

**THE DETERMINANTS OF INFLATION IN THE KENYAN ECONOMY**

**BY**

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FOR THE DEGREE OF MASTER OF ARTS IN ECONOMICS**

**SCHOOL OF BUSINESS AND ECONOMICS**

**MASENO UNIVERSITY**

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## Declaration

### Declaration by the candidate

This Thesis is my original work and has not been presented for a degree in any other University.

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This Thesis has been submitted for examination with our approval as University supervisors.

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## **Dedication**

I dedicate this work to Angela Akinyi Ochieng.

## Abstract

Since 2003, the monetary policy in Kenya has pursued inflation targeting policy that pegs the desired inflation rate at 5 per cent. However, Inflation targets in Kenya have been missed frequently and the CBK has been unsuccessful at keeping and maintaining the inflation at the target rate. The average level of inflation has also been higher (10.17%) compared with the level of inflation in developed (3%) and emerging economies (8%). Missed inflation targets present a dynamic inconsistency challenge to policy makers. Previous studies on inflation yield conflicting results as far as determinants of inflation in Kenya are concerned. The lack of consensus implies that the determinants of inflation in Kenya may not yet be known. Similarly previous studies on inflation in Kenya have a linear relationship between the variables in the models. There is no a priori reason to assume that the inflation model has to be linear without test for non-linear effects. The specific Objectives of the study were to establish the monetary and non-monetary determinants of inflation in Kenya and test for possible non-linearity in the inflation model in Kenya. The conceptual framework for the study was anchored on the aggregate demand and cost-push theories while an explanatory research design was adopted. Secondary quarterly data of all the variables during period of 2001 to 2013 were obtained from the databases of the Central Bank of Kenya and Kenya National Bureau of Statistics. Data was analyzed using OLS method. The study found out that real GDP growth negatively ( $\beta = -0.5150369$ ) and significantly ( $P=0.0020$ ) affect the inflation rate while changes in oil prices) positively ( $\beta=0.03753$ ) and significantly ( $P=0.019$ ) affect the inflation rates. It also found that the previous period's inflation rate (lag inflation rate) positively ( $\beta=0.78760$ ) and significantly ( $P=0.0000$ ) affected inflation rates of the current period. The results mean that a unit increase in Real GDP results into a reduction of inflation by 0.515 units and that a unit increase in the price of oil would result into a 0.03753 increase in the levels of inflation. The results also mean that a unit increase in lagged inflation rate leads to a 0.787 increase in the current inflation rates. In addition the findings revealed that the inflation model exhibits a linear structure as the coefficients of squared terms of the predictor variables were found to be statistically insignificant. It concluded that real GDP growth, changes in oil prices and the previous period's inflation rate to be the key determinants of inflation in Kenya. The study recommends that focus for policy makers should be growing the Real GDP as way of controlling the inflation rate. An increase in real GDP leads to a decrease in inflation rate and therefore policies geared towards increasing capital formation such as reinstating investment tax credit can be used to spur real GDP growth. The second focus area for policy makers should be containing price fluctuation (changes in oil prices).According to the results an increase in Oil prices leads to an increase in inflation rate and therefore policy makers should adopt stabilization policies to deal with economic shocks that may put short-run pressure on factors that drive inflation.

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## Abbreviations and Acronyms

|                |   |
|----------------|---|
| ADF            | Augmented Dickey-Fuller                               |
| AfDB           | African Development Bank                              |
| AR             | Autoregressive (Model)                                |
| ARDL           | Autoregressive Distributed Lag Model                  |
| AIC            | Akaike Information Criterion                          |
| BG             | Breusch-Godfrey                                       |
| CBK            | Central Bank of Kenya                                 |
| CBR            | Central Bank Rate                                     |
| CPI            | Consumer Price Index                                  |
| df             | Degrees of Freedom                                    |
| DW             | Durbin-Watson Static                                  |
| ECM            | Error Correction Method                               |
| GDP            | Gross Domestic Product                                |
| HDI            | Human Development Index                               |
| IMF            | International Monetary Fund                           |
| Ksh            | Kenya Shillings                                       |
| Km             | Kilometers  |
| KNBS           | Kenya National Bureau of Statistics                   |
| LM             | Lagrange Multiplier                                   |
| MA             | Moving Average (Model)                                |
| MS             | Mean of Squares                                       |
| M <sub>3</sub> | Money Supply  |
| OECD           | Organization for Economic Cooperation and Development |
| OLS            | Ordinary Least Square Method                          |
| REER           | Real Exchange Rate                                    |
| Root MSE       | Root Mean Squared Error                               |
| SS             | Sum of Squares  |
| US             | United States of America                              |
| VAR            | Vector Autoregressive                                 |
| VIF            | Variance Inflation Factor                             |

# CHAPTER ONE: INTRODUCTION

## 1.1 Background of the study

Inflation refers to the increase in the general level of price of a basket of goods and services that is representative of an economy over a period of time. Inflation is measured by the percentage change in a price index, which is the average price level for a set of goods and services, relative to a base year Romer (2009).

