its inflation objective, Kenya pursues monetary aggregates targeting framework. This framework has not changed over time but the CBK is constantly refining monetary policy operations and procedures to augment efficiency and effectiveness in an evolving financial and economic environment. Resulting from insistent failure of MP to deliver on its price stability objective in the late 1980s and the early 1990s, the CBK stimulated substantial changes to monetary policy operation procedures i.e. introduction of new instruments. Some of the radical changes implemented include the movement towards use of indirect instruments of monetary control by introducing OMO and by liberalising interest rates and exchange rate. This makes monetary policy framework more specific with regard to the inflation objective being pursued and the instruments used to achieve it.

Effectiveness of any monetary framework rest on how strong and reliable the monetary transmission mechanisms is, Central Bank's independence and transparency in successfully communicating the monetary policy actions. This enriches the reliability of the CB, eventually influencing any public expectations (Mishra et al., 2012).

Since the central bank cannot directly control money supply growth, it uses its balance sheet items which are Net Foreign Assets (NFA) and Net Domestic Assets (NDA) to alter liquidity conditions of the commercial banking system. A ceiling on NDA as well as a floor on Net International Reserve is set consistent with desired growth in reserve money which is eventually set to influence money supply growth on to an inflation consistent path. The effects of the policy instruments on the goal variables are indirect rather than direct. Monetary policy actions affect directly wider financial markets stock market such as government and corporate bond markets, mortgage markets, markets for consumer credit,

foreign exchange markets among others (Mishkin,2000).Though the effectiveness of monetary policy relies not necessarily on using a wide range of instruments but harmonized use of various instruments is necessary to the application of a rational monetary policy.

1.2 Statement of the Problem

Since countries are moving away from use direct controls towards market-oriented approaches of implementing monetary policy, interest has improved in the effectiveness of monetary policy. Monetary policy tries to attain a set of goals expressed in terms of macroeconomic variables like inflation, real output and employment (Ioannidis & Kontonikas, 2006). However, the outcome of monetary policy actions such as changes in the CBR on these objective variables are indirect with instant effect on the broader financial markets which incorporate new information faster. Although a large number of central banks have embraced inflation target, it is not universal. One of the limitations imposed against inflation targeting is that it pays unsatisfactory attention to economic objectives apart from inflation. CBK is assigned with the duty of formulating and employing monetary policy concentrating at achieving and maintaining low inflation and ensuring economic growth (Kinyua, 2001). Understanding what the objective of monetary policy should and how this should be carried out in order to achieve those objectives constitutes an important problem of current monetary policy.

Despite Kenya implementing monetary policy aimed at achieving stable prices and fostering economic growth since 1990's, the economy has been reporting low economic growth and high rates of inflation. The country has experiences increasing rate of inflation over the past decade with the general level of commodity prices increasing despite the frequent interventions by the Central Bank's Monetary Committee. These indicate that there is still a point of disconnect between the various objectives that the CBK pursues and the outcome of the policy objectives.

Diverse findings on the effects of policy actions on goal variables are coming at a time when a wave of monetary policy regime change is cutting across the continent of Africa and hence the need for a better understanding of policy transmission and effectiveness. This study sought to complement existing literature by further examining effectiveness of monetary policy in Kenya by use of a Factor Augmented Vector Autoregressive Model (FAVAR).

1.3 Research Questions

i. What is the impact of repo rate innovations on price stability and GDP in Kenya?
ii. What is the relationship between money supply, price stability and GDP in Kenya?
iii. What is the effect of exchange rate fluctuations on price stability and GDP in Kenya?

1.4 Research Objectives

The general objective of the study was to examine the effectiveness of monetary policy on inflation control and economic growth in Kenya using the FAVAR model. The specific objectives were:

i. Determine the impact of repo rate innovations on price stability and GDP in Kenya.
ii. Determine the relationship between money supply, price stability and GDP in Kenya.
iii. Determine the effect of exchange rate fluctuations on price stability and GDP in Kenya.

1.5 Significance of the Study

This study aimed at contributing to the current monetary policy debate on appropriateness of money or interest rate based monetary policy anchors by examining using a Factor Augmented VAR the effectiveness of MP on maintaining price stability and ensuring economic growth. The literature available was separated between money and interest rate instruments, suggesting that the instrument choice should depend on the economic fundamentals of a particular country (Poole, 1970). It is therefore important to empirically validate effectiveness of policy instruments in order to enhance public expectations and

success of the central bank's monetary policy innovations. The findings will also inform contemporary question on the choice of monetary policy frameworks and instruments, a debate that is currently sweeping across several sub-Saharan African central banks

1.6 Scope of the Study

This study sought to complement existing literature by further examining effectiveness of monetary policy in Kenya Using a FAVAR Model using quarterly data from 1997 to 2015 since this period was characterized by minimal economic growth and high inflation rates, and because time series data were only available during this period.

1.7 Organization of the Study

The research paper is organized in five chapters. Chapter one provides the background information and objectives of the study whereas chapter two offers a critical review of the relevant literature. Chapter three highlights the research design and methodology adopted in the research. Chapter four presents the empirical results and interpretations. Lastly, chapter five focuses on the conclusions and policy implications of the study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews both theoretical literature and empirical literature that exists on monetary policy transmission mechanisms and monetary policy tools.

2.2. Theoretical Literature

There are opposing theories regarding the effects of monetary policy on nominal and real variable. The New Classical views have been put forward by the real business cycle (RBC) and New-Keynesians school (NKE). The RBC by Kydlland & Prescott, (1982) and Prescott, (1986) contend that there is no role for monetary policy as the business cycle reflects rational decisions by economic agents. Contrary to this view, the New-Keynesians find a significant effect of monetary policy in the short-run arising from Calvo pricing. They argue that nominal rigidities in price and wage adjustments would result in monetary authorities exploiting dividends from monetary policy (Mankiw, 1985). According to the New-Keynesian analysis MP affects real variables in short-run.

2.2.1 Theories of Money Demand

Quantity Theory of Money

The quantity theory of money is one of the oldest existing economic doctrines. It states that changes in the general level of are determined largely by variations in the quantity of money in transmission via the following equation.

$$M \times V = P \times Y \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots 2.1$$

Where; M is the quantity of money, V is the money velocity, P is the price level and Y is the output level.

Equation (2.1) is called quantity equation and it links price level and output level to quantity of money. The quantity equation is converted to classical quantity theory of money by assuming that both the income velocity of money M and the output level Y were fixed. Real output is assumed to be fixed since the economy was at full employment with variations in velocity being presumably insignificant. With both V and Y being fixed due to price level being proportionate to the money stock, making the classical quantity theory, therefore, a significant inflation theory.

Keynesian Liquidity Preference Theory

Keynes in 1936, developed liquidity preference theory in his book titled, 'The general theory of Employment, Interest, and Money'. In this book, his focus was on transactional and asset theories of money demand. Keynes picked out three motives of money holding which are transaction motive, precautionary motive and speculative motive.

Speculative money demand is Keynes's most important innovation. According to this theory, money demand is negatively related to interest rate. The theory insinuates that demand for speculative money balances is dependent on both observable market nominal interest rates as well as expectations of the people about future rates.

Combining these three demands gives the Keynesian liquidity preference function that describes total money demand as,

$$M_d/_P = \mu(R,Y) \quad \text{.....2.2}$$

Where M_d is the money demand, P is the price level, R is the nominal interest rate and Y is the level of output.

The function implies that demand for real money balances is inversely proportional to the nominal interest rate and is positively related to real income. In contrast to the quantity theory

preposition of velocity being constant, this theory describes velocity as pro-cyclical, because pro-cyclical movements of interest rate bring about pro-cyclical movements in velocity.

Friedman's Modern Quantity Theory

In 1956, Friedman integrated an asset theory and a transactions theory of the money demand into the framework of neoclassical microeconomic theory of consumer behaviour and producer behaviour. He regarded monetary assets to be durable goods yielding a flow of services that cannot be observed proportional to the stock, which enter as opinions in the utility as well as production functions. In addition, he assumes that money is in competition with other assets like bonds, stocks and physical goods to be part of individual's and business firm's portfolios. Friedman argued that marginal utility of monetary services drops with increase in the amount of money held. He therefore expressed his equation for modern quantity theory as follows:

$$M_d/_P = \beta(Y_p, R_b, R_m, R_e, \pi_e) \quad \text{.....2.3}$$

Where:

Y_p= permanent income, R_b =anticipated nominal rate of returns on bonds, R_m= anticipated nominal rate of returns on money, R_e= anticipated nominal rate of returns on equities, π_e= anticipated rate of inflation.

2.2.2. Transmission Mechanisms

The Traditional Interest Rate Channel

This channel states that increase in money supply causes a drop in the real interest rate because of the Keynesian supposition of sticky price. An increase in short-term interest rates following changes in monetary policy increases the cost of capital, and hence depresses spending and hence inflation. Evidence of effectiveness of this channel in Africa has been

documented by Al-Mashat et al., (2007) and Cheng, (2006) for Egypt and Kenya, respectively.

The Asset Price channel

Monetary policy has an effect on asset prices like equity, bonds, and real estate which changes the firm's market of stock values as well as wealth of households which in turn affect aggregate demand. This channel operates via two mechanisms; that is Tobin's Q-investment theory in 1969 and Ando-Modigliani life cycle consumption theory in 1963. Tobin's interpretation of the asset channel is depicted as: Relaxed monetary policy raises both equity prices and their demand. This in turn boosts market value of the firms relative to the replacement cost of capital. The results are increased investment and output (Afandi, 2005).

According to the Ando-Modigliani life cycle consumption model, variations in monetary policy impact the individual's long-term wealth hence changes their consumption behaviour. The theory is premised on the fact that individuals seek to smoothen their consumption in the long run. Consumption relies on lifetime income not current income (Mishkin, 1995). Expansionary monetary policy varies consumers 'portfolio composition. An interest rate reduction causes people to minimize holding interest earning deposits and bonds and instead substitute them with equity hence increases stock prices (Afandi, 2005). Since common stocks being a major component of wealth, the rise in stock prices will increase their wealth leading to advanced consumption spending and increased output.

The Credit Channel

It gives an explanation on the effect of monetary policy through the impact of informational asymmetry existing amid a creditor and a debtor (Mishkin, 1995). This channel is embedded under the balance sheet and the bank lending channels. In the former, as monetary policy

tightens, borrowers' balance sheets weaken, lowering their collateral value and raising external finance premium. This eventually raises the moral hazard and adverse selection which leads to curtailment in lending and investment spending. The bank lending channel states that a disruption in the supply of bank loans as a result of contractionary monetary policy makes loan-dependent producers bear costs related to finding new lenders. This raises their external finance premium directly hence lowering borrowing levels and decreases economic activity.

The Exchange Rate Channel

Monetary policy has an influence on exchange rate via either interest rates, inflationary expectations or direct intermediation in foreign exchange markets (Dabla-Norris et al., 2006). With flexible exchange rates, rise in domestic real interest rates following a contractionary monetary policy leads in net capital inflows due to interest rate differentials. This results to domestic currency appreciation and a fall in exports and hence output. Currency appreciation makes imports cheaper resulting to a leakage in the national income identity hence lowering aggregate output. Viability of the exchange rate channel is tested for Ghana by Ocran, (2007) and for Malawi by Mangani, (2012).

Expectations Channel

Under this channel, changes in policy rates change economic agent's anticipations of future interest rate path, growth rate and inflation levels. These anticipations frequently affect choices made by firms and households concerning current levels of saving and investment which then affect price of labour, goods, services and assets.

2.2.3. Monetary Policy Tools

In the MP process, variables perform significant roles acting as tools, indicators, goals, as well as targets. The design of MP by the monetary authorities necessitates suitable variables

on which it can concentrate on as indicators of the need for such a policy (Handa, 2005). Such variables should offer facts on the existing and future state of the economy, more so of goal variables, also called policy guides. Since a MP indicator reflects the state of the economy, it requires that its value must vary if a policy innovation that state so that the indicators are directly or indirectly roles of policy instruments. The tools available to monetary authorities vary on a country basis, based on different political systems, statutory and institutional structures, economic structures, advancement of capital and money markets and so on. Though effectiveness of MP does not essentially rely on using a variety of tools, harmonized application of different tools is crucial to the application of a sensible monetary policy.

Open Market Operations (OMO)

The OMO is Central Bank's major tool for monetary policy execution, (Sargent & Smith, 1987). The purchase and selling of government treasury and government agency securities essentially determine the CBR. CBR is the rate of interest that banks lend balances to the Central Bank and to other depository institutions overnight. CBR also impacts on monetary and financial situations and this eventually affect output, employment as well as inflation.

CBs in most developed countries conduct MP largely through OMO, where money is given out in exchange for securities having been discounted with short run nominal interest rate, (Wallace ,1981). Therefore, costs of money acquirement rely on the existing discount rate and accessibility of collateral. In macroeconomic theory, it has regularly been implied that OMO are not relevant since they are equal to lump-sum money transfers, (Eggerston & Woodford, 2003). The CB buys or sells securities to the financial institutions. One such security is Treasury Bills. By selling securities the CB reduces the supply of reserves but by buying security it rises the supply of reserves to the Deposit Money Banks, thus upsetting the money supply.

Repo Rate

It is the rate of interest used by central bank when selling and or repurchasing government securities to or from commercial banks (www.centralbank.go.ke). Here, securities are traded for cash with an arrangement to repurchase them at a later date. The securities effectively act as security for a cash loan and on the other hand cash acts as security for a securities loan. Several sorts of transactions exist with basically equal economic purposes. A significant individual aspect of repos arises from their ability to act as collateral to get cash or get securities (Brunetti, Filippo & Harris, 2009). This characteristic is valued by market players for it lets them get the securities necessary to meet additional contractual requirements, i.e. making delivery for future contracts. Repos can also be used as leverage, to finance long positions in securities and to finance short positions for hedging interest rate risks (Ewerhart & Tapking, 2008). Repos are valuable to central banks as a monetary policy instrument as well as a source of information on market expectations. Repos are preferred as monetary policy instrument since they bear a moderately low credit risk as they serve as a flexible tool to manage liquidity. They also function effectively as an instrument for indicating the position of monetary policy (Hördahl & King, 2008).].

