OPTIMAL MONETARY POLICY FOR MINIMIZING LOSS RESULTING FROM INFLATION DEVIATION

BY

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DECLARATION

This is my original work and that to the best of my knowledge has never been presented for the award of any degree in any other university or institution.

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APPROVAL

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DR. KENNEDY O. OSORO

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DEDICATION

This work is dedicated to the Suji's lineage and in particular Imbuye's family. My assurance to you is that it shall be well with this milestone.

ACKNOWLEDGEMENT

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LIST OF ACRONYMS AND ABBREVIATIONS

ADF	-	Augmented Dickey-Fuller
CBK	-	Central Bank of Kenya
CBR	-	Central Bank Rate
FDI	-	Foreign Direct Investment
GDP	-	Gross Domestic Product
IFS	-	International Financial Statistics
KNBS	-	Kenya National Bureau of Statistics
MPC	-	Monetary Policy Committee
OECD	-	Organization for Economic Cooperation and Development
OLS	-	Ordinary Least Squares
OMO	-	Open Market Operations
UNCTAD	-	United Nations Conference on Trade and Development
VECM	-	Vector Error Correcting Model
WDI	-	World Development Indicators

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ABSTARCT

This study aimed to investigate the optimal monetary policy instrument in Kenya to minimize loss resulting from inflation deviation, specifically between interest rates and money reserve. Using time series data between 1980 and 2016 and applying Ordinary Least Squares (OLS) and Vector Error Correction Model (VECM), the study established that interest rates as a monetary policy tool is optimal in minimizing losses arising from inflation deviation in Kenya. A positive correlation is found between the money markets and economic output and interest rate while a negative relationship exists between the level of economic output and exchange rates. There is greater flexibility in using interest rates as a monetary tool since it would influence monetary aggregates and the money markets easily and drive the economy to the desired output level and minimizing losses that may be caused by deviation of inflation rate from the target.

CHAPTER ONE: INTRODUCTION

1.0 Background

World over, the Central Banks or Federal Reserve Banks are charged with maintaining either the inflation level or the aggregate output through relevant monetary policy tool such as Open Market Operations (OMO), reserve requirements, discount window operations just to mention but a few. With the aggregate output being used to gauge the healthiness of a nation by interested partners such as the investors (local and international), political elite and so on, the central banks have a tough responsibility to maintain the level of inflation so as to maintain certainty in the economic environment.

An inflation rate, defined as a yearly rise in the general prices levels of bundles of goods and services purchased by consumers in the economy (Word Bank, 2010), plays a significant role in the economic growth and development. Its rate, expressed as a percentage change of inflation from the base year or by the GDP deflator, can give a clue on the cost of living of the citizens. For instance a higher inflation rate means that price levels are rising more than the wages of the average citizen and this may lead to a low living standard. Equally, as the inflation start rising, producers will respond by raising their prices and banking rates also escalates the interest rates to cover up the value money lost. A higher interest rates is likely to signal failing of marginal businesses thus increasing the unemployment rate hurting the economic growth of the country involved.

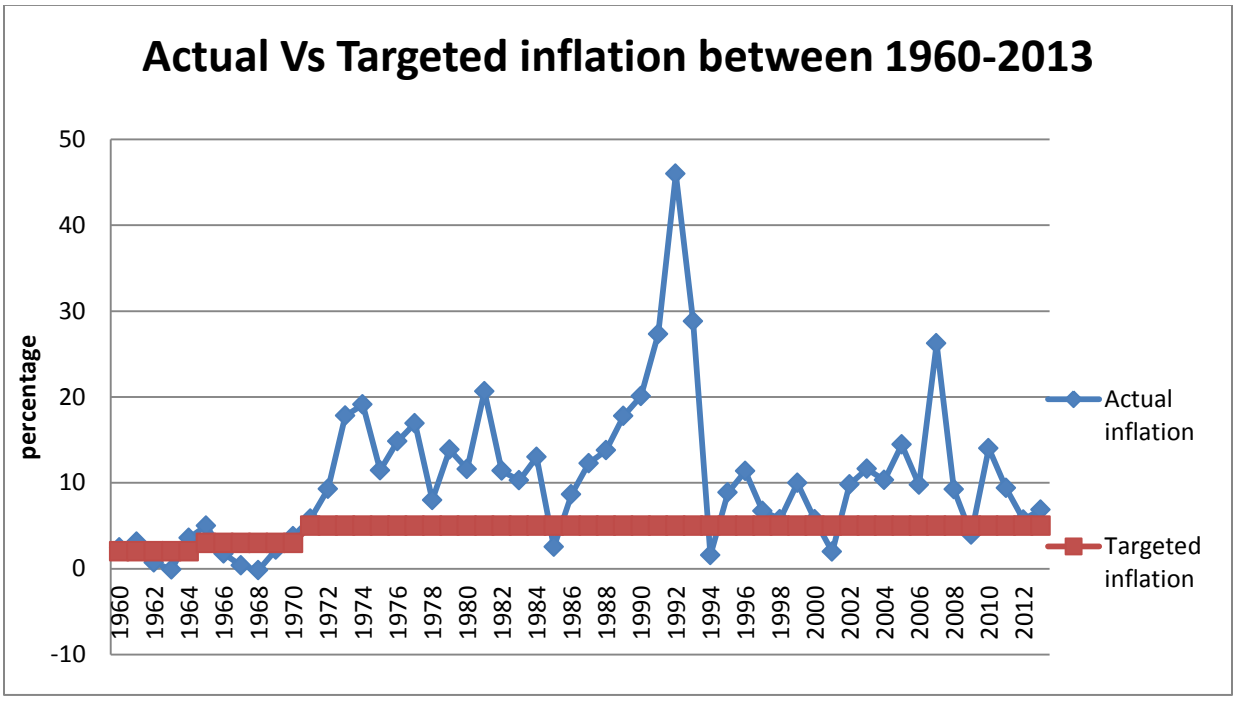
Deflation rates (defined as a constant fall in the general price levels) may not stimulate investments which could result to slow economic growth. Literature supports a steady inflation