The Consumer Price Index (CPI) is the most commonly used index for measuring inflation. The rise in the price level reduces the purchasing power of the currency in an economic unit. Inflation occasions income and wealth redistribution effects depending on who benefits from the price increases Romer (2009). Additionally, at the macroeconomic level, inflation fosters uncertainty in the economy, affects long-time planning and commitments and diverts resources from production as firms and consumers spend more time and resources trying to avoid inflation Totonchi (2011).

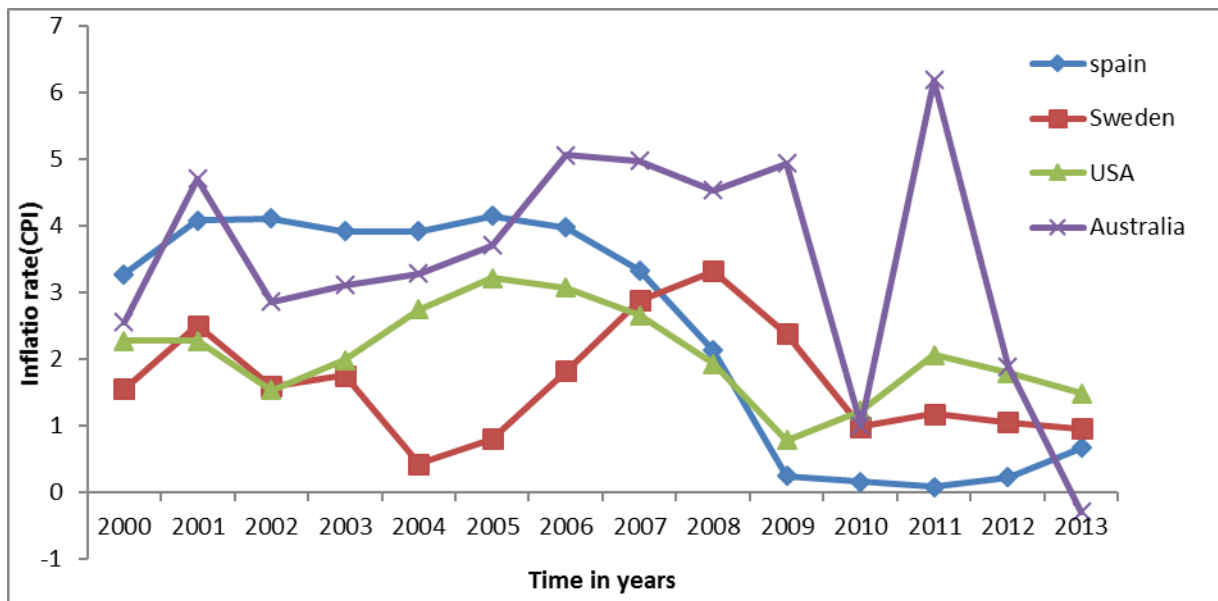
In the United States, inflation rate ranged between 0.79 and 3.22 for the period 2001 to 2013 as indicated in Figure 1.1. This rate of inflation is mostly referred to as creeping or mild inflation. According to the U.S. Federal Reserve (2012), when prices rise 2 percent or less, it is actually beneficial to economic growth. That is because mild inflation sets expectations that prices will continue to rise. As a result, it sparks increased demand as consumers decide to buy now before prices rise in the future. By increasing demand, mild inflation drives economic expansion.

Ueda (2009), Dhakal (2002), Baek and Koo (2009), Pain *et al.* (2006), Balakrishnan and Ouliaris (2006) have all attempted to establish the monetary and non-monetary determinant of Inflation in the United States. While Dhakal (2002) found money supply to be an important determinant of United States inflation, Baek and Koo (2009) found money supply to be insignificant. Likewise study by Balakrishnan and Ouliaris (2006) found past inflation and the output gap to be the main driver of United States inflation whereas Pain *et al.* (2006) and Ueda (2009) found output gap to be less significant factor in driving the United States inflation. This contradiction is extended to studies by Assenmacher-Wesche, Gerlach and Sekine (2007), Dua (2009) and Nishizaki, Sekine, and Ueno (2014) who all found output gap to an important factor driving inflation in Japan.