Interest Rates

Modigliani and Cohn, (1979), presented the money illusion outcome where markets tend to be depressed when nominal interest rates are high even when the real interest rate is not high. They maintained that stock markets respond unsuitably to inflation due to investors' ignorance that interest rate increase is to compensate for the increase in inflation. Howells and Keith, (2000) claim that prices of equity, like the price of other assets will react to vagaries in interest rates. This implies that if the CB increases the interest rates, for example, the rate offered on the risk-free assets rises and if more can be earned on risk-free assets, the holders of risky shares will also demand a higher return. The share prices will also reduce in

case the equity market entirely is more risk averse and demands a higher premium at any level of risk. However, Bernanke and Kuttner, (2003), concluded that only slight of the market's response can be ascribed to the impact of monetary policy on the real rates of interest. Robinson, (1952), claimed that financial systems do not incentive economic growth but instead, financial deepening responds basically to developments within the real sector. For this reason, many prominent economists give negligible role, if any, to the contribution of financial systemin economic growth. The CB is concerned with the rate of the Treasury bill that it impacts via sale of short-term government securities. This acts as the basis upon which commercial bank lending rates are set.

Money Supply

It is the summation of currency outside banks and deposit liabilities of commercial banks, (CBK ,2012). Deposit liabilities are described in narrower and broader senses as: narrow money (M1), broad money (M2), and extended broad money (M3) which are defined as: M1= Currency outside banking system + demand deposits

M2 =M1 + time and savings deposits + certificates of deposits + deposit Liabilities of Non-Bank Financial Institutions (NBFIs)

M3= M2 + residents' foreign currency deposits.

The CBK targets broad money M3 in its policy decisions, Rotich et al. (2007), indicating that during times of increased inflation or positive output the CBK reacts by use of contractionary MP.

Exchange Rates

Stock exchange markets act as a medium through which excess funds are channelled from money lender to money borrower (Mishkin,2000). Grounded on this argument, instability in stock prices affects the productivity of the financial sector significantly and the economy as a

whole. The financial position of an economy, primarily determined by the capital market is subject to its foreign exchange instability. This makes foreign exchange market advances to have cost implications on every economic agent. Empirical confirmation on the effect of foreign exchange market instability on stock market largely synchrony. While (Mishra, 2004), disclosed that there is no theoretical agreement on the interaction between stock prices and exchange rate, Solnik, (1987), concludes that the relationship between stock market and local currency is negative.

2.3. Empirical Literature

Chow & Shen, (2004), wanted to establish the association between price level, money and output for the China Macro Economy. The study used annual data for the period covering 1954 to 2002 employing a VAR model in the analysis: The study was motivated by Friedman proposition which states that output responds to money shocks first, and prices later. Results from impulse response function revealed that in the first year after relaxed monetary shock, the impact is largely on real output, which die down quickly while in the second year, price die out over a long horizon thus confirming Friedman findings.

Kandil, (2004), analysed impact of exchange rate variations on price inflation and real output growth in 22 emerging countries. The study was motivated by the need to establish the appropriate exchange rate policy for developing countries. The study utilized rational expectation model that decomposes movements in exchange rates into two i.e. anticipated and unanticipated component. The study examined annual time series data covering the period 1955-1995 of price level, real energy price, real output, short-term interest rates, government spending, real effective exchange rates and money supply and. The findings revealed that, depreciation of exchange rate both anticipated and unanticipated increases inflation and lowers real output growth confirming the negative impact of currency depreciation on economic productivity in emerging countries. The study recommends

reducing unexpected currency variations to protect economic performance from the hostile effects of this fluctuations in developing countries.

Rasche and Williams, (2005), studied the Effectiveness of Monetary Policy. Their analysis addressed varying opinions on the effectiveness of monetary policy, inflation targeting as an effective monetary policy, monetary policy and short-run output balance, and hitches in executing a short-run stabilization policy. In their conclusions, they found that inflation targeting by central banks appeared to have an attractive result of consistently hitting targets on a "medium run" horizon. However, it was not clear what the impact of inflation targeting outside a credible commitment to price stability was, since the CB that's huns inflation targeting framework have amassed an analogous record of low and stable inflation. Secondly, it was not clear what would happen to low and stable inflation if bad shocks were experienced. Finally, the instance for steadily effective short run monetary equilibrium policies is challenging, this is because there are just numerous dimensions to uncertainty in the setting in which CB function.

Shokoofeh, (2006), investigated the effectiveness of monetary policy in the USA during the period 1990 to 2004. The study employed multiple regression model on monetary aggregates (M 1 and M2), consumer expectation and mortgage rates. Consumer expectation was used in the analysis because it captures the overall state of the macro economy better than single variables like inflation rate, short-term and long-term interest rates and it avoids the problem of multi-collinearity. The study established that variation in money supply have no impact on mortgage interest rates. The new development necessitates further analysis to establish whether it holds for developing countries.

Cheng, (2006), sought to investigate monetary transmission mechanism in Kenya by investigating how the Central Bank's REPO rate affects prices, real output and nominal effective exchange rate. The study used VAR technique to analyse monthly data during the

period 1997 to 2005. The study observed that an exogenous rise in CBK repo rate is followed by appreciation of nominal exchange rate and decline in prices but insignificant effect on output. The slow reaction of real output to a monetary innovation is that the Kenyan financial system is afflicted with structural shortcomings, thereby hindering the monetary transmission to the real sector of the economy.

Rotich, Kathanje and Maana, (2007), conducted a study on monetary policy function in Kenya. Their study reviewed the behaviour of monetary policy then and the Central Bank rule-based conduct in Kenya using Taylor rule after modifying to account for the features in emerging economies, they tested if the CBK reacted to variations in GDP growth, inflation and the exchange rate in a steady and predictable fashion. The results show that during the period after financial liberalization i.e. 1997-2006, CBK had used monetary aggregates as the key policy instrument of conducting MP. The estimate of the coefficient on the inflation gap implied that an increase in anticipated annual inflation of one percent induced the CBK to less the growth of broad money by 4.2 percent. At the same time, the coefficient of inflation with respect to repo rate was 2.4 and is in line with Taylor's non-accommodative policy. The results show that CBK followed a rule to target inflation with allowance for output balance.

Chuku ,(2009), investigated the impact of monetary policy innovations in Nigeria employing Structural Vector Auto regression (VAR) on quarterly data covering the period 1986 to 2008. The variables included in the model include; minimum rediscount rate, broad money supply, real gross domestic product (RODP), real effective exchange rate, and consumer price index (CPI). The results of impulse response functions revealed that monetary policy innovations have real and nominal effects on economic variables reliant on the policy variable chosen. The study also revealed that price-based nominal anchors do not have a substantial effect on real economic activity. An innovation in the quantity-based nominal anchor (M2) affects

economic activities modestly. The study concludes that monetary policy shocks have been a modest driver of business cycle fluctuations in Nigeria.

In its regional economic outlook IMF, (2010) the IMF used single equation and panel VAR frameworks to study effects of monetary policy on Sub-Sahara African countries. They found that a shock to reserve money increases output, inflation, and monetary aggregates, and leads to exchange rate depreciation in floating exchange rate regimes. This implied that money is a strong determinant of inflation in Sub-Saharan-African countries contrary to the weak links observed in advanced countries. The study also found strong evidence of price puzzle. An increase in the discount rate depresses growth, but somewhat anomalously increases inflation and depreciates the exchange rate. These findings cast doubt on use of interest rates as an active monetary policy instrument in Africa. Rather, the evidence renders credence to monetary aggregate targeting in the region. They however point out that the influence of monetary policy on growth is weakened by supply shocks and changes in risk premiums at times of global turbulence, a feature that warrants further analysis.

Waliullah and Rabbi, (2011) analysed the effectiveness of monetary policy in Pakistan. Time-series econometric methods like unit roots, ARDL and ECM were used on quarterly data covering the period 1972 to 2005. The study employed ARDL due to its many advantages over the traditional approaches of causality and co-integration. Variables used in the model include; MI, GDP and CPI. The study established that stable, long-run relationship exists amongst MI, GDP and CPI. Further analysis established that short-run monetary policy is moderately effective and that money supply is exogenous and causes substantial movement in the price level and hence GDP. The study recommends monetary policy in Pakistan to devise strategies to ensure long-run price stability through balanced expansion in money supply as this stability will aid economic agents in their decision-making.

Mangani, (2012), uses a VAR framework and demonstrates that that the Policy rate does not transmit to changes in inflation. The study further finds evidence that reserve money and broad money had no discernible impact on prices contradicting IMF, (2010). The exchange rate is found to have significant impact on prices, a finding which is consistent with small open economies whose production and consumption systems are import dependent. The study however did not income real GDP and this may have influenced observed results.

Gichuki et al., (2012), sought to determine the optimal monetary instruments for Kenya, employing stochastic IS-LM model. The study sought to establish the optimal instrument between interest rates and reserve money in manipulating the conduct of monetary policy in Kenya and further establish if a combination of policy mix of the two instruments was a better policy than using either of them independently. Variables used in the model include gross domestic product, M3, and CBK over draft interest rate. The study applied quarterly data between years 1994 to 2010. The study established that the interest rate is a superior policy instrument over reserve money in meeting Kenya's monetary policy objectives. The study further revealed that a combination policy mix performs better than the two instruments working independently.

Gichuki and Moyi, (2013), assessed the monetary condition index for Kenya. The study employed a simple aggregate demand function for the computation of monetary condition index. Variables utilized in the model include GDP, 91-day T-bill rate, credit to private sector, and real exchange rate. The study utilized quarterly time series data covering the period 2000 to 2011. Empirical results established presence of co-integration between real GDP and the exogenous variables such as the interest rates, exchange rates and claims on private sector indicating that these three variables are the main channels of monetary transmission in Kenya.

Asongu, (2013), assessed the long-run and short-run effects of monetary policy on output and prices on annual data in a sample of 10 African countries experiencing high inflation rates. The study employed vector autoregressive, vector error correction and granger causality econometric techniques. Variables used in the model include; financial depth (M2/GDP), credit efficiency (Credit/deposits) and size (deposits/total assets). The study established that permanent changes in financial depth, efficiency credit and size affect prices in the long-run but in cases of disequilibrium; only financial depth and size adjust inflation to the cointegration relations. The study further established that monetary policy does not affect prices in the short-run.

2.4 Overview of Literature Review

From the theoretical literature reviewed, different theories having different propositions on the effect of monetary policy actions on the real economy depending on the assumptions made. Empirical literature also seems to be no consensus over the effectiveness of monetary policy on inflation and economic growth in Kenya. This calls for further research on effectiveness of monetary policy in Kenya. In developed nations, monetary authorities target interest rates as their intermediate target while in developing nations, most monetary authorities target monetary aggregates mostly due to inefficient financial market and uncompetitive banking sector (Kathanje et al., 2007). In addition to the mentioned challenges in the choice of monetary policy instrument, globalization of financial markets has drastically reduced the independence of monetary policy by considerably eroding the ability of small open economies to control interest rates independently of world markets (Asongu, 2013). There appears to be no consensus on the choice of variables in testing the effects of monetary policy on economic growth and prices.

In view of the diverse findings and the divide in modelling approaches on the subject, this study will contribute to the policy debate by digressing from the conventional VAR to a

Factor Augmented VAR (FAVAR) approach after controlling for potential breaks and using the Principal Component Analysis. Including factors in the VAR widens the information set and exposes a coherent picture of the effects of monetary policy innovations by improving precision of the impulse responses.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This chapter expounds on which methodology the study adopted for it to achieve the objectives. Specifically, the chapter covers the research design, theoretical framework, empirical framework, data estimation, definition and measurement of variables and the diagnostic tests.

3.2. Research Design

The study adopted non-experimental research design. The study used time series empirical data on the study variables for period between 1997 and 2015 to study the efficacy of monetary policy tools in achieving the mentioned objectives in Kenya by establishing the interrelationship among variables.

3.3. Theoretical Framework

The effectiveness of monetary policy on inflation control and economic growth in Kenya was analysed by using the quantity theory of money (Fisher, 1947). This theory gives the existing relation between money, prices and output. It believes that price level is positively related to supply of money. This is presented by the use of the quantity equation by Fisher in 1947 given as $MV = PY$.

Where:$M =$ quantity of money in circulation over which the CBK has some control, $V =$money velocity, $P =$price level and $Y =$level of output.

The theory assumes fixed money velocity and fixed output level since the economy is at full employment. This implies that the general price level is determined by the quantity of money in circulation. As a result, the quantity equation can be transformed into $M = kPY$, where k represents a constant.

The study recognises that in the short-run, the economy does not operate at full employment level of real GDP. Expansionary monetary policies can lead to increase in real GDP through increase in aggregate demand. The variables in the study comprises of inflation, exchange rate, repo rate, money supply, lending rate and GDP growth.

The multivariate models present inflation and economic growth being a function of stated variables as follows:

$INFL$= f ($EX, REPO, M, GDP, LIR$)……. 3.1

$INFL= \alpha_0 + \alpha_1 EX + \alpha_2 REPO + \alpha_3 M + \alpha_4 GDP + \alpha_5 LIR + \varepsilon$…….3.2

Where: $INFL$ =Inflation; EX= Exchange rate (US dollar); $REPO$= repo rate; M= Money Supply (M3); GDP= GDP growth, LIR = Lending rate.

3.4 Empirical Framework

3.4.1. The Vector Autoregressive Framework

Correlation between macroeconomic variables is a fact making distinction between endogenous and exogenous policy shocks difficult, (Stock & Watson, 1989). To deal with these, the Vector Autoregression (VAR) which frequently is used when predicting systems with related time series as well as investigating dynamic effect caused by random disturbances on a system of variables becomes handy. VAR was introduced by (Sims, 1980). The study by passed structural modelling but harnesses the dynamic effect of random disturbances where every variable is treated as endogenous and is regressed on lagged values of all other variables and an exogenous shock.

Equation 3.3 is a representation of a standard VAR

$$y_t = \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + \beta x_t + \varepsilon_t \quad \text{..... 3.3}$$

Where y_t is a vector of K endogenous variables while $x_t$represents a vector of exogenous variables, α and βrepresents coefficients that are to be estimated while$\varepsilon_t$represents a vector of innovations. These innovations have a contemporaneous relationship but cannot be correlated with their own lags or other explanatory variables. Simultaneity is not an issue because lags of endogenous variables are on the right-hand side of the equations; therefore, using OLS will give estimates which are consistent and equal to the Generalised Least Square estimation.

Considering the shortcoming of the VAR, precisely inability to control for all the information and the degrees of freedom problem that limits the number of time series that can be contained within VAR, the model is augmented the model with a factor computed from as many series as available and estimate a Factor Augmented Vector Autoregressive model.