rate that can be predicted by all stakeholders as it is certain to plan. However a fluctuating inflation rate like the case of Kenya is very uncertain (see figure 1).

1.1 Inflation rates in Kenya since 1960

Kenya's inflation target per year averages 5%. This is contrary to the actual inflation in each year as shown in the figure 1. For instance, between 1972 and 1983, the country experienced a higher inflation (averaging 15%) than the targeted inflation (Economic survey, 1984). The main causes of this sharp rise of inflation were in three folds: the oil crisis of 1970's, the global world recession as well as unfavourable climatic conditions to support African's agriculture. But the worst inflation in history was in 1992 when it hit above 40%.

Figure 1.0 Inflation rate of Kenya since 1960



Source: author's computation

With the central bank trying its best to stabilize this fluctuation, questions linger as to whether the use of interest rates and money reserves simultaneously has had any impact on stabilizing the inflation rate. Thus there is a need for the central bank of Kenya to make a choice between interest rates and money reserves to hit the targeted inflation rate.

Although our study advocates for a choice to be made between the interest rates and money reserves to achieve the targeted inflation rates, literature is inconclusive on which of these two major monetary policy tools is superior. For instance, while interest rates did do better to stabilize inflation rate for Canada according to Gordon (1979), findings by Sergeant and Wallace (1975) disagrees with the choice of interest rates since such an instrument may lead to equilibrium indeterminacy. But there are those studies that have revealed that the effectiveness of a given monetary policy solely rely on the economic environment at work (Niemann, et al, 2010).

Kenya has for a long time grappled with managing inflation using a mix of interest rates and money reserves. The Monetary Policy Committee (MPC) of the Central Bank of Kenya, which became operational in January 2008, has since then been reviewing developments in the economy and formulate approaches to addressing macroeconomic challenges. The main focus has always been in the pronouncements regarding interest rates – in particular the Central Bank Rate (CBR). Additionally, initiatives relating to money reserves has also been addressed through review of the Cash Reserve Ratio (CRR) of the banking sector and the cycles for compliance. The continued combined use of interest rates and money reserves have had mixed results. With this inconclusiveness in the optimal choice of monetary policy, it is prudent that Kenya makes a rational choice that will be informed by our study.

1.1.1 Inflation and macroeconomic variables

According to Romer and Chow (1996), nominal wages are negatively related to growth in money in the short run and thus inflation and unemployment are inversely correlated. The model states that unemployment and inflation have a trade off only in the short run but the same could not be said in the long run. Thus, theory predicted that monetary policy could not be effective in stabilizing inflation and unemployment in the long run as there was no trade off between the two macroeconomic variables. For Friedman (1968), the absence of a trade-off between unemployment and inflation gave rise to natural rate of unemployment since consumer agents formed expectations on the level of inflation. To them, unemployment in such environment can be solved through manipulating the supply side especially by providing the labour market information. In this scenario of expectation, the faster the economic agent anticipates inflation growth, the faster the wages demand increase (Friedman, 1968).

A better example of the real impact of high inflation in major macroeconomic variable is given by IMF working paper by Braumann (2000). In their observation of 23 episodes from 17 countries that faced high inflation, inflation had a contractionary effect on the gross domestic product, employment as well as investment. Equally, high inflation led to a decline in real wages, real depreciation as well as improvement in the external trade.