. Similarly, the level of inflation rates for Sweden, Australia and Spain have been within the 3% to 5% range and they are therefore said to be experiencing creeping or mild inflation. This rate of inflation is considered good for economic growth. However in the year 2009 during the global financial crisis a sharp decline in inflation rate was experienced. A lower inflation rate, below 2 per cent would be associated with an elevated probability of falling into deflation, which means prices and perhaps wages, on average, are falling a phenomenon associated with very weak economic conditions Sovuthea (2013) and Damian (2010). Like in the United States, several studies have been done to establish the monetary and non-monetary determinants of inflation in Sweden, Australia and Spain. For instance, Jacobs and Williams (2014) looked at the Determinants of Non-tradables Inflation in Australia for the period of 1990-2014. They found the rate of non-tradables inflation in Australia to be determined by business cycle, inflation expectations, unit labour cost, change in unemployment rate and output gap. Their findings seemed to support an earlier study conducted by Norman and Richards (2010) on Modelling Inflation in Australia whose results showed that unemployment rate, growth in unit labour costs and the output gap to be important determinants of inflation Australia. Brouwer and Ericsson (1995) on the other hand found that continued low inflation in Australia is as a result of sustained low growth rates in unit labour costs, import prices and exchange rates. These findings are contrary to the findings by Dwyer and Leong (2001) who noted that unlike in the 1990's where episodes of currency depreciation usually generated an increase in inflation, they now appeared to have little or no effect on retail import prices so that, despite a significant depreciation, domestic inflation remained undisturbed.

From the reviews above, it is evident that studies on inflation in developed economies yield conflicting results as far as the monetary and non-monetary determinants of inflation are concerned. The lack of consensus implies that the monetary and non-monetary determinants of inflation in developed economies such as USA, Australia, Sweden, Japan and Spain may not yet be known. In addition Studies of inflation in Developed economies have been growing. For instance studies by Brouwer and Ericsson (1995), Damian (2010), Delgado and Robinson (1994), Sovuthea (2013), Thomas (1999), are decades apart and still reveal the need to uncover the determinants of inflation.

**Figure 1.1: Trends of Inflation rate of selected countries in Developed Economies**



Source: World Bank Indicators Database (2014)

In emerging economies such as Pakistan, Brazil and Ukraine the average rates of inflation during the study period were 9.1%, 6.5% and 9.3% respectively with highest inflation rate recorded at 20.2%, 14.7% and 25.2% respectively against a target rate 6 percent for Pakistan and 5 percent for Brazil. In Brazil and Pakistan inflation rate of 3 to 6 percent is known to have positive effects on the economy, since it encourages investment and production and allows growth in wages Khan (2005) and Hussain (2005). However, when inflation crosses targeted rate of 6 percent, it leads to negative effects Khan, Ahmed and Hyder, (2007). Several studies have been conducted in the emerging economies with the aim of establishing monetary and non-monetary determinants of inflation. Khan, Ahmed and Hyder (2007) conducted a study on inflation determinants in Pakistan using data from the 1972 to 2006 and found the most important determinants of inflation to be adaptive expectations, private sector credit, exchange rates and rising import prices. On the other hand Akbari and Rankaduwa (2006) conducted a study on Inflation targeting in a small emerging market economy for the period 1982-2004 a case study of Pakistan and found out that there was an insignificant relationship between interest rate, exchange rate and inflation. This is contrary to the findings by Khan, Ahmed and Hyder (2007) who singled out exchange rate to be an important determinant of inflation in Pakistan.

Likewise in Ukraine, Novikova and Volkov (2012) while modelling core inflation in Ukraine for the period 2003-2012 found the exchange rate and labor costs (nominal wage) to cause both headline inflation and core inflation; particularly the exchange rate was found to be the

key explanatory variable. This is contrary to Lissovolic (2003) who found that the long term role of exchange rate in influencing inflation has declined over time and also there is no significant long-term link between money supply and inflation. Leheyda (2005) found that the inflationary process experienced in Ukraine between 1998 and 2003 were as a result of the changes in the money supply, wage rates, exchange rates, real output and exogenous shocks, money demand, purchasing power parity and mark-up relationships. Bilan and Siliverstovs (2005) also found growth of monetary supply, change in average wage and change in inflation expectations all to be main determinants of inflation. These findings are contrary to those of Kirchner, Weber and Giucci (2008) who while conducting a study on Inflation in Ukraine using data 199-2008 found out Money Supply, output gap and Wages rates to have no influence on Ukrainian inflation and Novikova and Volkov (2012) who found out no significant link between money supply and inflation.