3.4.2 Factor Augmented VAR

Economic agents in Kenya consider an extensive range of economic indicators to give an opinion of the performance of the economy. Using standard VAR as an estimation method for vast system of variables becomes impossible if long history of data is unavailable. This is principally challenging in Kenya because of a combination of inadequate data availability as well as speedy structural transformation. Following the moderately short samples of reliable data available for Kenya's series, estimating large VARs is either impossible or highly undependable because of over parameterization.

In the study of monetary policy, FAVAR combines standard VAR with factor analysis to exploit large data sets. It enjoys numerous advantages compared to VARs in evaluating effectiveness of monetary policy, these include; improved identification of the policy

innovations; avoiding the use of single variable to represent theoretical constructs and allowing for computation of impulse responses for many of variables.

FAVAR is different from dynamic factor model in two key aspects. Firstly, some factors are presumed to be observed directly in FAVAR unlike in dynamic factor model. Secondly, FAVAR is interested in identification of factors instead of just forecasting. Lastly FAVAR is also concerned with impulse response functions and variance decompositions. The FAVAR model detailed below which was adopted by this study and much of its notations are adopted from Bernanke et al., (2005).

Let y_t be an $Mx1$ vector of observable economic variables. Contained in y_t are policy variables and other measures of real economic activity and prices that are observable. The standard approach of approximating VAR is to use vector y_t alone. In practice, however, vast information is not in this vector and could be extremely relevant to policy dynamics. Let this unobserved information set be condensed in a second vector, Kx1 denoted as F_t. K is expected to be relatively small as the FAVAR is a data reduction technique. Bernanke et al., (2005), argued that F_t can be interpreted to represent economic concepts where one or two series cannot be used as a proxy, for example, real activity, credit conditions or inflation.

The FAVAR model combined dynamics of the two vectors y_t and F_t as:

$$\begin{bmatrix} y_t \\ F_t \end{bmatrix} = \Phi(L) \begin{bmatrix} y_{t-1} \\ F_{t-1} \end{bmatrix} + \varepsilon_t \quad \text{..... 3.4}$$

$\Phi(L)$ is a lag polynomial of order d while the error term ε_t is orthogonal. In case the terms in $\Phi(L)$ which link y_t and F_t are zeros, the system degenerates to a standard VAR. If not, then equation (3.4) becomes a FAVAR model. Equation 3.4 permits for simple comparison as well as provides a means of analysing the marginal input of additional information which factor F_t contains.

Bernanke et al., (2005) notes that if the correct system is a FAVAR, estimating a standard VAR in $y_t$excluding F_t will eventually results to coefficient estimates that are biased and also impulse response coefficients and variance decomposition will be unreliable.

Since the factors F_t are unobserved, equation 3.4cannot estimated directly. Let X_t be the $Nx1$ matrix of the informational set, such that $N > K + M$.

Assuming that the information set X_t is related to the unobserved factor F_t and the observed factor y_t in a linear form, equation (3.5) is observed.

$X_t = \Gamma^f F_t + \Gamma^y Y_t + v_t$ ……3.5

Where $\Gamma^f$is an NxK loading matrix of the factor while Γ^y is an NxM loading matrix of the observable variables. v_t is a $Nx1$vector of error terms which is orthogonal. The method used for estimation determines whether the error terms are weakly correlated or uncorrelated over time.

Equation 3.5 states that Y_t and F_t characterize joint forces that determine the dynamics of X_t . Although X_t in equation has contemporaneous relationship with independent variables, the equation can be modified without loss of generality and meaning by including lags of the factors.

Just like the unrestricted VAR, the FAVAR does not impose prior restriction on the relation among X_t, F_t and Y_t . Sims, (1980) argues that imposing prior structural constraints in modelling the behaviour of the economy may result in potential gains but if these restrictions are incorrect, they lead to biases.

There are two approaches of estimating equation (3.4) and (3.5). The first is to use the two-step Principal Component Analysis (PCA). The second approach is to use single-step

Bayesian likelihood approach. Bernanke and Boivin, (2003) used both procedures and find similar results and conclude that use of both methods in one analysis is redundant.

Borrowing from Stock and Watson (1998, 1999), unobserved factors F_t in equation (3.5) will be estimated using principal components because of its superiority in handling data irregularities as it can take series of different frequencies and its computational simplicity. By using this method, every factor has a meaningful economic interpretation.

After estimating the factors using the PCA methodology the estimated principal components are incorporated in the VAR model to generate the FAVAR model. The study will then estimate equation (3.6) as a standard VAR system with output factor, inflation factor and each policy variable separately before considering policy variables in combination.

$$\begin{bmatrix} y_t \\ F_t' \end{bmatrix} = \Phi(L) \begin{bmatrix} y_{t-1} \\ F_{t-1}' \end{bmatrix} + \varepsilon_t \quad \text{..... 3.6}$$

Where y_t represents policy variables i.e. repo rate, reserve money, broad money, lending rate and exchange rate

F_t'represents the estimated inflation factor and output factor

3.4.3. Autoregressive Dynamic Lag Model

The autoregressive distributed lag (ARDL) model was used to model the relationship between money supply, price stability and GDP in a single-equation time-series setup. This was used to achieve the second objective which seeks understand the relationship between money supply, price stability and GDP.

$$GDP_t = \alpha_0 + \sum_{i=1}^{p} \beta_i GDP_{t-i} + \sum_{j=1}^{q} \gamma_j M3_{t-j} + \sum_{l=1}^{r} \varphi_l Infl_{t-l} + \varepsilon_t \text{.....3.7}$$

$$Infl_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Infl_{t-i} + \sum_{j=1}^{q} \gamma_j M3_{t-j} + \sum_{l=1}^{r} \varphi_l GDP_{t-l} + \varepsilon_t \text{.....3.8}$$

Where GDP is specified as a function of its own lags and the current lags of other exogenous variables i.e. Money Supply and Inflation. Inflation is also specified as a function of its own

lags and lags of other exogenous variables i.e. Money Supply and GDP. β, γ and φ are coefficients while α is a constant.

3.5 Model Estimation

The study applied two-step PCA methodology to the estimation of monetary FAVARs to achieve objectives 1 and 3 and ARDL model to achieve objective 2. The observed variables are presented in Table 2 below. The model is estimated using E-views using Quarterly data from 1997 to 2015.

Table 3.1: Definition and Measurement of Variables

Variable	**Description and measurement**
Repo rate (Percent)	Interest rate at which the CB sells and or repurchases government securities to or from commercial banks (www.centralbank.go.ke). The study applied figures recorded by CBK for the period of the study and will be measured as a percentage in Kenya Shillings.
Inflation (Inf) (Percent)	Rate at which overall price levels of goods and services rise as the purchasing power of currency fall. The variable was measured using Consumer Price Index (CPI) as a proxy representing inflation rate existing in Kenya during the study period. Percentage change in CPI measures inflation
Exchange Rate (ER) (Ksh/USD)	It is the official nominal Kenya Shilling per USD. The exchange rate was measured by taking the average applicable exchange figures for the United States Dollar because it is the mostly used common currency.

Reserve Money (RM) (Ksh)	It calculated as the summation of money in circulation, Vault cash and deposits of the commercial bank kept at CBK. This will be measured in Kenya shillings.
Broad Money (M3) (Ksh)	It is calculated as summation of cash outside banks, time deposit, demand deposits and savings deposits. The study used the money supply figures by CBK measured in Kenya Shillings.
Real GDP (Percent)	This is the real growth rate of the economy measured by percentage change in GDP using 2010 as the base year.
Lending Rate (LR) (Percent)	Average of maximum and minimum commercial banks' lending rates. It will be measured as a percentage.
Information Set Xt	Constructed through PCA analysis from the following variables:91-day Treasury bill rate (TB),Real Interest Rate(r), Total Investment(TI),Fiscal Deficit(FD), General government lending (GNL), Private sector credit (psc), Gross National Savings (GNS), Net Capital Account (NCA), Current Account Balance (CAB), Government Revenue (GR), Manufacturing Value Added (MVA), Crude Oil Price (COK)*,and Agriculture Price Index (API)*.

Note: *Denotes Slow-moving variables, otherwise fast-moving

Choosing information to include in Xt is not a haphazard issue. Although Stock and Watson, (2002) argue that more data is always good, Boivin and Ng, (2005) demonstrate that in practice this may mean using more of the same data since most series are related. Bernanke et al., (2005) shows that the pre-screening of series is largely an ad hoc process.

3.6. Diagnostic Tests

To establish the goodness of fit of the FAVAR model, the study conducted diagnostic tests. The study examined the stability condition, serial correlation, Lag exclusion test, and residual serial correlation associated with the model (Enders, 2004).

3.7 Impulse Response Analysis on FAVAR

The impulse response function was used to trace the impact of each shock on each variable in FAVAR over a given time horizon. Shock to the ith variable has an effect directly on the variable itself as well on other endogenous variables in the model (Enders, 2004). For instance, a shock to monetary policy variable impacts real GDP and prices in different ways depending on how long it takes for the shock to be fully transmitted to target variables.

3.8 Variance Decomposition

The variance decomposition presented a further step of establishing what percentage of the variation in a series was due to its own shocks and which percentage was due to shocks of other variables in the model at a given period following (Enders, 2004). Variance decomposition analysis determined the proportion of a variance in a series that was due to its own shock, the other variables shocks and other identified institutional shocks.

CHAPTER FOUR

EMPIRICAL FINDINGS

4.1 Introduction

This chapter presents the discussions of the empirical findings of the study. It presents the descriptive statistics, time series properties, diagnostic test and the results of the model estimation. The presentation of empirical results are arranged according to the study objectives.

4.2 Data Characteristics

The study used quarterly time series data for the period 1997-2015 since this is the period where most reforms in monetary policy took place. The sources of data included Central Bank of Kenya, Kenya National Bureau of Statistics and World Development Indicator Database. Data was collected for the following variables; repo rate (repo), inflation rate (Infl), exchange rate (ex), growth of broad money (m3), real GDP (gdp), and lending interest rate (lir). The variables used for principal component analysis included; agricultural price index (API), crude oil prices in Ksh (COK), fiscal deficit (FD), private sector credit (PSC), real interest rates (R), 91 days treasury bill rate (TB), total investment (TI), current account balance (CAB), general government lending/borrowing (GNL), government revenue (GV), gross national saving (GNS), manufacturing value added (MVA), and net capital account (NCA).

4.3 Descriptive Statistics for Variables

Descriptive statistics gives summary of the data and show how the data is distributed. Table 4.1 shows descriptive statistics for repo rate, inflation, exchange rate, broad money growth rate, real GDP, and leading interest rate. GDP and exchange rates are in logarithms. The descriptive statistics for the factors are in Appendix 1 Table A2. The statistics includes

minimum, maximum, mean, standard deviation, skewness and kurtosis, the Jacque- Bera statistics and the p-value.

Table 4.1: The Descriptive Statistics

	Exchange rate (Logarithm) (Ksh. to US$)	Real GDP(Logarithm) (Ksh)	Inflation (Percent)	Lending rate (Percent)	Broad money Growth rate	REPO rate (Percent)
Mean	4.331155	12.64303	7.940857	17.70285	-0.01132	1.892134
Median	4.350883	12.61953	6.955	16.30977	0.021	2.004179
Maximum	4.559051	13.11738	17.07	30.71809	1.396	3.277145
Minimum	4.087195	12.34373	1.81	12.21485	-1.308	-0.71335
Std. Dev.	0.100277	0.222195	3.817522	4.920219	0.317441	0.820319
Skewness	-0.60718	0.454834	0.697826	1.260542	0.791033	-1.05634
Kurtosis	3.162861	2.135778	2.681838	3.873418	12.89746	3.997652
Jarque-Bera	4.378543	4.591928	5.976457	20.76295	293.0163	15.69382
Probability	0.111998	0.100664	0.050377	0.000031	0.00	0.000391
Observations	70	70	70	70	70	69

Source: Author's calculations (2019)

Table 4.1 shows that exchange rates have a mean of 4.33, a standard deviation of 0.1, a minimum of 4.1 and a maximum of 4.6. This indicates that generally, exchange rate had an upward trend. GDP had a mean of 12.64, a standard deviation of 0.22, a minimum of 12.34

and a maximum of 13.12. The standard deviation indicates that GDP have not be very volatile over the period of study and also GDP had an upward trend. Inflation had a mean of 7.94 percent and a standard deviation of 3.84. The minimum of inflation was 1.81 and the maximum was 17.07. This indicates that inflation was very volatile during the study period and sometimes it was outside the target inflation of 7 ± 2 percent. Lending rate also was volatile with a mean of 17.7 percent and standard deviation of 4.92. The minimum lending rate was 12.22 and the maximum was 30.72 percent. The growth of broad money had a mean of -0.011 and a standard deviation of 0.32. The higher standard deviation than the mean indicates that the variable for broad money have outliers. The repo rate had a mean of 1.9 and standard deviation 0.82. The minimum repo rate during the period was -0.71 and the maximum was 3.3.

4.4 Pre-Estimation Tests

Before estimating the model, pre-estimation tests were conducted. Unit root test was conducted to guarantee that all variables used in the study were stationary and the variables which were nonstationary were differenced to ensure they were stationary. Furthermore, correlation analysis was conducted.

4.4.1 Stationarity Test

To test for stationarity, Augmented Dickey-Fuller (ADF) and Kwaito-Perron-Shimdt-Shin (KPSS) test were used.

To test for the order of integration using ADF unit root tests, equation (4.1) is estimated:

$$\Delta Y_t = \alpha + \beta_t + \rho Y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta Y_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.1$$

The null and alternative hypotheses of the ADF test are as follows:

H0: $\rho = 0$ (The series have unit root)

H1: $\rho < 0$. (The series do not have unit root)

If the computed t-statistics is greater than the asymptotic critical values in absolute term, the null hypothesis i.e. series contained unit root was rejected and the study concluded that the series was stationary (Gujarati, 2004).

From the ADF test at level, inflation rate, broad money and repo rate are stationary at 5 per cent level of significance, while exchange rate, GDP, and lending rate contain unit roots (non-stationary). Therefore, using the ADF test the null hypothesis for the presence of a unit root was not rejected at 5 per cent level of significance for exchange rate, GDP, and lending rate. However, the presence of a unit root was rejected at 5 per cent level of significance for inflation, broad money, and repo rate and hence they are stationary at level.