According to Tobin (1965), inflation is instrumental in promoting economic growth. According to them, inflation led to a reduction in real balances and thus shifted savings to capital accumulation as shown in the Tobin effect using a Solow neoclassical model. However, the Tobin's effects suffered one contradiction after another leading to a challenge from Sidrausky (1967) who showed that if money enters a utility function, then Tobin's effect was neutralized. Sidrausky (1967) suggest that inflation makes holding of real money balances expensive as

compared to consumption and thus economic agents tend to consume more than saving and hence cause inflation and capital accumulation reduces. But to Sidrausky (1967), inflation has no influence of real variables. Conclusively, inflation encourage more consumption rather than saving which reduces economic growth through a reduction in capital accumulation.

When labour supply in the economy is endogenous, inflation has a negative effect on the gross domestic product (Brock, 1974). To them, inflation makes leisure less expensive over working as workers are faced with a tradeoff between working and leisure. As workers reduces their labour supply for the less expensive leisure, output contracts.

1.2 Statement of the Research Problem

There are many tools or instruments that the central bank can use to stabilize inflation rate fluctuation. One of these instruments is the setting of the interest rate. Such interest rates form the basis of return to investment as well as the cost of borrowing with the economy. There are two main ways the interest rates can be revealed: short-term interest rates that are reflected through treasury bills and the long-term interest rates through the long-term bonds. Interest rates can be viewed as the price attached to the use of funds (Darryl, 1969). The central bank has an obligation to set official short-term interest rates in which the commercial banks and any other lender will borrow from them thus indicating the price of liquidity.

Kenya uses the Taylor's rule to adjust this interest rate according to the economic environment with an aim to stabilize the inflation rate. But this is done simultaneous with the central bank first setting the targeted inflation followed by the interest rate based on the premise that money expansion is likely to lead to an increase in interest rate (Darryl, 1969).

In stabilizing the economic fluctuation, governments utilize either monetary policy or fiscal policy in isolation or a policy mix of the two. The choice of these policies depends on the economic environment as well as the targeted goal by the government. From literature, fiscal policy is effective in stabilizing the economy under a fixed exchange rate regime while monetary policy is superior in a flexible exchange regime. Equally, monetary policy has been widely applied to stabilize two macroeconomic variables: output and inflation. With the central bank playing a crucial role in controlling the level of the general price levels (inflation) in the economy, the choice between interest rates and money reserve, which forms the main instruments used to control the inflation, must be optimal for the targeted inflation to be achieved. In Kenya, the central bank has preferred a policy mix of money reserve and interest rate, which has not worked well to reduce the inflation rate. As such, Kenya has not achieved the targeted rate of 5.00%. According to Dornbusch and Fischer (1990), the Federal Bank of United States of America was unable to achieve its monetary policy targets not because of the technical reasons but because of the choice of both money reserve and interest rates simultaneously. Could it be that the missing of the targeted inflation rate in Kenya is as a result of policy mix or could it be as a result of irrationality in the choice of the tool to be applied? So, what is the optimal monetary policy to stabilize the volatile inflation rate in Kenya in a bid to minimize the losses resulting from deviation from the targeted inflation rate?

1.3 Study questions

1) What is the optimal monetary policy choice which minimizes effects arising from inflation deviation?
2) What is the policy recommendation based on the study findings?

1.4. Study Objectives

1.4.1 The general objective

The overall objective of this study is to determine the optimal monetary policy that minimizes the loss resulting from inflation deviation

1.4.2 The specific objectives

1) To estimate the effect of use of both reserve money and interest rate as a monetary instrument to minimize on loss resulting from inflation deviation in Kenya
2) To offer policy recommendation based on the study findings.

1.5 Significance of the study

Inflationary target is crucial for any country. Indeed a little inflation has been considered as good since it stimulates investment but a large deviation from the targeted inflation is harmful to economic growth especially to savings. Dornbusch and Fischer (1990) did explain that most central banks do fail to achieve their targeted inflation due to a simultaneous setting of both interest rates target and money stock target. Our study is specific on the influence of these policies separately and a mix of the two to see the impact on the loss resulting from inflation. Thus the findings of this study will be beneficial in two folds: First and foremost, the information from our study findings will inform both private and public policy makers on the optimal monetary instrument that minimizes losses resulting from inflation. Lastly, the study findings will add to the body of existing literature as no study has been carried on the same area for the Kenyan economy.