In Brazil, Carlson (2013) in his study Determinants of Hyperinflation: Case Studies from Latin America Based Economies found inflation was due to external debt and monetary base growth. The countries (including Brazil) took on excessive levels of external debt which eventually contributed to spiraling inflation. The exogenous money growth carried out by the central banks also greatly contributed to rising inflation. This is contrary to the findings of Kirchner, Weber and Giucci (2008). Still in Brazil, Serrano and Suma (2005) in their study Distribution and Cost-Push inflation in Brazil under inflation targeting found that the inflation in Brazil between the years 1999 to 2014 were as a result of the changes in the money supply, wage rates, exchange rates and output growth contrary to Narayan and Narayan (2011) who did not find any evidence of a systematic relationship between inflation and output growth in Brazil. From the studies reviewed above, it is evident that studies on inflation in emerging economies yield conflicting results as far as the monetary and non-monetary determinants of inflation are concerned. The lack of consensus implies that the monetary and non-monetary determinants of inflation in emerging economies such as Pakistan, Ukraine and Brazil may not yet be known.

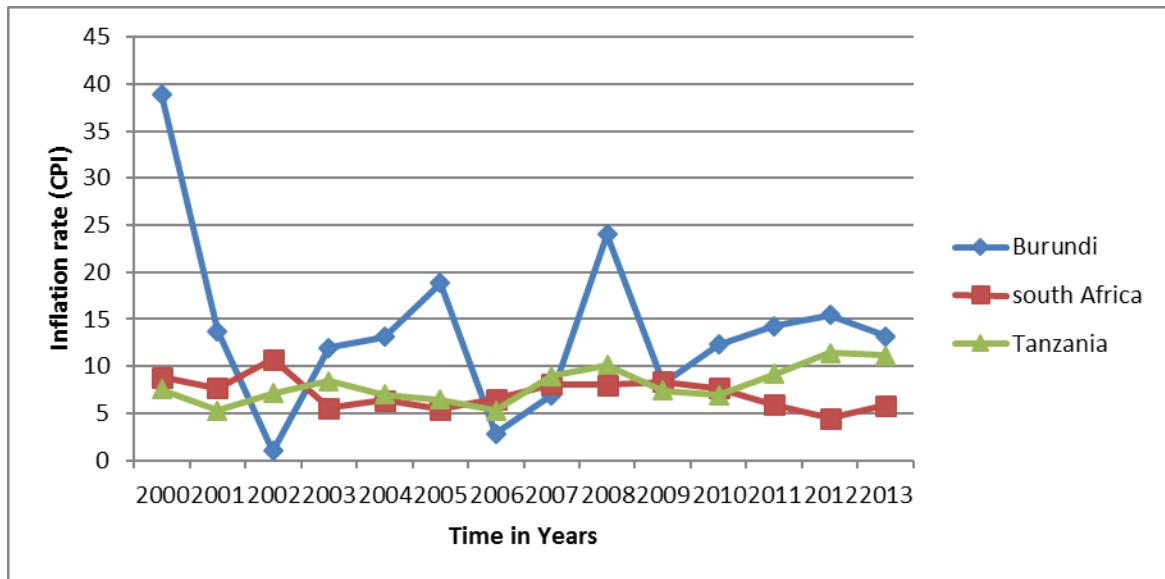
In many Sub-Saharan Africa countries inflation and inflation volatility have been gradually declining with mean inflation rate for the periods 1985-1995, 1995-2005, 2005-2013 at 28.7%, 14.9% and 10.1% respectively, Nguyen, Dridi, Unsal and Williams (2015). Nevertheless, managing inflation pressures remains one of the biggest challenges for policymakers in the region. Headline inflation is considerably more volatile in Sub Sahara Africa relative to other regions given high share of food in the CPI and more volatile relative

food prices (mostly owing to unstable agricultural production). Output and inflation tend to be negatively correlated as a result, making the tradeoff between inflation and output stability potentially more severe. The prevalence of supply-side shocks also reduces the ability of monetary policy in influencing inflation in the short run. (IMF 2014).