Table 4.2: ADF Unit Root Test Results

Null Hypothesis: the variable has a unit root							
At Level							
		EX	GDP	INFL	LIR	M3	REPO
Constant	t-Statistic	-2.1435	1.3727	-5.18***	-2.4597	-8.66***	-3.42**
	Prob.	0.2288	0.9988	0.0000	0.1302	0.0000	0.0136
	Conclusion	Non-stationary	Non-stationary	Stationary	Non-stationary	Stationary	Stationary
Constant & Trend	t-Statistic	-1.8466	-1.6098	-5.73***	-2.2768	-8.60***	-3.384*
	Prob.	0.6711	0.7791	0.0001	0.4398	0.0000	0.0624
	Conclusion	Non-stationary	Non-stationary	Stationary	Non-stationary	Stationary	Stationary

Note: ***stationary at 1percent; ** stationary at 5percent; * stationary at 10percent levels of significance.

Source: Author's calculations (2019)

For non-stationary variables, ADF test was done at first difference. Table 4.3 shows the ADF test results for all variable differenced once. The table shows that at first difference, all variables are stationary except lending rate.

Table 4.3: 1st Difference Using ADF Stationarity Tests Results

At First Difference							
		d(EX)	d(GDP)	d(INFL)	d(LIR)	d(M3)	d(REPO)
Constant	t-Statistic	-6.49***	-9.33***	-6.30***	-1.5755	-10.44***	-6.94***
	Prob.	0.0000	0.0000	0.0000	0.489	0.0000	0.0000
	Conclusion	Stationary	Stationary	Stationary	Non-stationary	Stationary	Stationary
Constant & Trend	t-Statistic	-6.58***	-9.78***	-6.31***	-1.6577	-10.36***	-6.90***
	Prob.	0.0000	0.0000	0.0000	0.758	0.0000	0.0000
	Conclusion	Stationary	Stationary	Stationary	Non-Stationary	Stationary	Stationary

Note: ***stationary at 1percent; ** stationary at 5percent; * stationary at 10 percent levels of significance.

Source: Author's calculations (2019)

The 1st difference of exchange rate and GDP are stationary at 5 percent level of significance. Therefore, exchange rate and GDP are integrated of order I (1) while inflation, broad money and repo rate are integrated of order I (0). However, lending rate is non-stationary at first difference, ADF test was done at the second difference.

Table 4.4: 2nd Difference using ADF Stationarity Tests Results

Lending rate 2nd Difference	Intercept only	-6.0245***	Stationary
	Trend and Intercept	-6.0015***	Stationary

Source: Author's calculation (2019)

After the 2nd difference, lending rate is stationary at 5 percent level of significance. This implies that lending rate is integrated of order two i.e. I (2).

Table 4.5: KPSS Unit Root Test Results

Null Hypothesis: the variable has a unit root							
At Level							
		EX	GDP	INFL	LIR	M3	REPO
Constant	t-Statistic	0.4268*	1.0950***	0.1198	0.6005**	0.0676	0.1692
	Conclusion	Non-stationary	Non-stationary	Stationary	Non-stationary	Stationary	Stationary
Constant & Trend	t-Statistic	0.0922	0.2178***	0.0598	0.2666***	0.0601	0.1472**
	Conclusion	Stationary	Non-stationary	Stationary	Non-stationary	Stationary	Non-Stationary

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

Source: Author's calculations (2019)

The KPSS test shows that inflation and broad money are stationary at level, repo rate is stationary without trend and exchange rate, GDP growth rate and lending rate are non-stationary at level.

Table 4.6: 1st Difference Using KPSS Stationarity Tests Results

At First Difference							
		d(EX)	d(GDP)	d(INFL)	d(LIR)	d(M3)	d(REPO)
Constant	t-Statistic	0.1211	0.3585*	0.0289	0.4746**	0.0419	0.0825
	Conclusion	Stationary	Non-stationary	Stationary	Non-stationary	Stationary	Stationary
Constant & Trend	t-Statistic	0.0712	0.0671	0.0278	0.0695	0.0399	0.0333
	Conclusion	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary

(*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

Source: Author's calculations (2019)

The KPSS test shows that all variables are significant at level.

4.4.2 Test for Multicollinearity

In regression analysis, multicollinearity tends to inflate the standard errors which affect the hypothesis testing. To test for multicollinearity between the variables, correlation analysis was done and variables with above 0.8 correlation coefficient was deemed to be collinear. Table 4.5 shows the results of correlation analysis.

Table 4.7 Correlation Results

Correlation						
	EX	GDP	INFL	LIR	M3	REPO
EX	1					
GDP	0.4586***	1				
INFL	0.2020	0.1008	1			
LIR	-0.3856**	-0.508***	-0.2515	1		
M3	0.0990	0.0089	-0.0845	0.0237	1	
REPO	-0.1117	-0.0053	0.0156	0.4102***	0.3265*	1

Source: Author's calculations (2019)

Table 4.7 demonstrates that the variables of the study are not highly correlated. None of the variables have correlation of 0.8 or higher. Exchange rate is positively correlated with GDP, inflation, and broad money while it is negatively correlated to leading rate and repo rate. GDP is positively correlated to inflation and broad money but negatively correlated to lending rate and repo rate. Inflation is negatively correlated to leading rate and broad money but positively correlated to repo rate. Lending rate is positively correlated to broad money and repo rate while broad money is positively correlated to repo rate.

Table 4.8: Variance Inflation Factors

Variance Inflation Factors: Dependent variables		
	GDP	Inflation
EX	2.0157	1.6271
GDP	N/A	1.9187
INFL	1.3535	N/A
LIR	1.88501	1.5261
M3	1.1942	1.7423
REPO	1.6388	1.4402

Source: Author's computation (2019)

The variance inflation factors from the regression analysis of GDP and Inflation shows that none of the variance has a factor above 10 and hence, there is no multicollinearity.

4.5 Regression Analysis

A multivariate regression was conducted for both the inflation model and the growth model as specified in chapter 3 under the theoretical framework. Table 4.9 shows the regression results for inflation model. The dependent variables are exchange rate, leading rate, broad money, GDP and Repo rate. The regression uses Newey-West standard errors due autocorrelation.

Table 4.9: Regression Results for Inflation

$$Infl_t = \alpha_0 + \beta_1 Ex\_rate_t + \beta_2 Lir_t + \beta_3 M3_t + \beta_4 gdp_t + \beta_5 repo\_rate_t + \varepsilon_t$$

The table 4.9 shows that exchange rate, lending rate, broad money, GDP and repo rate explains 6 percent of variation in inflation in Kenya. However, the variables are insignificant at 5 percent except for lending rate and repo rate.

Dependent Variable: Inflation				
Included observations: 70				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.2816	33.2439	0.5800	0.5639
Exchange rate	6.7412	5.2007	1.2962	0.1996
Lending rate	-0.2820**	0.1212	-2.3268	0.0231
Broad money	-2.0566	1.5162	-1.3563	0.1797
GDP	-2.9809	2.5818	-1.1545	0.2526
Repo rate	1.1206*	0.6656	1.6834	0.0972
R-squared	0.1272			
Adjusted R-squared	0.0591			
F-statistic	1.8670			
Prob(F-statistic)	0.1125			
No. of observations =70				

Note: Standard errors in bracket. *, **, **** represent significant at 10 percent, 5 percent and 1 percent respectively.

Source: Author's calculations (2019)

Lending rate is negative and significant at 5 percent. The model suggests that a unit increase in lending rate leads to 0.28 unit point reduction in inflation ceteris paribus. This is as expected as increase in lending rate reduces borrowing for consumption and investment reducing inflationary pressures.

Table 4.10: Regression Results for GDP

$$gdp_t = \alpha_0 + \beta_1 Ex\_rate_t + \beta_2 Lir_t + \beta_3 M3_t + \beta_4 infl_t + \beta_5 repo\_rate_t + \varepsilon_t$$

Table 4.10 shows that exchange rate, inflation, lending rate, broad money and repo rate explain 36.23 percent of variation in GDP. The model shows that exchange rate, lending rate, and repo rate are significant at 5 percent. However, inflation and broad money are insignificant at 5 percent.

Dependent Variable: GDP				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.673751	1.043421	9.271187	0.0000
Exchange rate	0.759303	0.233939	3.245732	0.0019
Inflation	-0.006845	0.005928	-1.154583	0.2526
Lending rate	-0.023241	0.005306	-4.379929	0.0000
Broad money	-0.078240	0.073041	-1.071179	0.2881
Repo rate	0.076904	0.031147	2.469081	0.0162
R-squared	0.408493			
Adjusted R-squared	0.362281			
F-statistic	8.839627			
Prob(F-statistic)	0.000002			
No. of observations =70				

Note: Standard errors in bracket. *,**,**** represent significant at 10 percent, 5 percent and 1 percent respectively.

Source: Author's calculations (2019)

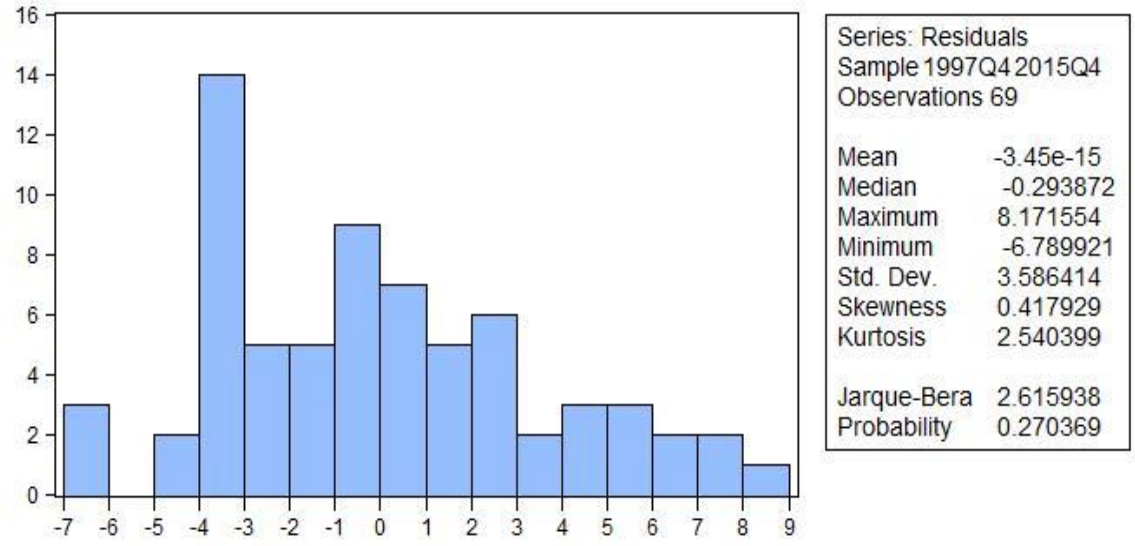
Exchange rate have a positive effect on GDP. A percent increase in exchange leads to 0.75 percent increase in GDP ceteris paribus. An appreciation in a currency may affect GDP by making importation of capital goods and input cheaper. A unit point increase in lending rate leads to a 0.02 unit point decrease in GDP ceteris paribus. Raising lending rate increases the cost of borrowing to investor which dampens economic growth. The study also found that a unit increase in repo rate leads to 0.08 unit decrease in GDP ceteris paribus. Since repo rate is used to control inflation which have a negative effect on GDP, increase in repo rate may increase GDP reducing the negative effect inflation have on GDP.

4.6 Post-Estimation Diagnostics Test

Two models were estimated by OLS and the residual were tested for normality and serial correlation. In the first model, the dependent variable was inflation and independent variables were repo rate, exchange rate, broad money, GDP and leading rate. In the second model, the dependent variable was GDP and the independent variables were repo rate, exchange rate, broad money, GDP and leading rate.

4.6.1 Normality Test - Histogram-Normality Test

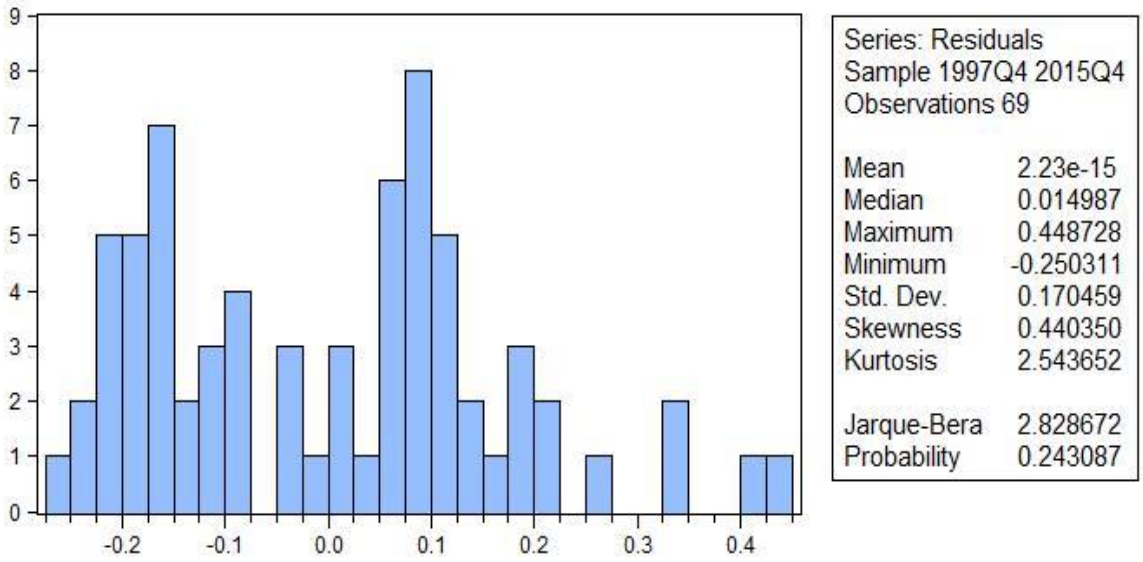
Figure 4.1 Dependent Variable: Inflation



Source: Author's calculations (2019)

Figure 4.1 shows the histogram of the residual of inflation model and the associated Jarque-Bera statistic. For the normality test, the probability of the Jarque-Bera should be more than the 0.05. The null hypothesis stated that the error term was normally distributed. The Jarque-Bera Statistics was 2.6159 with probability value 0.2704 which was greater than p-value of 0.005 (5percent). Thus, the null hypothesis was not rejected, and the study concluded that the residuals were normally distributed.