1.6 Organization of the proposal

Following this introduction is Chapter Two which presents the theoretical literature review as well as the empirical literature review and the overview of the two. Chapter Three is the methodology and discusses the conceptual framework, model specification, empirical model, data type, source and topology of the variables as well as the pre-test statistical tests that is used to analysis the data. Chapter Four is the analysis of data and discussion of the result. It thus presents the descriptive statistics, diagnostic tests and the empirical findings. Chapter Five presents the summary of the study findings, conclusion and policy recommendation. It begins with the motivation of the study followed by summary findings and policy recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.0 Theoretical literature reviews

The choice of monetary policy instrument is pegged on the economic environment of a given nation. According to White (1979) the characteristics of the demand curve and supply curve form the basis in which either money reserve or interest rate can be chosen to achieve the monetary growth targets. For instance, in a theoretical perspective, the reserve money is effective when the disequilibrium is on the supply side while interest rates will be effective in stabilizing the economy when the disequilibrium is from the demand side (White, 1979). However, the choice of either a single policy or a mix of several instruments solely lies on the policy makers.

2.0.1 Money supply as an instrument to stabilize prices

Many macroeconomists have preferred money supply over the other instruments as it is more effective in correcting the disequilibrium in question faster than other instruments (see Friedman, 1996 and Poole 1970). For instance, in his k-percentage rule, (Friedman,1996) showed that price levels can grow at a given level given a rate in which money supply was set to grow by the central bank. Those in support of the k-percentage rule suggests that it is very effective in imperfect markets like Kenya where those responsible for monetary policy have no idea on how to stimulate the economy. Such rate, for optimal effectiveness has to be equated to the rate of the gross domestic product.

Equally, Gavin et al (2005) developed a general equilibrium framework in which they revealed that with efficient money growth rule, the persistency of inflation was checked and that price level turned to be more volatile than money supply – a condition that was corrected through the use of interest rates.

2.0.2 Interest rate as a monetary policy

This is better illustrated by the Taylor's rule. In his proposal of a hypothetical monetary policy to stabilize output and inflation target gaps, Taylor (1993) offered a potential useful framework in which monetary policies could be evaluated in reducing loss resulting from either GDP or inflation deviation. This rate is expressed as

$$I = 2 + \pi + \frac{1}{2}(\pi - 2) + \frac{1}{2}(Y - Y^*)$$

Where I represent the short-term policy rate the central bank authorities would wish to set, π is the rate of inflation while $Y - Y^*$ is the output gap. Since the Phillips curve is given as

$$\pi = \pi^e + \beta[y - y_n]$$

The central bank will always strive to keep the $\pi = \pi^e = \pi^*$. If it succeeds to keep this inflation at the expected or natural rate, then $y = y_n$ and that there will be no loss resulting from inflation deviation. According to Taylor (1993), the central bank has only one monetary policy that is able to achieve a twin target of maintaining inflation as well as minimizing output deviation. To him, this instrument is the interest rate which is given by equation

$$i = i^* + \gamma[\pi^e - \pi^*] + \delta[y - y_n]$$

In this case, γ and δ are the relative weights that the central bank do attach to the deviation in inflation and output respectively. And i^* is the nominal rate.

2.0.3 Monetarist theory

This is a theory that was postulated by Friedman (1982). Basing his argument on the quantity theory of money, the theory links spending by economic agents to the total money in circulation as the main cause of frequent inflation witnessed in some economies. For instance, any monetary

policy by the government through its central bank that seeks to stabilize both inflation and exchange rates do stabilize the economic growth as well as raise the level of employment. Thus according to this theory, which is based on adaptive concept since inflation for the future is based on past inflation records, control of money supply is suitable in controlling the loss resulting from inflation deviation.

2.0.4 Structural rigidity theory

This was first put forward by Ndebbio (1993) who in his argument on why there is persistent inflation in some economies especially among the developing countries stated that inflation is mainly caused by structural rigidities in the economy. Such structural rigidity arose from public finance imbalances such as budget deficit arising from the government's inability to raise enough revenue for her ever increasing public expenditure. We can deduce that effort by the government to ensure balanced budget through fiscal policies would address persistence in high inflation deviation.

2.1 Empirical Literature review

Bhattacharya and Singh (2007) used an overlapping generation's model to investigate the monetary policy choice in two different economic environments (real economic shocks and nominal economic shocks). The study revealed that the welfare of the economic agents were high when money growth targeting was used at a time of real shocks while interest rates maximized welfare at times of nominal shocks.

In their attempt to control the inflation, Poole and Leiberman (1972) tested the use of money stock as compared to the traditional interest rates. The study revealed interest rates were easier to

control and thus led to desired outcome than monetary stock whose data was available after a significant lag period as it was subject to substantial revisions.

Athanasios and Volker (2012) while investigating the complexity and monetary policy in reducing the losses associated with monetary policy among the Euro zone area arising from the mis-measurement, through the use of new model data reveals the fragility of policy analysis in optimization process. Equally the study found out that interest rate as a monetary policy tool was quite robust as long as it responds to current outcomes of output and inflation.