Several studies have been conducted with the aim of establishing monetary and non-monetary determinants of inflation in Sub-Saharan Africa. Olubusoye and Oyaromade (2008) analyzed the main sources of fluctuations in inflation in Nigeria using the framework of error correction mechanism and found that lagged inflation, consumer price index, expected inflation, petroleum prices and real exchange rate significantly propagate the dynamics of inflationary process in Nigeria. The level of output (Real GDP) and money supply were found to be insignificant. Ndidi (2013) found money supply to significantly determine inflation in Nigeria while imported inflation and real exchange rate not to be significant both in the short-run and long-run. Kinda (2011) while examining the determinants of inflation in Chad using quarterly data from 1983-2009 showed that the main determinants of inflation in Chad to be foreign prices, exchange rates movements and public spending. Rutasitara (2004) in her study exchange rate regime and Inflation in Tanzania found out growth in real GDP, exchange rate and growth in Money supply to be the main determinants of inflation in Tanzania. Laryea and Sumaila (2012) also found output level, monetary supply and exchange rate to be the main determinants of inflation in Tanzania. While Olubusoye and Oyaromade (2008) found output (Real GDP) and money supply to be insignificant all the other studies Ndidi (2013), Kinda (2011), Rutasitara (2004), Laryea and Sumaila (2012), found output (Real GDP) and money supply to be to be important factors determining inflation rates in respective countries. As such these studies yield conflicting results as far as the monetary and non-monetary determinants of inflation are concerned. The lack of consensus implies that the monetary and non-monetary determinants of inflation in developing economies of Sub-Saharan Africa may not yet be known.

Figure 1.2 indicates the trends of Inflation rate in selected countries in Sub-Saharan Africa. The inflation rate of South Africa for the period 2000-2013 ranges between 5-10 percent. Similarly, inflation rates of Burundi and Tanzania for the same period of time have been between 10 percent and 20 percent and therefore these countries are considered to be experiencing high levels of inflation. This kind of inflation is considered harmful to the economy because a higher inflation rate would reduce the public's ability to make accurate longer-term economic and financial decisions.

**Figure 1.2: Trends of Inflation rate of selected countries in Sub-Saharan Countries**

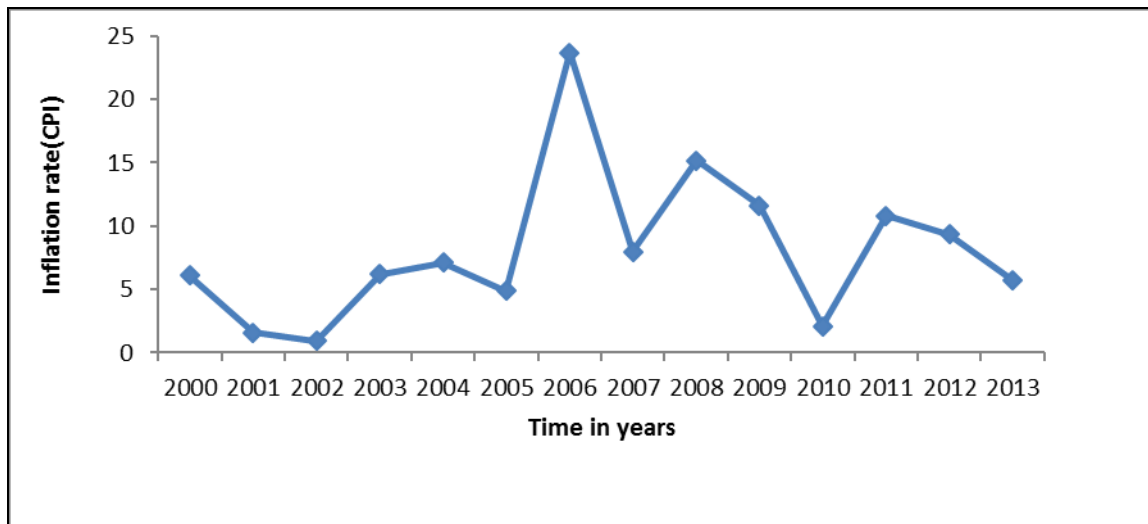


*Source: World Bank Indicators Database (2014)*

Since the year 2003, the monetary policy in Kenya has pursued inflation targeting policy that pegs the desired inflation rate at 5 per cent. However, Inflation targets in Kenya have been missed frequently and the Central Bank of Kenya has been unsuccessful at keeping and maintaining the inflation at the target rate. The level of inflation has also been higher compared with the level of inflation in developed (average of 3%) and some of the emerging economies (average of 8%). For instance the average inflation rate between 20001 and 2013 was 10.17% while the highest inflation rate experienced in the country over the period was 26.2% with the least being 1.96%. The Figure 1.3 below shows the trend of inflation in Kenya for the period 2001 to 2013.