Figure 4.2 Dependent Variable: GDP



Source: Author's calculations (2019)

Figure 4.2 shows the histogram of the residual of economic growth model and the associated Jarque-Bera statistic. For the normality test, the probability of the Jarque-Bera should be more than 0.05. The null hypothesis stated that the error term was normally distributed. The Jarque-Bera Statistics was 2.8287 with probability value 0.2431 which was greater than p-value of 0.05 (5percent). Thus, the null hypothesis was not rejected, and the study concluded that the residuals were normally distributed.

4.6.2 Autocorrelation Test- Breusch-Godfrey Langrage Multiplier Test

Serial correlation is said to be present if residuals of one period are correlated to the residuals of the previous period. Breusch-Godfrey Serial Correlation LM test was used to test for the presence of serial correlation in both inflation and economic growth model. The null hypothesis for serial correlation test was stated as, H0: There is no serial correlation. If the probability value (p-value) is greater than 5percent, hence fail to reject the null hypothesis. Table 4.11 displays the results of Breusch-Godfrey Serial Correlation LM test for Inflation model.

Table 4.11: Serial Correlation Tests: Dependent Variable: Inflation

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	103.6494	Prob. F (2,61)	0.0000
Obs*R-squared	53.3123	Prob. Chi-Square (2)	0.0000

Source: Author's calculations (2019)

The probability value is less than 5 percent, therefore, the null hypothesis of no serial correlation is rejected, concluding there is presence of serial correlation. Thus, to correct for presence of serial correlation, the study used HAC (Newey-West) standard errors.

Table 4.12: Serial Correlation Tests: Dependent Variable: GDP

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	188.4358	Prob. F (2,61)	0.0000
Obs*R-squared	59.3876	Prob. Chi-Square (2)	0.0000

Source: Author's calculation (2019)

The probability value is less than 5 percent, hence, the null hypothesis of no serial correlation is rejected, implying presence of serial correlation. Thus, to correct for presence of serial correlation, the study used HAC (Newey-West) standard errors.

4.7 The Responsiveness of Inflation and GDP to Shocks in Repo Rate

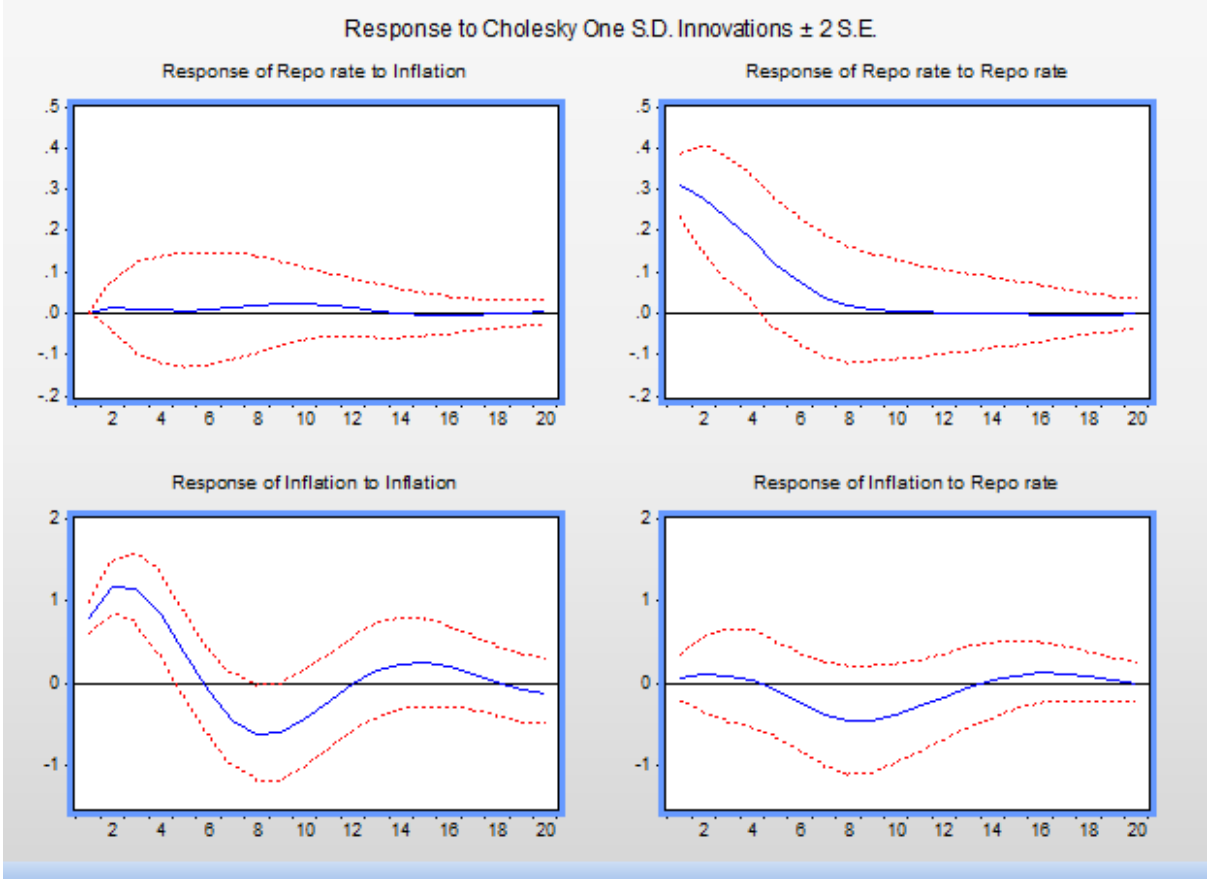
The first study objective was to determine the impact of repo rate innovations on price stability and GDP in Kenya. To achieve the objective, the study estimated FAVAR model and derived impulse response functions and variance decomposition of price stability and GDP. The forecasting was done over a twenty-year time horizon. The FAVAR model coefficient cannot be interpreted since they are not from structural model. However, the coefficients are important for derivation of impulses responses functions (IRF) and

forecasting error decompositions. The IRFs map out the dynamics response path of the variable caused by shock in another variable.

4.7.1 The Response of Inflation to Repo Rate Innovations

Figure 4.3 shows the impact of one standard deviation shock of repo rate to inflation and traces the dynamic responses of price stability over ten periods.

Figure 4.3: Impulse Response Functions of Inflation



Source: Author's calculations (2019)

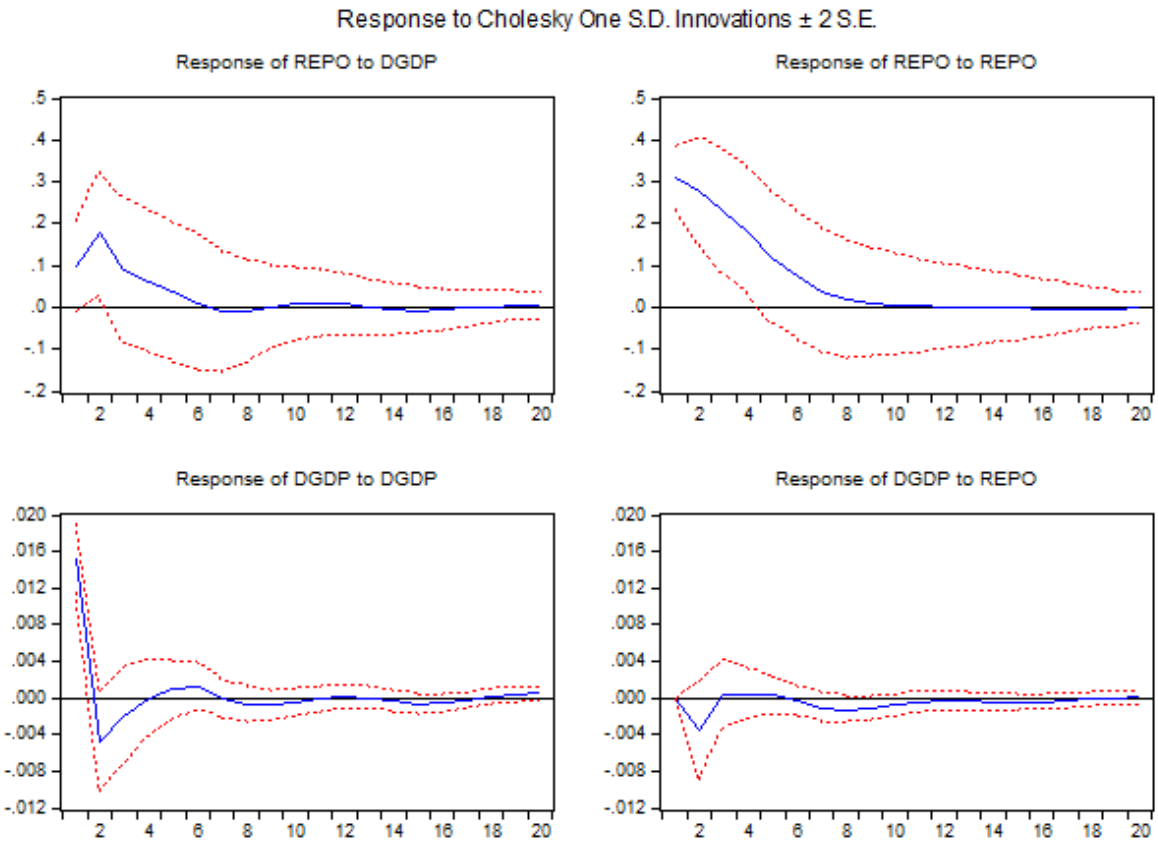
One standard deviation innovation shock on repo rate causes inflation oscillate around zero. The study found that one standard deviation shock of repo rate to inflation have a slightly positive effect, that becomes negative by fifth quarter and positive by 13 quarter. The impact is persistently negative; however, shocks declines until the eighth quarter and start rising. Repo rate as monetary policy instrument are intended to control inflation. Increases in repo

rate increases the cost of borrowing by banks which passes the cost to customers that reducing the amount of money circulating in the economy. Less money supply in the economy reduces inflation pressures as it reduces consumption and investment demand. The study findings confirm Cheng (2006) study that found that an exogenous increase in CBK repo rate leads to decline in prices.

4.7.2 The Response of Economic Growth to Repo Rate Innovations

Figure 4.4 shows the impact of one standard deviation shock of repo rate to GDP and traces the dynamic responses of GDP over ten periods.

Figure 4.4: Impulse Response Functions of the GDP.



Source: Author's calculations (2019)

Figure 4.4 shows that one standard deviation innovation shock on repo rate do not have a significant impact on GDP. The impulse response function of the period closely follows the zero line, indicating that the impact of repo rate innovation on GDP is very minimal. Repo

rate is monetary policy instrument that is used to control inflation by increasing the cost of borrowing. An increase in repo rates will reduce consumption, investment, exports and increase imports through the exchange rate channel. Therefore, repo rate increase has two major impact on the economy. On one hand, it controls inflation which has a positive impact on economic growth. On the other hand, it reduces investment and exports that have a negative effect on the economic growth. The study found that the two effect balances out and overall, repo rate in Kenya may not be an effective tool to increase economic growth. The study findings are in line with the findings of Sun, Gan, and Hu, 2010) in China that founds that repo rate have insignificant impact on economic growth.

4.8 Relationship between Money Supply, Price Stability and GDP in Kenya

The second objective of the study was to determine the relationship between money supply, price stability and economic growth in Kenya. To achieve the objective, cointegration analysis using ARDL model was conducted to determine whether money supply, price stability and economic growth had a long run or a short run relationship. The estimated ARDL model is shown in Appendix 1 Table A4. The ARDL model assumes that there is no serial correlation. Table 4.13 shows the Breusch_Godfrey Serial Correlation test.

Table 4.13: Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.238517	Prob. F(2,51)	0.7887
Obs*R-squared	0.611617	Prob. Chi-Square(2)	0.7365

Source: Author's calculations (2019)

The table 4.13 shows computed F statistic of 0.2385 with a p-value of 0.7887. Therefore, reject null hypothesis of presence of serial correlation and conclude that ARDL model do not

have serial correlation. Therefore, the study can test for cointegration using the bound test. The results of bound test are given in Table 4.14.

Table 4.14 Bound test

ARDL Bounds test Included observations: 66 Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	K
F-statistic	6.204728	2
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10percent	4.1919	5.060
5percent	4.8712	5.8511
2.5percent	5.7911	6.592
1percent	6.3421	7.5221

Source: Author's calculations (2019)

Table 4.14 show that the bound test has an F-statistic of 6.2947 which is above the critical value of 5 percent significance level. Therefore, reject the null hypothesis of no long run relationship and conclude that there is a long run relationship among money supply, inflation and economic growth.

Table 4.15 shows both the short run and long run relationship between GDP, money supply and inflation. The table shows that most of the short run coefficients are significant at 10 percent. The Lag of first and second difference of GDP have a negative effect on GDP while the first difference of money supply has a positive effect on GDP. The coefficients are significant at 5 percent. For inflation, the first and third lag of first difference have a positive effect on GDP while the second lag has a negative effect. Only the coefficient of the third lag is significant at 10 percent.

The table also shows the cointegration term (CointEQ(-1)) which is -0.1620. The coefficeint is negative as required and is significant at 5 percent significance level. This confirms that there is a long run relationship between GDP, money supply and inflation. The coefficeint indicates that, 16 percent of disequilibrium in GDP is corrected in the first quarter.

Table 4.15: ARDL Cointegrating And Long Run Form

Dependent Variable: GDP Selected Model: ARDL (3, 2, 4) Included observations: 66				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-0.231806	0.133709	-1.733667	0.0888
D(GDP(-2))	-0.231786	0.131467	-1.763079	0.0837
D(M3)	0.015327	0.007470	2.051803	0.0451
D(M3(-1))	-0.019333	0.008276	-2.336010	0.0233
D(INFL)	-0.008299	0.002420	-3.428897	0.0012
D(INFL(-1))	0.000708	0.004566	0.155037	0.8774
D(INFL(-2))	-0.001557	0.004273	-0.364497	0.7169
D(INFL(-3))	0.004342	0.002457	1.767251	0.0829
D(@TREND())	0.002319	0.000797	2.909876	0.0053
CointEq(-1)	-0.162023	0.072614	-2.231300	0.0299
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
M3	0.239482	0.123713	1.935786	0.0582
INFL	-0.028648	0.012833	-2.232380	0.0298
C	12.463991	0.099040	125.847693	0.0000
@TREND	0.014312	0.001842	7.771028	0.0000

Source: Author’s calculations (2019)

The long run relationship indicates that money supply has positive effect on GDP and the coefficient is significant at 10 percent. The coefficeint indicates that a 10 percent point increase in money supply, increases GDP by 2.4 percentage point holding other factors constant. This is as expected theoretically. Money supply can be used to stimulate demand in the economy that can increase economic growth. Therefore, money supply is an effective monetary policy tool. On the other hand, inflation have negative effect on GDP and the coefficeint is significant at 5 percent. This is expected theoretically, as an increase in inflation erodes consumers' and investors' confidence. The study found that a 10 percent point increase in inflation reduces GDP by 0.3 percentage point holding other factors constant. The study findings of long run relationship between GDP, money supply and inflation confirmed a study by Ahmed and Suliman,(2011) that found a long run relationship among the three variables in Sudan. Furthermore, the results are in line with (Walillah and Rabbi ,2011) that found a long run relationship between GDP, money supply and inflation in Pakistan.