Reduction in the loss resulting from the choice of monetary policy has been on the rise in recent time. Gichuki et al, (2012) in their study on the optimal monetary policy to reduce output deviation in Kenya using a cross sectional data between 1994 and 2010 compared utilization of monetary policy instrument independently as well as policy mix. Their study revealed that interest rates were superior in minimizing loss in output deviation as compared to money reserve when applied independently. However, the policy mix of interest rates and money reserve was optimal as it minimized losses under the period of study.

Similar study done by Phongthiengtham (undated) in Thailand to investigate the effectiveness of monetary base and interest rates using a vector error correction model revealed that interest rates were more effective but the optimal monetary policy had the mix of the two major macroeconomic variables.

2.2 Literature overview

Both the theoretical and empirical literature cited are in agreement that there is a cost incurred in choice of monetary instrument to curtail inflation in the economy. While majority are in consensus that interest rates do better in minimizing loss resulting from inflation deviation over

money reserve, the policy mix of the two achieves the optimal minimization that makes the society better off. Despite optimal monetary policy choice having been done in several parts of the world, their scope has been on the minimization of the loss resulting from output deviation. There exists a gap in establishing which monetary policy would minimize losses arising from deviation of inflation rate from the targeted inflation rate. Thus our study uniquely adds to the body of existing literature through investigation of the optimal monetary policy that will minimize loss resulting from inflation deviation. There are few studies done in Kenya and this study can set the stage for review of other economies.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This part, which is the methodology, is divided into four main sections. Section 3.1 presents the theoretical framework followed by section 3.2 which is the empirical model. Finally, sections 3.3 and 3.4 present estimation technique and the pre estimation test respectively.

3.1 Theoretical framework

Let's start from the Phillips curve equation given as

$$y = y_n + b(\pi - \pi^e) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

And that b>0, y is the output, π is the inflation, π^e is the expected inflation from the private sector while y_n is the output at period n.

Let's assume that the central bank has the ability to control π by deciding the optimal inflation rate through minimizing the quadratic loss function given by

$$L = \frac{1}{2}\{a(\pi - \pi^*)^2 + (y - ky_n)^2\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where $\pi - \pi^*$ is the deviation of inflation from the targeted and $y - ky_n$ is the deviation from the targeted output and that k>1

In this scenario of minimizing losses, the central bank will always strive to keep y above y_n as well as reduce the deviation$\pi - \pi^*$.

Replacing equation 1 in equation 2 and assuming that π^* is zero we have a loss function modeling out the output and inflation as

$$L = \frac{1}{2}\{[a\pi^2] + [(1-k)y_n + b(\pi - \pi^e]^2\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Using rational expectation, we can, theoretically compute solutions that $\pi = \pi^e$ which will minimize the loss from inflation deviation. We know that under the rational expectation, the private sector usually acts on expectation assuming that the central bank will respond to any deviation of the π^e that they choose. From such, rational private sector set their equation as

$\pi^D = \frac{1}{a+b^2}[b\pi^e(k-1)]y_n$ ……4

For rational private sector, they will choose$\pi^e = \pi^D$ and in this case their rational expectation value will be

$$\pi_{RE} = \pi^e_{RE} = \frac{b}{a}(k-1)y_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

At equilibrium

$$y_{RE} = y_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

And thus the loss is

$$L_{RE} = (k-1)^2\frac{a-b^2}{b}y_n^2 > L^D \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where L^D is the discretionary solution gotten from the partial derivative of the loss function as is equivalent to

$L^D = (k-1)^2 y_n \frac{a}{a-b^2}$ ……8

3.2 Empirical model

To obtain the empirical model, we will borrow from Poole (1970) who begun by assuming there are two markets with a stochastic trend: the money market given by

$$lnM = b_0 + b_1 lnY + lnr + v \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

And the goods market as

$$lnY = a_0 + a_1 lnr + a_1 lnExR + u \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 10$$

By using the Vector Error Correction Model, we will estimate the values of a and b in equations 9 and 10 which will then be used to compute the estimated

$$L^D = (k-1)^2 y_n \frac{a}{a-b^2} + u \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 11$$

And

$$L_{RE} = (k-1)^2 \frac{a-b^2}{b} y_n^2 > L^D + v \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 12$$

The one that yields the greater $L_{RE} > L^D$ will be assumed to be the best choice to minimize the loss from inflation as discussed in equation 7.

3.3 Data type, source and Typology of variables

This study will be based on the annual time series data (1980-2016) of the main macroeconomic variables that influence inflation i.e. the real national income, the real money stock, real interest rates. Data will be sourced from the Central Bank of Kenya, Kenya National Bureau of Statistics,

International Monetary Fund database, International Financial Statistics, United Nations Conference on Trade and Development database and World Development Indicators.