**Figure 1.3: Trends of Inflation rate in Kenya 2000-2013**



*Source: World Bank Indicators Database (2014)*

Studies of monetary and non-monetary determinants of inflation in Kenya are numerous. However these studies of inflation in Kenya yield inconsistent results among themselves as well as in relation to global studies. For instance Ndung'u (1994), Adam et al (1996),Ndung'u (1996), Durevall and Ndung'u (2001) Barasa (2009), Durevall and Sjö (2012) Kiptui (2009), Andre et al., (2013),Mwega (2014) found interest rates, exchange rates, money supply, real GDP, food and non-food world prices, world energy prices and supply shocks to be important factors in explaining the movements in the inflation rate in Kenya. Tumkou and Caroline (2012) on the other hand found that interest rate does not affect inflation. Another study by Ryan and Milne (1994) found that the contribution from monetary variables (interest rates, money supply and world prices) were insignificant.

In a nutshell, studies on inflation in developed, emerging and developing economies yield conflicting results as far as the monetary and non-monetary determinants of inflation are concerned and at the same time there is little agreement about the relative importance of different sources of inflation. One school of thought believes that inflation is largely influenced by non-monetary factors such as supply shocks, which somewhat obscures the role of demand side factors and hence the monetary transmission mechanism in the inflation process. The other school of thought argues that non-monetary factors affect only the short-run path of inflation while in the long-run, monetary variables determine the inflation rate.

The lack of consensus implies that the monetary and non-monetary determinants of inflation in developed, emerging and developing economies may not yet be known. Confronted with this uncertainty regarding the true determinants of inflation, policy makers can only make best guesses, without knowing for sure whether these guesses are backed by solid empirical foundations. As a consequence of this wide disagreement on the sources of inflation, there is also no consensus on how inflation should be fought. Thus, the lack of knowledge about inflation carries also strong policy implications. This study sought to fill these gaps.

The reviewed studies of Inflation in developed, emerging and developing economies also used the Autoregressive Distributed Lag Models (ARDL) and multivariate vector autoregressive (VAR) models. However, such models are based on the assumption of linearity in the data. There is now growing evidence that macroeconomic series contain nonlinearities and therefore is asymmetric (its behaviour is different during different phases of business cycle) Tiao and Tsay (1994) and Stanca (1999). For example, Shyh (2010) provides evidence of non-linearity of inflation rate in OECD countries. Similarly, Yildirim (2004) provides the evidence for non-linearity in Turkish inflation rate and estimates Logistic Smooth Transition Auto-regressive Model (LSTAR). Testing for non-linearity has become an important area of research in econometrics because of its profound implications for model adequacy, market efficiency and predictability Brooks (1996). If there is evidence of non-linearity, this suggests that, at least in the short term, forecasts may be improved by switching from a linear to a non-linear modelling strategy, and furthermore, the tests may be viewed as general tests of model adequacy for linear models in the sense that if there is still dependence in the residuals of a linear model, the original linear models can no longer be viewed as an accurate representation of the data Hinich and Patterson, (1995) and Brooks (1996).

Despite the abundance of studies on the behavior of inflation rates in Kenya, non-linearity has not been considered yet by the existing literature. Also as stated earlier, despite the fact that there is increasing evidence of nonlinearity in macroeconomic data, none of the reviewed studies have tested for possibility of non-linearity in the inflation model. This study was an attempt to bridge this gap.

## **1.2 Statement of the Problem**

Since the year 2003, the monetary policy in Kenya has pursued inflation targeting policy that pegs the desired inflation rate at 5 per cent. However, Inflation targets in Kenya have been missed frequently and the Central Bank of Kenya has been unsuccessful at keeping and maintaining the inflation at the target rate. The average level of inflation has also been higher (10.17 per cent) compared with the level of inflation in developed (3per cent) and emerging economies (8 per cent). Missed inflation targets present a dynamic inconsistency challenge to policy makers. The implication of dynamic inconsistencies is that macroeconomic policies formulated on the basis of inconsistent inflation forecasts may have a negative impact on the economic growth prospects of the country and the subsequent long term socio-economic aspirations such as the Millennium Development Goals and Kenya Vision 2030 goals. Previous studies on inflation yield conflicting results as far as determinants of inflation in Kenya are concerned. Confronted with this uncertainty regarding the true determinants of inflation, policy makers can only make best guesses, without knowing for sure whether these guesses are backed by solid empirical foundations. As a consequence of this wide disagreement on the sources of inflation, there is also no consensus on how inflation should be fought. Similarly studies on inflation in Kenya have looked at the relationship between inflation and GDP growth, interest rates and the impact of monetary policy tools on inflation and in their estimations consider a linear relationship between the variables in the models. There is no apriori reason to assume that the inflation model has to be linear without test for non-linear effects. This study therefore sought to establish the monetary and non-monetary determinants of inflation in Kenya and also test for possible non-linearity in the inflation model in Kenya.