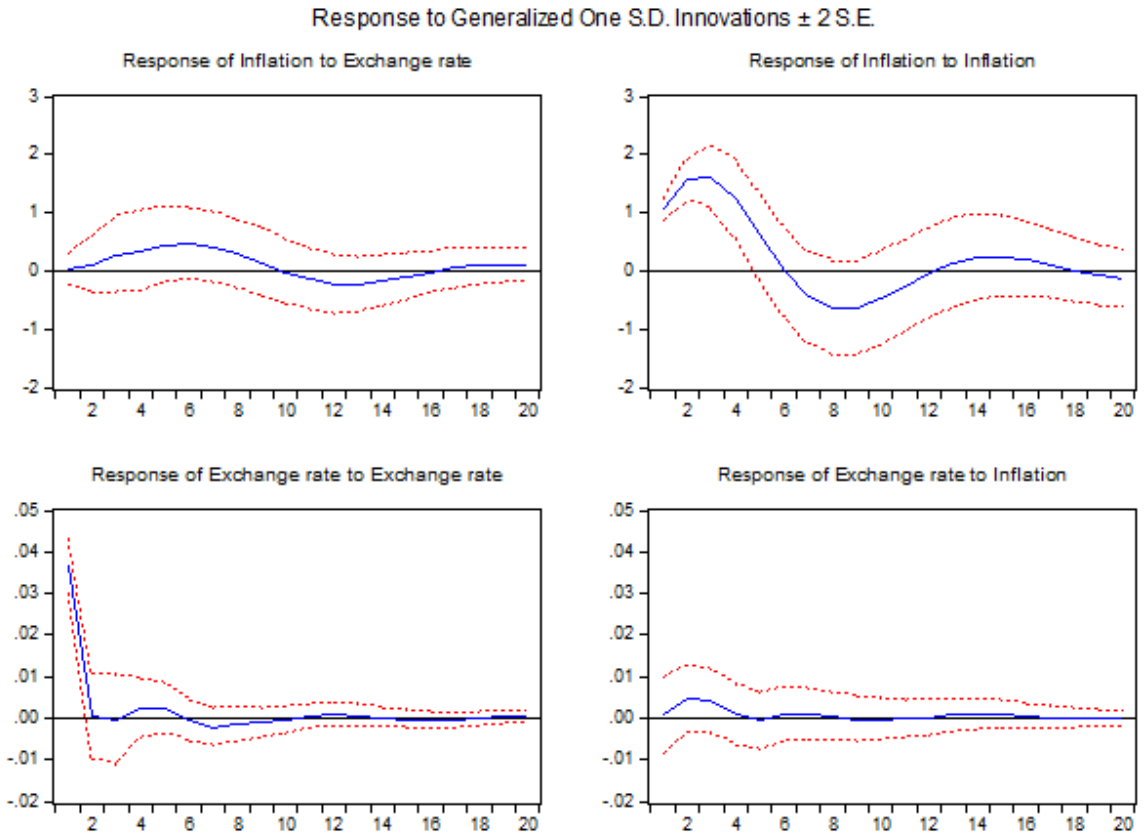
4.9 The Response of Inflation and GDP to Exchange Rate Fluctuations

The third study objective was to determine the effect of exchange rate on inflation and GDP in Kenya. To achieve the objective, the study estimated FAVAR model and derived impulse response functions and variance decomposition of price stability and GDP.

4.9.1 The Response of Inflation to Exchange Rate Fluctuations

Figure 4.5 shows the impact of one standard deviation shock of exchange rate to inflation and traces the dynamic responses of price stability over twenty periods.

Figure 4.5: Impulse Response Functions of Inflation



Source: Author's calculations (2019)

One standard deviation innovation on exchange rate have positive effect on inflation, that becomes negative by tenth quarter. The study found that one standard deviation shock of exchange rate to inflation have a positive effect. However, inflation seems to be almost zero after the tenth quarter. Exchange rate affects the prices level in the country through the import-export channel. When exchange rate depreciates import becomes more expensive which increases the cost of inputs like crude oil and also food stuff as Kenya is net food importer. This will increase inflation. The study found that for the period under study this not the case in Kenya, but the effect occurs with a lag. The results are contrary to Kandil (2004) and Mangani (2012) studies that found out that exchange rate has significant effect on

inflation. The lag on effect of exchange rate on inflation may be due to structural weakness in the financial sector.

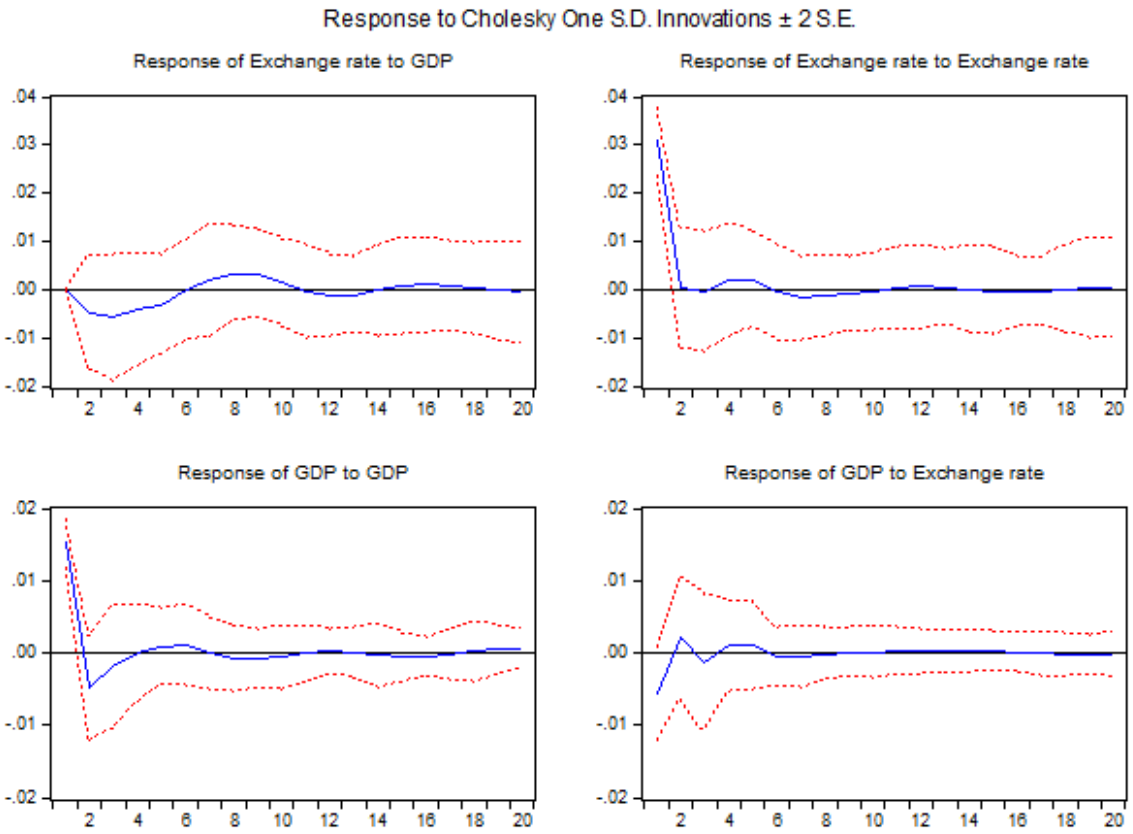
4.9.2 The Response of Economic Growth to Exchange Rate

Figure 4.6 shows the impact of one standard deviation shock of exchange rate to GDP and traces the dynamic responses of GDP over twenty periods.

One standard deviation innovation on exchange rate has unstable effect on GDP. The study found that one standard deviation shock of exchange rate to GDP have a small negative effect seen in the first quarter and turns positive on third quarter but dies out by sixth quarter. Therefore, the effect of exchange rate on GDP is seen with a lag. Exchange rate affects the GDP in the country through the import-export channel. When exchange rate depreciates import becomes more expensive which increases the cost of inputs like crude oil. However, it also makes it attractive to export. Therefore, depreciation have both a negative and positive effect on GDP, as export will increase economic growth while high input prices will reduce GDP.

As the impulses shows in Figure 4.6, the effect of exchange rate on GDP oscillate around zero. The study findings contradict Kandil (2004) that found that in emerging countries currency depreciations tends to have a negative effect on GDP.

Figure 4.6: Impulse Response Functions of the GDP



Source: Author's calculations (2019)

4.9.3 Variance Decomposition of Inflation and GDP

The forecast error decomposition shows the percentage of the variance of the error made in forecasting a variable due to a precise shock in a specified time horizon. The importance of repo rate and exchange rate in inflation and GDP can be measured through variance decomposition. The second column in Table 4.16 and 4.17 shows the forecast error of each variable while other column shows the percentage of the forecast error variance explained by each variable.

Table 4.16 shows the variance decomposition of inflation.

Table 4.16: Variance Decomposition of Inflation

Period	S.E.	DEX	DF1	DF2	DF3	DGDP	DLIR2	REPO	M3	INFL
1	0.0306	14.0706	4.2174	0.191	0.0193	4.3314	3.6459	0.0051	1.6586	71.8608
2	0.0397	5.8549	1.4612	7.0300	2.3737	1.2319	12.8129	0.5861	0.5499	68.0995
3	0.0422	2.9835	1.6242	6.7255	11.0498	0.6058	11.0410	0.4667	1.1387	64.3650
4	0.0469	2.7118	5.3170	4.3375	19.4206	0.8665	8.5674	0.3996	0.8669	57.5126
5	0.1004	19.1039	11.1420	8.4884	22.8887	3.4692	4.2083	0.4682	0.4383	29.7931
6	0.1323	19.4761	12.9031	9.1076	24.0221	2.9241	5.6999	0.7939	0.3633	24.7098
7	0.1435	19.0257	12.5597	8.8483	23.7000	2.8439	5.5841	2.4990	0.3925	24.5467
8	0.1854	20.2942	20.6609	7.4654	19.9471	2.3964	5.2303	2.7965	0.5301	20.6790
9	0.2445	20.4116	18.5173	7.5081	20.1344	3.3932	7.3034	2.9443	0.5772	19.2105
10	0.3119	29.9864	34.1023	8.4576	9.21306	1.5732	5.7654	1.4018	0.3337	9.1667
Cholesky Ordering: DEX DF1 DF2 DF3 DGDP DLIR2 REPO M3 INFL										

Source: Author's calculations (2019)

F1, F2, F3 and F4 are factors generated from the information matrix using PCA.

F1: Linear combination of the original variables in the information matrix and accounts for the maximum possible variance.

F2, F3 and F4: Captures most information not captured by the F1 and also uncorrelated with F1.

The variance decomposition of price stability due to one standard deviation of repo rates, indicates that inflation explains 71.86 percent of forecast error variance while repo rate explains less than 1 percent in period one. However, exchange rate explains 14 percent of forecast error variance in the first period. The impact of inflation on its forecast error variance decreases to 9 percent by the tenth quarter, while repo rate increases to 1.4 percent and exchange rate increases to 30 percent.

Table 4.17 shows the variance decomposition of GDP due to one standard deviation shock in repo rate.

Table 4.17: Variance Decomposition of the GDP

Period	S.E.	DEX	DF1	DF2	DF3	DGDP	DLIR2	REPO	M3	INFL
1	0.0307	55.5930	4.6999	3.7198	17.9548	18.0326	0	0	0	0
2	0.0397	43.2016	3.3773	3.7931	11.7066	16.7900	19.1281	0.5958	0.0574	1.3500
3	0.0422	39.1648	6.3399	3.8145	10.5067	15.0080	22.0277	0.8809	0.6718	1.5857
4	0.04686	36.6954	5.8458	4.4424	9.8102	17.6443	20.0560	1.1997	1.9034	2.4028
5	0.1004	37.4476	35.6023	7.7063	4.6543	5.3826	6.6945	0.7382	0.7281	1.0460
6	0.1323	43.8228	44.6019	5.8729	1.4967	1.8242	1.4294	0.1644	0.2294	0.5582
7	0.1435	47.5013	34.2918	4.9539	4.4818	5.8793	1.7050	0.2269	0.5197	0.4402
8	0.1854	38.2655	42.2571	7.2669	3.1310	3.4757	4.7275	0.2641	0.3302	0.2821
9	0.2445	42.2301	40.9504	6.4695	2.9595	3.7036	2.7708	0.3484	0.4066	0.1612
10	0.3119	40.8491	39.0501	6.5029	2.8842	5.5752	4.0112	0.3337	0.6190	0.1746
Cholesky Ordering: DEX DF1 DF2 DF3 DGDP DLIR2 REPO M3 INFL										

Source; Author's calculations (2019)

The table shows that in the first period, GDP explain 18.03 percent of the forecast error variance while repo rate explains zero forecast error variance in GDP. However, exchange rate explains 56 percent of forecast error variance in the first period. The impact of GDP on its forecast error variance reduces to 6 percent by the tenth quarter, while repo rate increases to 0.3 percent and exchange rate decreases to 41 percent.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The chapter provide a summary of the research findings, conclusions, and recommendation. It also highlights some policy implication derived from study findings and point out the areas for further research.

5.2 Summary

The overall objective of the study was to investigate the effectiveness of monetary policy on inflation control and economic growth. Specifically, the study aimed to examine the response of price stability and economic growth on repo rate and exchange rate innovations. Furthermore, the study aimed to examine the relationship between economic growth, price stability and money supply. The effectiveness of monetary policy especially in developing countries is a long-standing issue due the underdeveloped financial sector. Given the central role of monetary policy in management of economy, it was therefore, important to examine if monetary policy tools are effective in management of inflation and economic growth.