Table 1 shows the type of data, source & typology of variables

Variable name	Variable proxy	Description	Source
Economic growth	$\mathbf{Y_t}$	Real national income of Kenya	UNCTAD 2015, IMF, IFS
Money reserve	**M**	Is the real money stock of Kenya under the period of study	Central Bank of Kenya, KNBS, IMF, IFS
Interest rates	r_i	Real interest rate that central bank lends to the commercial banks, called the Central Bank Rate (CBR) or its proxy for previous years before its introduction	Central Bank of Kenya, KNBS, IMF, IFS
Exchange rate	ExR	Real exchange rate in Kenya	WDI

3.4. Estimation technique

The study will use both the OLS estimation and the VECM to obtain the study objectives. While the OLS is in a unique advantage in this study as it uses observable sample whose regression equation can be estimated, the VECM determines whether the error correcting term has a long run causality effect. It is a special model in that it ensures that the economic variables in the model are stationary after first differencing.

3.5. Statistical tests

3.5.1. Unit root and stationarity test

The data to be used in the analysis of this research is a macroeconomic time series which, from a theoretical perspective suffers from non-stationarity (Nelson and Plosser, 1982). It will be vital to run a stationarity test first before using it since running a regression on a non-stationary data may lead to invalid empirical result and therefore the study will test stationary using Augmented Dickey-Fuller (1979, 1981).

3.5.2. Cointegration test

When two or more macroeconomic variables have a long run relationship, we conclude that those variables are cointegrated. Suppose the economic variables in this study have unit root, then the study will proceed to test for cointergration. To test for cointegration, the study will employ Johansen test.

3.5.3 Diagnostics Tests for Normality and Serial Correlation

This study will utilize Shapiro-Wilk test to conduct heteroscedasiticity test for the error term. It will involve computation of the, W, V, Z and P-value. We use the p-value to make an inference of normality. If our calculated p-value exceeds the critical value, then the variable will be statistically significant or normal in our case. If the calculated p-value is smaller than the critical value, then a variable is not significant or not normal. The credibility of the OLS parameters will be tested through testing for the degree of multicollinearity and heteroscedasiticity.

CHAPTER FOUR: ANALYSIS OF DATA AND DISCUSSION OF RESULTS

4.0 Introduction

This section presents the study results from the empirical analysis and discusses their economic interpretation. It begins with the description of all variables used in our model followed by diagnostic tests of the time series data and regression and finally discussion of results.

4.1 Descriptive statistics

Descriptive statistics was mainly carried out in this study to ascertain the statistical characteristics of the data used in the model. This study uses annual time-series data between 1980 and 2016. Determined to obtain the optimum monetary policy choice that reduces losses resulting from inflation deviation, the study estimates two structural model of money market and goods market into their reduced form. On the goods market, the reduced form expresses national income as a function of the real interest rate while in the money market, the reduced form expresses money reserve as a function of national income and interest rates. Data was obtained from World Development Indicators (WDI), United Nation Conference on Trade and Development (UNCTAD), Central Bank of Kenya (CBK) and Kenya National Bureau of Statistics (KNBS) online website.

Table 2: Descriptive statistics

Variable's name	Mean of variable	Standard Dev.	Maximum	Minimum
r_t	7.452821	6.602149	-8.009867	21.09633
Y_t	20,100,000,000	9,380,000,000	43,599,877,011	9,805,984,126
M_3	602,000,000,000	774,000,000,000	2,723,950,000,000	16,136,020,000

Source: Author's computation

From Table 2, the real interest rate has a mean of 7.452821 with a deviation of 6.602149 and a respective minimum and maximum of -8.009867 and 21.09633. Equally the mean and standard deviation of adjusted net national income was 20,100,000,000 and 9,380,000,000 US Dollars respectively. Lastly, the broad money under the period of study had a mean and standard deviation of Kshs. 602,000,000,000 and Kshs. 774,000,000,000 respectively. The minimum and maximum broad money in the period of study was Kshs. 16,136,020,000 and Kshs. 2,723,950,000,000 respectively.

4.2 Diagnostic tests

4.2.1 Normality test

This study uses the Shapiro-Wilk test to determine normality of variables. A variable is normal if the mean, median and mode are equal (that is normally skewed). The Shapiro-Wilk test gives four options, a W, V, Z and P-value. We use the p-value to make an inference of normality. If our calculated p-value exceeds the critical value then our conclusion is that the variable is normal. But if the calculated p-value is smaller than the critical value, then a variable will be non-normal.

Table 3: Shapiro-Wilk normality test

Variable	Observation	**W**	**V**	**Z**	Prob>z	**Status**
lnr_t	37	0.96278	1.386	0.683	0.24721	Normal
lnY_t	37	0.88064	4.444	3.124	0.00089	Non-normal
lnM_3	37	0.75116	9.266	4.663	0.0000	Non-normal

Source: Author's computation

Results from table 3 show that only real interest is normal at 5% level of significance. Both the adjusted net national income and broad money were found to be non-normal.