## **1.3 Objectives of the Study**

### **1.3.1 General objectives**

To investigate the determinants of inflation in the Kenyan economy

### **1.3.2 Specific Objectives**

1. To establish the monetary determinants of inflation in Kenya
2. To investigate the non-monetary determinants of inflation in Kenya
3. To test for possible non-linearity in the inflation model in Kenya.

#### **1.4 Research Hypotheses**

**H<sub>01</sub>** Money supply growth, Exchange Rates and Interest Rates do not have a significant relationship with inflation rate

**H<sub>02</sub>** GDP growth rate, Oil Price Change and Lag inflation rate do not have a significant relationship with inflation rate

#### **1.5 Scope of the Study**

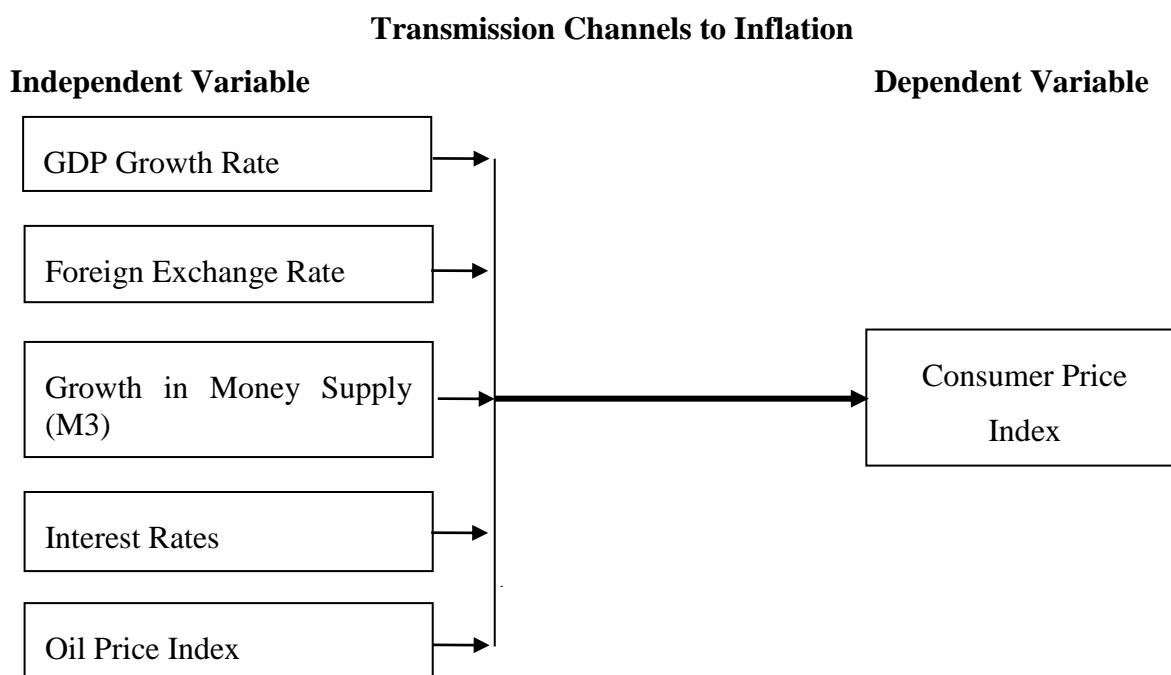
The study used quarterly time series data for the period 2001 to 2013 as this is justified by the availability of quarterly data. The data for foreign exchange rates, inflation rate, GDP growth rate and growth in money supply and interest rate were obtained from the Central Bank of Kenya and the Kenya National Bureau of Statistics. The data for oil prices were obtained from the Kenya National Bureau of Statistics. The area of study; Kenya is an East African country with coordinates latitude of 1<sup>00</sup>1N and longitude of 38<sup>00</sup>1E. The map is attached as annex (i).

#### **1.6 Justification of the Study**

This study is very important to macroeconomists, financial analyst, academicians, policy makers and Central Bank officials in understanding the monetary and non-monetary determinants of inflation and thus come up with the relevant policies so as to keep prices at the reasonable rate that stimulate production. It is necessary to policy makers to clear doubt as many studies on the monetary and non-monetary determinants of inflation remains inconclusive. Monetary policy framework in Kenya has targeted annual inflation at below 5 per cent, this has been persistently missed. Missing the targeted inflation rates has the negative consequences of sub-optimal growth which affects the ability of the country to meet medium and long term development goals and poverty reduction as outlined in Kenya Vision 2030. This study is also deemed important to financial analysts as it would enable them be in a position to make informed decisions regarding operations of their firms as the success of these institutions also depends on the inflation rate experienced in the economy. This study would thus enable them be cognizant of the determinants of inflation rate and thus would have to consider all these factors when making financial decisions.