The motivation of the study was that most Central Banks are moving from direct controls to market-oriented approaches to management inflation, real output and employment. However, market-oriented approaches use intermediate variables which may filter the intended impact. Despite Kenya implementing monetary policies, it has not been able to achieve its goals. Furthermore, empirical literature on the effectiveness of monetary policy is coming at time when a wave of monetary policy regime changes is cutting across Africa. Therefore, the study sought to fill the gap by examining the effectiveness of monetary policy in Kenya using a Factor Augmented Vector Autoregressive model and Autoregressive Distributed Lag model.

To achieve the objective of the study, data was collected on money supply, GDP, inflation, lending interest rates, repo rate and exchange rate. More data for factor analysis was collected on agricultural price index, crude oil prices, fiscal deficit, private sector credit, real interest rates, 91 days treasury bill rate, total investment, current account balance, general government lending/borrowing, government revenue, gross national saving, manufacturing value added, and net capital account. The data was collected from CBK, KNBS and World Bank Development Indicators. The study used FAVAR model and ARDL model to answer the research objective. The estimated models were subjected to pre and post diagnostic test such as residual property test and normality tests prior to making conclusions from the models.

The first objective was to determine the impact of repo rate innovations on price stability and GDP in Kenya. The empirical findings show that repo rate generally have a negative effect on inflation. The response of inflation is not instantaneous as it's positive and turns negative at fifth quarters. On the other hand, the study found that repo rate shocks do not have significant effect on GDP. The response of GDP to shock on repo rate are close to zero.

The second objective of the study was to determine the relationship between money supply, price stability and GDP in Kenya. The empirical findings show that money supply, price stability and GDP have a long run relationship. The study found that 16.20 percent of disequilibrium in GDP is corrected in the first quarter. Furthermore, the study found that a 10 percent increase in money supply leads to 2.4 percent increase in GDP ceteris paribus. Also, the study found that a 10 percent increase in inflation, reduces GDP by 0.3 percent ceteris paribus.

The third objective was to determine the effect of exchange rate fluctuations on price stability and GDP in Kenya. The study found that exchange rate fluctuations had unstable effect on

inflation. Furthermore, the effect of exchange rate fluctuations on GDP was unstable, oscillating form negative to positive.

5.3 Conclusions

Founded on the empirical findings, the study concludes that first, repo rate is effective monetary policy to in controlling inflation but ineffective in stimulating economic growth. Second, the study concludes that there exists a long relationship between GDP, price stability, and money supply. Furthermore, the study concludes that money supply has a positive effect on GDP while inflation have a negative effect on GDP. Third, the study concludes that exchange rate is an ineffective monetary policy tool in controlling inflation while it is effectiveness on GDP is indeterminant.

5.4 Policy Implications

In the view of the empirical findings, repo rate is an effective monetary policy tool in the management of the inflation. Therefore, the finding imply that Central Bank of Kenya should use repo rate to control inflation. However, repo rates are not effective in stimulating GDP. Hence, the findings imply that it should not be used during downturn to improve economic growth.

Furthermore, study shows that there exists a long run relationship between GDP, money supply and inflation. The findings imply that the Central Bank of Kenya should take into consideration the long run impact on GDP when designing tools to control inflation. Inflation have negative effect on GDP and this imply that Central Bank of Kenya should ensure that there is no high inflation.

The study findings also imply that exchange rate is not an effective monetary policy tools to control inflation and stimulate GDP growth. Hence, the CBK should not target exchange rate in the management of the economy.

The study commends that the CBK to target repo rate as it is more effective in controlling inflation or price stability. Moreover, the study recommends that the CBK should maintain stable inflation as inflation have negative effect on GDP. Also, the Central Bank of Kenya should target money supply to stimulate economic growth.

5.5 Areas for Further Research

The focus of the study was limited to the effectiveness of monetary policy. The study focused on repo rate, money supply, inflation and GDP. The study proposes more research on other channels of monetary policy transmission like asset price channel and credit channel.

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APPENDIX 1

Definitions of the Information Set Variables

91-day Treasury bill rate (TB): it is a short-term investment sold at a discount issued by the government every week and with a maturity of 91 days.

Real Interest Rate(r): an interest rate that has been adjusted to remove the effects of inflation so as to reflect the real cost of funds to the borrower and the real yield to the lender or to an investor

Total Investment (TI): total amount of money that a country or an entity has in a given place.

Fiscal Deficit (FD): difference between total revenue and total expenditure of the government.

General government lending (GNL): a measure of the extent to which general government is either putting financial resources at the disposal of other sectors in the economy and non-residents.

Private sector credit (psc): financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment.

Gross National Savings (GNS): is derived by deducting final consumption expenditure from Gross national disposable income, and consists of personal saving, plus business saving, plus government saving, but excludes foreign saving.

Net Capital Account (NCA): includes government debt forgiveness, investment grants in cash or in kind by a government entity, and taxes on capital transfers, migrants' capital transfers and debt forgiveness and investment grants by nongovernmental entities.

Current Account Balance (CAB): a country's trade balance plus net income and direct payments.

Government Revenue (GR): money received by a government. It is an important tool of the fiscal policy of the government and is the opposite factor of government spending.

Manufacturing Value Added (MVA): the total estimate of net-output of all resident manufacturing activity units obtained by adding up outputs and subtracting intermediate inputs.

Crude Oil Price (COK)*: spot price of one barrel of the benchmark crude oil. The price depends upon its grade, location and the content of sulphur present in it.

Agriculture Price Index (API)*: a lagging indicator which changes after the economy has begun to follow a particular pattern or trend.

APPENDIX 2

Table A1: Factor Analysis using Principal Component Analysis

Rotated loadings: L * inv (T)'				
	F1	F2	F3	F4
API	-0.447122	0.693798	-0.208288	0.396042
CAB	-0.072031	-0.866159	-0.023863	0.203379
COK	0.875944	-0.091704	0.340759	-0.028364
GNL	-0.928818	0.067569	-0.006879	0.098381
FD	-0.732351	0.409821	-0.461455	0.176486
GV	0.033747	-0.012718	0.156782	-0.817609
GNS	-0.560435	-0.381709	-0.067923	0.370866
MVA	0.095141	0.015942	0.975037	-0.095959
NCA	0.651701	0.061449	0.126086	-0.365836
PSC	0.816807	0.075768	-0.478011	-0.106102
R	-0.293968	0.558160	-0.579064	0.195789
TB	-0.102625	0.844015	-0.008925	0.020500
TI	0.768809	-0.370844	0.292430	0.270208

Table A2: Descriptive Statistics of the Factors

	F1	F2	F3
Mean	8.80E-10	-2.30E-09	-4.23E-09
Median	-0.506129	-0.233689	-0.227921
Maximum	2.141903	2.546635	2.074514
Minimum	-1.221715	-1.498804	-1.754788
Std. Dev.	0.998941	0.989130	0.993237
Skewness	0.728113	0.932780	0.378342
Kurtosis	2.092406	3.582749	2.256729
Jarque-Bera	8.587602	11.14140	3.281317
Probability	0.013653	0.003808	0.193852
Sum	6.16E-08	-1.61E-07	-2.96E-07
Sum Sq. Dev.	68.85387	67.50813	68.06992
Observations	70	70	70

APPENDIX 3

Table A3: Unit root test for the factors

Null Hypothesis: the variable has a unit root				
At Level				
		F1	F2	F3
With Constant	t-Statistic	-0.7515	-3.3037	-2.0861
	Prob.	**0.8260**	**0.0186**	**0.2509**
With Constant & Trend	t-Statistic	-2.2400	-2.9980	-1.9718
	Prob.	**0.4601**	**0.1405**	**0.6059**
		n0	n0	n0
Without Constant & Trend	t-Statistic	-0.9648	-3.1152	-2.1202
	Prob.	**0.2960**	**0.0023**	**0.0336**
		n0	***	**
At First Difference				
		d(F1)	d(F2)	d(F3)
With Constant	t-Statistic	-3.5447	-4.0463	-2.9909
	Prob.	**0.0096**	**0.0022**	**0.0408**
		***	***	**
With Constant & Trend	t-Statistic	-3.3612	-4.9857	-3.0357
	Prob.	**0.0654**	**0.0007**	**0.1304**
		*	***	n0
Without Constant & Trend	t-Statistic	-3.2109	-3.9356	-2.9772
	Prob.	**0.0017**	**0.0002**	**0.0034**
		***	***	***
Notes:				
b: Lag Length based on SIC				

APPENDIX 4

Table A4: ARDL Model

Dependent Variable: GDP Method: ARDL Included observations: 66 after adjustments Maximum dependent lags: 4 (Automatic selection Dynamic regressors (4 lags, automatic): M3 INFL Number of models evaluated: 100 Selected Model: ARDL(3, 2, 4)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.606171	0.128288	4.725089	0.0000
GDP(-2)	1.99E-05	0.151160	0.000131	0.9999
GDP(-3)	0.231786	0.131467	1.763079	0.0837
M3	0.015327	0.007470	2.051803	0.0451
M3(-1)	0.004141	0.007752	0.534269	0.5954
M3(-2)	0.019333	0.008276	2.336010	0.0233
INFL	-0.008299	0.002420	-3.428897	0.0012
INFL(-1)	0.007150	0.004299	1.663239	0.1022
INFL(-2)	-0.000708	0.004566	-0.155037	0.8774
INFL(-3)	0.001557	0.004273	0.364497	0.7169
INFL(-4)	-0.004342	0.002457	-1.767251	0.0829
C	2.019450	0.892358	2.263049	0.0278
@TREND	0.002319	0.000797	2.909876	0.0053
R-squared	0.993618	Mean dependent var		12.66055
Adjusted R-squared	0.992174	S.D. dependent var		0.216676
F-statistic	687.6873	Durbin-Watson stat		1.928832
Prob(F-statistic)	0.000000			
*Note: p-values and any subsequent tests do not account for model selection				

APPENDIX 5

Table A5: FAVAR Results

Vector Autoregression Estimates									
Included observations: 66 after adjustments									
Standard errors in ( ) & t-statistics in [ ]									
	DEX	DF1	DF2	DF3	DGDP	DLIR2	REPO	M3	INFL
DEX(-1)	-0.13019	0.392796	0.441504	-0.30357	0.046938	-0.31273	-1.59351	-1.32265	1.938321
	-0.15283	-0.23201	-0.28747	-0.49164	-0.0962	-0.3274	-1.83968	-1.30861	-4.45298
	[-0.85186]	[1.69303]	[1.53582]	[-0.61746]	[0.48794]	[-0.95518]	[-0.86619]	[-1.01073]	[0.43529]
DEX(-2)	-0.1513	0.100296	0.012664	-0.3877	-0.11289	0.411401	-1.64107	0.077647	0.644702
	-0.15807	-0.23996	-0.29733	-0.50849	-0.09949	-0.33863	-1.90274	-1.35347	-4.60563
	[-0.95717]	[0.41797]	[0.04259]	[-0.76246]	[-1.13463]	[1.21490]	[-0.86247]	[0.05737]	[0.13998]
DF1(-1)	0.343713	0.928525	-0.20329	1.32563	0.147926	0.313136	3.608043	1.440903	0.867366
	-0.17044	-0.25874	-0.32059	-0.54828	-0.10728	-0.36512	-2.05161	-1.45937	-4.96598
	[2.01665]	[3.58870]	[-0.63412]	[2.41781]	[1.37889]	[0.85762]	[1.75864]	[0.98735]	[0.17466]
DF1(-2)	-0.13612	-0.43787	0.454187	-0.34902	-0.09092	0.108565	-2.58953	-0.7026	4.189323
	-0.17617	-0.26744	-0.33137	-0.56672	-0.11089	-0.3774	-2.12062	-1.50845	-5.13301
	[-0.77264]	[-1.63726]	[1.37063]	[-0.61586]	[-0.81992]	[0.28766]	[-1.22112]	[-0.46577]	[0.81615]
DF2(-1)	-0.20296	0.047431	1.197487	-0.55121	-0.02692	0.217419	-0.14651	0.582107	1.635541
	-0.08595	-0.13047	-0.16167	-0.27648	-0.0541	-0.18412	-1.03458	-0.73593	-2.50423

	[-2.36139]	[0.36353]	[7.40719]	[-1.99364]	[-0.49763]	[1.18084]	[-0.14161]	[0.79099]	[0.65311]
DF2(-2)	0.110846	0.136368	-0.47052	0.061159	0.055372	-0.31696	-0.27945	-0.2896	-0.95616
	-0.08593	-0.13044	-0.16163	-0.27641	-0.05408	-0.18408	-1.03433	-0.73574	-2.50361
	[1.29001]	[1.04543]	[-2.91120]	[0.22126]	[1.02381]	[-1.72187]	[-0.27018]	[-0.39361]	[-0.38191]
DF3(-1)	0.186259	0.131776	-0.1255	0.631354	0.035721	-0.15064	0.987902	0.825075	-0.57582
	-0.08668	-0.13159	-0.16305	-0.27885	-0.05456	-0.1857	-1.04343	-0.74222	-2.52564
	[2.14875]	[1.00141]	[-0.76969]	[2.26416]	[0.65470]	[-0.81118]	[0.94679]	[1.11164]	[-0.22799]
DF3(-2)	0.019186	-0.1887	0.066893	0.252627	-0.02317	0.28451	0.384033	0.066346	1.371898
	-0.04787	-0.07267	-0.09004	-0.15399	-0.03013	-0.10255	-0.57621	-0.40988	-1.39474
	[0.40080]	[-2.59680]	[0.74293]	[1.64056]	[-0.76915]	[2.77441]	[0.66648]	[0.16187]	[0.98363]
DGDP(-1)	-0.37994	-1.49016	1.358198	3.530481	-0.22514	0.678554	3.241105	-0.644	-2.73846
	-0.29636	-0.4499	-0.55745	-0.95336	-0.18654	-0.63489	-3.56741	-2.53759	-8.63501
	[-1.28202]	[-3.31222]	[2.43645]	[3.70320]	[-1.20695]	[1.06878]	[0.90853]	[-0.25378]	[-0.31713]
DGDP(-2)	-0.44729	-0.53086	0.401338	0.891199	-0.07021	0.181001	-1.35657	-3.42837	-5.34683
	-0.33966	-0.51563	-0.6389	-1.09265	-0.21379	-0.72765	-4.08863	-2.90835	-9.89663
	[-1.31686]	[-1.02954]	[0.62817]	[0.81563]	[-0.32841]	[0.24875]	[-0.33179]	[-1.17880]	[-0.54027]
DLIR2(-1)	-0.07839	0.055784	-0.11485	-0.1929	0.013821	1.362786	-0.0997	-0.04959	-0.77514
	-0.0314	-0.04766	-0.05906	-0.101	-0.01976	-0.06726	-0.37793	-0.26883	-0.91479
	[-2.49675]	[1.17040]	[-1.94481]	[-1.90992]	[0.69939]	[20.2615]	[-0.26381]	[-0.18445]	[-0.84734]
DLIR2(-2)	0.023344	-0.04384	0.104541	0.146329	-0.01423	-0.78474	-0.05053	0.009696	0.731323
	-0.02968	-0.04505	-0.05582	-0.09546	-0.01868	-0.06357	-0.35722	-0.2541	-0.86467
	[0.78663]	[-0.97306]	[1.87281]	[1.53281]	[-0.76175]	[-12.3436]	[-0.14145]	[0.03816]	[0.84578]