4.2.2 Multicollinearity

This problem arises when two or more independent variables are strongly related. According to Gujarati (2012), a correlation of 0.8 and above indicates the possibility of collinearity between two variables. This study used the Vector Integrating Factor (VIF) and Tolerance (1/VIF) to test for multicollinearity. The VIF test directs that one first runs a regression followed by a VIF command in Stata. Then an inference is made based on the magnitude of the VIF value. If the VIF value is less than 10, then a variable has no multicollinearity. Conversely, if the VIF is greater than 10, then multicollinearity exists.

Table 4: VIF and Tolerance results

Variable	VIF	/1VIF	**Status**
lnr_t	1.000	0.997692	no multicollinearity
lnY_t	1.000	0.997692	no multicollinearity
lnM_3	1.000	0.997692	no multicollinearity

Source: Author's computation

Results from Table 4 show that there is absence of multicollinearity among all our variables because all our VIF values are less than 10.

4.2.3 Stationarity (Unit root test)

The study employs ADF test to test for stationarity in the individual variables. According to ADF test, a variable is declared stationary when it's t-calculated is smaller than the t-critical.

Table 5: ADF test results for the variables

Variable	**Test Statistic**	1% critical value	5% critical value	10% critical value	Nature
lnr_t	**-3.086**	**-3.675**	-2.969	-2.617	Non Stationary
lnY_t	**6.218**	**-3.675**	-2.978	-2.620	Non stationary
lnM_3	**9.452**	**-3.696**	-2.978	-2.620	Non stationary

Source: Author's computation

From table 5, all the variables were found to be non-stationary since their test statistic was greater than the critical values. These non-stationary variables require additional attention to determine whether they are co-integrated. Therefore, taking the first difference gives the results in table 6.

Table 6: ADF test results for differenced variables

Variable	**Test Statistic**	1% critical value	5% critical value	10% critical value	Nature
D_lnY_t	-8.673	**-3.682**	-2.972	-2.618	Stationary
D_lnM_3	-3.691	**-3.702**	-2.980	-2.622	Stationary
D_lnR	**-4.086**	**-3.702**	-2.980	-2.622	Stationary

Source: Author's computation

Table 6 shows that both the broad money and the adjusted net national income is stationary at first differencing.

4.2.4 Testing for Cointegration

When variables have a long run equilibrium relationship, we say they are cointegrated. Most of the time when economic variables are individually non-stationary; it is likely that cointegration may occur. Cointegration test is normally a pre-test for a time series data which tries to eliminate spurious regression situations of non-stationary data. Thus cointegration relationship existence implies that the regression of non-stationary series in their levels yield meaningful and not spurious results. To test for cointegration, the study employed Johansen tests for cointegration. According to Johansen tests for cointegration, if the trace statistic is greater than critical value, we fail to reject the null hypothesis and concluded that the variables have a long run association.

Table 7: Johansen test for cointegration

.vecrank m3 Y r						
		Johansen tests for cointegration				
Trend: constant						Number of obs = 32
Sample: 1982 – 2013						Lags = 2
Maximum Rank	Parms	LL	Eigenvalue	Trace statistic	5% critical value	
0	12	-943.09052	.	30.7737	29.68	
1	17	-934.50469	0.41528	13.6020*	15.41	
2	20	-929.55172	0.26623	3.6961	3.76	
3	21	-927.70369	0.10908			

Source: Author's computation

To establish whether the variables in the model are cointegrated or not, both trace statistic and the maximum eingen values were computed. Using trace statistic values in table 7, at rank zero, the null hypothesis is that there is no cointegration while the alternative hypothesis is that there is cointegration. To make a decision, we compare the trace statistic and the critical values. Since the trace statistic (30.774) is greater than the critical value (which is 29.68), we reject null hypothesis and conclude that the variables in our model have a long run equilibrium relationship.

4.3 Empirical Findings

Estimation of the reduced form of goods market provided the following results

4.3.1 Estimation of the loss in the goods market

. reg D_lnYt D_lnR D_lnExc						
Source	SS	df	MS	Number of obs	=	34
				F(2,31)	=	128.18
Model	15.1463631	2	7.57318155	Prob > F	=	0.0000
Residual	1.8315812	31	.59083265	R-squired	=	0.8921
Total	16.9779443	33	.514483161	Adj R- Squared	=	0.8852
				Root MSE	=	.24307
D_lnYt	Coef	Std. Err.	t	p>|t|	{95% conf. Interval}	
D_lnR	-.141409	1.332702	-1.06	0.297	-.4132154	.1303973
D_InExc	.0012793	.0000813	15.74	0.000	.0011136	.0014451
_cons	22.9971	.3911872	58.79	0.000	22.19927	23.79493

Thus a_0 = 22.9971 while a_1= -0.14141. The result is that exchange rate is negatively correlated with economic output, with an R^2 of 89.21%, which supports the general economic theory.