REPO(-1)	0.015435	0.012594	0.027805	-0.01211	-0.0103	-0.02287	0.80962	0.284051	0.011682
	-0.01381	-0.02096	-0.02597	-0.04441	-0.00869	-0.02958	-0.16619	-0.11821	-0.40226
	[1.11796]	[0.60088]	[1.07072]	[-0.27257]	[-1.18549]	[-0.77334]	[4.87171]	[2.40286]	[0.02904]
REPO(-2)	-0.02162	-0.01311	-0.06118	-0.01171	0.006755	0.018117	-0.0979	-0.07869	-0.45027
	-0.01272	-0.01931	-0.02392	-0.04091	-0.008	-0.02724	-0.15308	-0.10889	-0.37053
	[-1.70040]	[-0.67895]	[-2.55766]	[-0.28634]	[0.84395]	[0.66499]	[-0.63956]	[-0.72268]	[-1.21519]
M3(-1)	0.000496	0.013521	0.001763	-0.03116	-0.00513	0.085789	0.447519	-0.35297	0.081919
	-0.0173	-0.02626	-0.03254	-0.05565	-0.01089	-0.03706	-0.20823	-0.14812	-0.50403
	[0.02865]	[0.51488]	[0.05418]	[-0.56001]	[-0.47112]	[2.31494]	[2.14913]	[-2.38300]	[0.16253]
M3(-2)	0.018348	-0.02583	-0.01226	0.032056	0.006349	0.017025	0.220535	-0.25361	1.270756
	-0.01821	-0.02764	-0.03425	-0.05857	-0.01146	-0.039	-0.21916	-0.15589	-0.53047
	[1.00776]	[-0.93450]	[-0.35806]	[0.54733]	[0.55402]	[0.43651]	[1.00630]	[-1.62684]	[2.39553]
INFL(-1)	0.003644	-0.00361	-0.00599	-0.00124	-0.0016	0.006533	0.017174	-0.0124	1.474342
	-0.00332	-0.00504	-0.00625	-0.01068	-0.00209	-0.00712	-0.03998	-0.02844	-0.09677
	[1.09715]	[-0.71615]	[-0.95829]	[-0.11615]	[-0.76512]	[0.91824]	[0.42956]	[-0.43604]	[15.2353]
INFL(-2)	-0.00322	0.001023	0.004243	0.004818	0.001787	-0.00583	0.005332	-0.00307	-0.70746
	-0.003	-0.00456	-0.00565	-0.00966	-0.00189	-0.00643	-0.03613	-0.0257	-0.08745
	[-1.07401]	[0.22441]	[0.75157]	[0.49903]	[0.94571]	[-0.90704]	[0.14758]	[-0.11936]	[-8.08940]
C	0.010035	0.071619	0.034577	-0.09354	0.018266	-0.0262	0.283317	-0.23932	2.584295
	-0.02169	-0.03292	-0.04079	-0.06976	-0.01365	-0.04646	-0.26105	-0.18569	-0.63188
	[0.46274]	[2.17541]	[0.84764]	[-1.34087]	[1.33814]	[-0.56398]	[1.08530]	[-1.28882]	[4.08986]
R-squared	0.341234	0.708018	0.855598	0.542072	0.217667	0.952688	0.772567	0.334731	0.946702

Adj. R-squared	0.08894	0.596195	0.800295	0.366695	-0.08195	0.934568	0.685464	0.079947	0.92629
Sum sq. resids	0.062962	0.145098	0.222764	0.65155	0.024945	0.288953	9.123045	4.616124	53.45131
S.E. equation	0.036601	0.055563	0.068845	0.11774	0.023038	0.078409	0.440576	0.313393	1.066425
F-statistic	1.352527	6.33161	15.47111	3.090898	0.726484	52.57791	8.86966	1.313785	46.37973
Log likelihood	135.861	108.3101	94.16291	58.74592	166.415	85.57792	-28.3479	-5.86667	-86.6908
Akaike AIC	-3.54124	-2.70637	-2.27766	-1.20442	-4.46712	-2.01751	1.434784	0.753535	3.202751
Schwarz SC	-2.91089	-2.07601	-1.64731	-0.57407	-3.83677	-1.38716	2.065139	1.38389	3.833106
Mean dependent	0.003634	0.044412	-0.03382	0.001113	0.011422	0.002245	1.82532	-0.00945	7.968939
S.D. dependent	0.038346	0.087437	0.154056	0.147951	0.022148	0.306528	0.785572	0.326726	3.927962
Determinant resid covariance (dof adj.)		2.68E-19							
Determinant resid covariance		1.26E-20							
Log likelihood		669.2035							
Akaike information criterion		-15.0971							
Schwarz criterion		-9.42388							

APPENDIX 6

Table A6: Data Used in Model Analysis

year	dex	df1	df2	df3	dgdp	dlir2	infl	m3	repo
1997-10-01	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	8.38	0.025	3.277145
1998-01-01	-0.03539	-0.11236	0.101731	#N/A	0.00846	#N/A	7.63	-0.116	3.198673
1998-04-01	-0.02015	-0.09741	0.072822	-0.00771	0.00386	-0.21265	7.39	-0.027	3.104587
1998-07-01	-0.00471	-0.0848	-0.05334	-0.04225	0.00748	-0.42529	6.51	-0.051	2.397895
1998-10-01	0.039915	-0.06788	-0.25051	-0.06648	0.01271	-0.63794	4.06	-0.1	2.110213
1999-01-01	0.046882	-0.02185	-0.38501	-0.03576	0.01028	-0.73724	4.01	0.161	2.079442
1999-04-01	0.114408	0.065069	-0.26803	0.079002	0.00243	-0.38313	3.66	0.085	2.791165
1999-07-01	0.031118	0.110786	-0.1886	0.08286	-0.00571	0.084324	4.17	0.108	2.881443
1999-10-01	-0.01485	0.10015	-0.20665	0.063204	0.01271	0.55178	5.78	0.124	2.014903
2000-01-01	0.019251	0.042471	-0.31467	0.035102	0.01374	0.874882	7.36	0.009	2.302585
2000-04-01	0.019696	0.025403	-0.2833	0.051426	0.00135	0.620574	8.4	0.081	2.341806
2000-07-01	0.008505	0.040346	-0.17585	0.031514	0.0005	0.221907	9.61	0.071	2.558002
2000-10-01	0.013885	0.069705	-0.06191	-0.0157	-0.01692	-0.17675	9.97	0.056	2.679651
2001-01-01	-0.00013	0.095564	0.002443	-0.0708	0.00053	-0.4727	10.66	0.146	2.509599
2001-04-01	-0.00522	0.060981	-0.14891	-0.13458	0.02328	-0.35775	10.06	0.141	2.408745
2001-07-01	0.001178	0.0813	-0.04509	0.00051	0.01058	-0.14009	8.06	0.116	2.386926
2001-10-01	0.001616	0.050626	-0.10484	-0.0287	0.02665	0.077576	5.73	0.107	2.319442
2002-01-01	0.005532	0.026874	-0.10753	0.02344	0.00394	0.244257	3.49	0.037	2.09679
2002-04-01	-0.00543	-0.00635	-0.15152	0.016104	-0.0081	0.206997	2.28	0.041	1.987874
2002-07-01	-0.00366	-0.0259	-0.15364	0.03619	0.01422	0.118753	1.81	0.015	2.111425
2002-10-01	0.013159	-0.04711	-0.17454	0.032471	-0.00556	0.030512	1.97	0.004	1.754404
2003-01-01	-0.02342	-0.07452	-0.23342	0.018425	-0.02503	-0.05373	3.63	-0.221	-0.10536

2003-04-01	-0.05049	-0.09493	-0.28303	0.011753	0.01882	-0.12196	6.54	-0.221	-0.71335
2003-07-01	0.049352	-0.09985	-0.29105	0.014965	0.00726	-0.18618	8.34	-0.518	-0.10536
2003-10-01	-0.02051	-0.05722	-0.1307	0.067923	0.00573	-0.2504	9.81	-1.308	0.392042
2004-01-01	0.029991	-0.02643	-0.03576	0.029429	0.02817	-0.26975	10.06	1.163	0.336472
2004-04-01	0.014314	0.004318	0.044713	0.012021	0.00794	-0.10957	8.19	0.036	0.924259
2004-07-01	0.010187	0.023094	0.064644	-0.02319	0.02935	0.095489	9.59	0.093	1.99606
2004-10-01	-0.00383	0.065157	0.163448	-0.0037	-0.01581	0.300549	11.79	0.126	1.985131
2005-01-01	-0.05521	0.075532	0.135816	-0.05041	0.00553	0.447836	13.07	-0.099	1.997418
2005-04-01	0.016785	0.061132	0.057429	-0.00998	0.03172	0.364053	15.1	0.11	2.055405
2005-07-01	-0.04407	0.049393	0.048857	0.092111	0.00608	0.222498	13.24	0.024	2.054124
2005-10-01	-0.0028	0.02134	0.035069	0.164764	0.02519	0.080946	9.87	0.014	1.961502
2006-01-01	-0.00695	-0.00776	0.052415	0.21814	0.01082	-0.03917	8.61	0.006	1.811562
2006-04-01	0.011596	-0.0315	0.030115	0.109588	0.0193	-0.07354	6.33	-0.015	1.826161
2006-07-01	-0.01859	-0.02691	0.034976	-0.00629	0.00859	-0.08648	5.7	-0.057	1.848455
2006-10-01	-0.0334	0.002446	0.052885	-0.12771	0.01857	-0.09941	6.39	-0.07	1.912501
2007-01-01	-0.00442	0.039372	0.034666	-0.23676	0.02573	-0.10064	4.99	0.009	1.957274
2007-04-01	-0.04101	0.081577	0.046356	-0.19326	0.0015	-0.05503	4.46	0.029	2.129421
2007-07-01	-0.00363	0.11457	0.04943	-0.13323	0.02348	0.002286	4.57	0.032	2.004179
2007-10-01	-0.04557	0.141919	0.058003	-0.06766	0.02527	0.059608	4.27	0.038	1.873339
2008-01-01	0.023245	0.15933	0.062271	-0.01337	0.00762	0.102877	6.13	0.001	1.957274
2008-04-01	-0.01668	0.166906	0.091368	0.022581	0.01406	0.089961	9.86	-0.054	1.783391
2008-07-01	0.102241	0.146512	0.080764	0.025774	-0.03673	0.062999	13.02	-0.077	1.791759
2008-10-01	0.10171	0.106978	0.065376	0.042665	0.03666	0.036033	16.27	-0.074	1.432701
2009-01-01	0.025487	0.048779	0.019504	0.039452	0.01108	0.008538	17.07	-0.209	1.432701
2009-04-01	-0.03183	0.012763	-0.00563	0.016251	-0.00403	-0.02109	15.11	-0.201	1.011601
2009-07-01	-0.03797	0.002411	-0.02382	-0.02239	0.00567	-0.05126	12.41	-0.274	1.386294
2009-10-01	0.009916	0.014217	-0.04896	-0.06648	-0.00895	-0.08142	9.24	-0.371	0.8671

2010-01-01	0.020276	0.041762	-0.08264	-0.0951	0.01733	-0.10276	7.03	-0.299	0.667829
2010-04-01	0.045184	0.067207	-0.10037	-0.04971	0.02601	-0.08881	5.43	-0.336	0.609766
2010-07-01	-0.00781	0.09666	-0.05424	0.030579	0.00734	-0.06604	4.4	-0.429	0.357674
2010-10-01	0.007842	0.141015	0.098857	0.127773	-0.00793	-0.04326	3.96	-0.549	0.506818
2011-01-01	0.049088	0.162978	0.204682	0.146536	0.04117	0.001949	4.49	1.396	1.7492
2011-04-01	0.042064	0.185258	0.326085	0.11829	0.00052	0.13692	6.88	0.05	2.876386
2011-07-01	0.074868	0.175757	0.329394	0.019678	0.02559	0.294336	10.18	0.206	2.476538
2011-10-01	-0.09286	0.153701	0.290633	-0.04911	0.02264	0.451749	14.02	0.247	2.572612
2012-01-01	-0.03752	0.082582	0.065461	-0.16132	-0.0166	0.519392	16.45	-0.137	2.863343
2012-04-01	0.005887	-0.01918	-0.2732	-0.19211	0.02294	0.227964	15.97	-0.028	2.274186
2012-07-01	-0.00742	-0.01407	-0.18154	0.003686	0.02216	-0.15324	13.29	-0.14	1.859418
2012-10-01	0.031945	-0.01643	-0.11171	0.022062	0.01478	-0.53444	9.38	-0.364	2.247072
2013-01-01	0.005869	-0.00406	0.006388	0.0609	-0.00206	-0.79745	6.33	0.222	2.125848
2013-04-01	-0.02232	0.01696	0.078087	0.034385	0.01611	-0.58775	4.56	0.018	1.94591
2013-07-01	0.015739	0.049792	0.098223	-0.0012	0.02009	-0.25986	4.75	0.026	2.474014
2013-10-01	0.004512	0.104957	0.108398	-0.02047	0.01124	0.068017	5.72	0.043	2.107786
2014-01-01	0.010612	0.144261	0.00416	-0.07463	0.00502	0.322095	6.39	0.055	1.892134
2015-01-01	-0.08593	0.385926	-0.22518	-0.6683	0.14449	0.16221	4.56	0.067	2.67489
2015-04-01	-0.0301	-0.08576	-0.05211	0.727193	0.00163	0.245219	5.22	0.0788	2.98735
2015-07-01	-0.03971	-0.11076	0.058274	0.065788	0.00037	-0.03204	5.7	0.0589	1.815894
2015-10-01	0.009286	-0.14619	0.022833	-0.00267	0.00079	-0.01602	6.5	0.0768	2.247976