4.3.2 Estimation of the loss in the money market

.reg D_InM3 D_InYt D_InR						
Source	SS	df	MS	Number of obs	=	34
				F(2,31)	=	159.66
Model	67.4105621	2	33.7052811	Prob > F	=	0.0000
Residual	6.54422384	31	.211103995	R-squared	=	0.9115
				Adj R-Squared	=	0.9058
Total	73.954786	33	2.24105412	Root MSE		.45946
D_lnM3	Coef	Std. Err.	t	p>|t|	{95% conf. Interval}	
D_lnYt	1.995359	.1132039	17.63	0.000	1.764478	2.22624
D_lnR	1.507401	.2539865	5.93	0.000	.9893922	2.02541

_cons	-45.31777	2.839393	-15.96	0.000	-51.10875	-39.52679

Thus b_0= -45.3178, b_1 = 1.995 while b_2=1.507401. This implies that there is a positive correlation between the money market activity and the level of economic output and level of interest rates. 91.15% of the observations accurately predict the model.

From regression 13 and 14, we have **a_0, a_1, b_0, b_1,** and **b_2** we can estimate L^D and L_{RE} for both the money market and the goods market.

Therefore in case of interest rates as a monetary policy choice, L^D = -162.49 while L_{RE} = -159.4525

From the results we have found that L^D (which is equal to -162.49) is less than L_{RE} (which is equal to -159.4525) for interest rate policy.

Equally for the money reserve as a monetary policy choice, the results are that L^D = 0.9192 while L_{RE} = -24.71. From the analysis, we have found that L^D is greater than L_{RE}

Decision

From Poole (1970), the monetary instrument that has L_{RE}>L^D is the best to minimize the loss resulting from inflation. Thus our study finds that interest rate instrument is superior to the money reserve instrument since it has L_{RE}>L^D.

4.3.1 Discussion of the results

Our study sought to determine which monetary policy instrument is best in minimizing the loss that result from inflation deviation in Kenya for a period of 37 years (1980-2016). From the study regression, the study revealed that interest rate instrument was the best monetary policy instrument since it was found to have L_{RE}>L^D as was suggested by Poole (1970).

The basis is that interest rates is a key determinant of how the money markets would move. Monetary authorities can therefore easily influence monetary aggregates depending on economic position. Poole (1970) posits that authorities should push interest rates up in times of boom and down in times of recession, leaving monetary aggregates to track un-interrupted. Thus in choosing between the money reserve and interest rates, the Central bank of Kenya should use interest rate as it will bring the desirable result through reducing the loss resulting from inflation deviation.

Our study findings conform with findings by Poole(1970), Staundiger (2001), as well as a more recent findings by Atkeson et al (2007) who found that the interest rate instrument was superior to the monetary aggregates in influencing the direction of monetary policy.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Motivation of the study

The success of any economy lies on its ability to stabilize major economic shocks in the business community. Any economy's central bank has a mandate to maintain fairly stable inflation rate and allow a small or targeted inflation that is good to boost production in the economy. However, large variation in inflation may send undesirable signals to the investors as they will perceive the investment environment. Owing to the fact that the Central Bank of Kenya has for a long time missed to stabilize its inflation due to the fact that it uses the interest rate and money reserve simultaneously, our study was concerned with which of the two main policies (interest rate or money reserve instruments) is likely to minimize the loss resulting from inflation deviation. The aim was to help the policy makers and other stakeholders make optimal decisions so as to stabilize inflation in Kenya.

5.2 Summary and Conclusions

It was our aim to establish the optimal instrument for monetary policy in Kenya between the interest rate and reserve money. Our study revealed that there was no long run relationship between the variables in the model as was evident by no cointegration. Using data between 1980 and 2016, OLS and Vector Error Correction Model (VECM), the results of this analysis showed that interest rate instrument leads to a lower loss in the monetary policy objective (minimization of the inflation deviation) than the reserve money instrument.

5.3 Policy Recommendations

In keeping with the findings of other studies similar to this study, the following are the policy recommendations arising from this study: The finding that the interest rate instrument minimized losses in monetary policy compared to reserve money should inform the Central Bank of Kenya to rely exclusively on the interest rate instrument as a pure instrument policy rather than using reserve money or using the two instruments at the same time. This will help steer monetary policy in the right direction while solving the problem of the simultaneous use of the instruments.

5.4 Suggestions for Further Research

This study was limited to the choice of the monetary policy instrument between interest rates and reserve money to reduce the losses resulting from inflation deviation from its targeted inflation in Kenya. This leaves room for further research especially on the effectiveness in the combination of the two main monetary policy instruments in minimization of loss resulting from inflation deviation.

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