## 1.7 Conceptual Framework

Inflation in an open economy is assumed to originate from both the demand and the supply side. Specifically the supply side is captured by the tradable sector whereas the demand side is represented by the non-tradable sectors. It is further assumed that the overall price level is a weighted average of the price of tradable goods and non-tradable goods. The price of tradable goods is determined by movement in exchange rates and foreign prices assuming that purchasing power parity holds. Hence depreciation (appreciation) of exchange rate or an increase (decrease) in foreign prices will increase (decrease) domestic prices. The price of non-tradable goods on the other hand is set in the domestic market, where demand for non-tradable goods for simplicity is assumed to move in line with demand in the overall economy. As a result the price of non-tradable goods is determined by the money market equilibrium condition, where real money supply equals real money demand. The demand for real money balances is assumed to depend on real income and inflationary expectations/supply shocks. The interplay between variables and how they translate to inflation is presented in figure 1.4 below.



Source: Adopted from UNDP (2010)

Figure 1.4: Conceptual Framework

## CHAPTER TWO: LITERATURE REVIEW

### 2.1 Introduction

This chapter reviewed theoretical and empirical literature on determinants of inflation in the Kenyan economy.

### 2.2 Theoretical Literature

There are two fundamental tenets on which the theories of inflation are built, these are; the aggregate demand (demand pull) and cost-push theories. The demand-pull theory states that inflation results from a rise in aggregate demand Hellwig (2002). As such, the theory regards price changes as a market clearing mechanism and inflation is seen as a result of excess demand in commodity and factor markets. Consequently, factors that influence demand-pull inflation include increases in money supply, government spending and the price level in the rest of the world. Conversely, under the cost-push theory, inflation is seen as the result of factor prices accelerating more rapidly than factor productivities. Essentially, cost-push inflation occurs as a result of decreases in aggregate supply Hellwig (2002). This may be due to an appreciation in wages or the price of raw materials. Such increases lead to higher production costs, hence the term ‘cost-push’ inflation. Higher production costs may bring about a reduction in the employment rate and a drop in output Hellwig (2002) and Hendry (2001).

Through the avenues of demand pull and cost push theories, followers of the Keynesian and Monetarist schools of thought have formulated different approaches to understand the inflationary process. According to the Keynesians Keynes (1936), inflation is a result of income disturbances and shocks to the economy, like oil price increases, while the Monetarists believe that inflation occurs because of excess demand and inappropriate monetary responses to economic situations Freidman (1968).

The Keynesian Model may be represented as

$$\pi = f(l, w, u, o, p^e), \dots \dots \dots (2.1)$$

where  $\pi$ ,  $l$ ,  $w$ ,  $u$ ,  $o$ ,  $p^e$  represent inflation rate, excess demand for labour, wage rate, unemployment rate, output and price expectations, respectively.

The Monetarist Model may be structured as

$$\pi = f(y, m_s, i), \dots\dots\dots (2.2)$$

where  $y$  represents changes in real income,  $m_s$  money supply and  $i$  refers to the cost of holding cash (interest rate). Classical theorists have also constructed models in an effort to better understand the causes of sustained price increases in an economy. Their approach is quite similar to that of the monetarists where inflation is a product of ‘too much money chasing too few goods’. In this state, the increased money supply leads to a jump in the demand for goods and services, thereby causing inflation Laidler (2005) and Qayyum (2006).

In an effort to combat criticisms from the Monetarists, the Keynesians put forward a modified theory of inflation, based upon imperfect competition. In this theory, the Keynesian theorists state that to an individual worker in wage negotiations, the price level is exogenous Hendry (2001), Qayyum (2006) and Svensson (2000). However, to all the workers in the negotiation, the price level is endogenous. As a result, inflation occurs because workers want higher wages and firms want higher profits. Therefore, if workers are granted a wage increase, firms will increase prices (by a mark-up) and this leads to inflation. That is, inflation is influenced by wage increases and firms’ mark-up prices Friedman (1968).

Similar to the Keynesians, the Monetarists found an angle to combat criticism from the Keynesians by proposing a theory in which firms are unsure of the reason for a price increase. That is, they may be unsure if there are inflationary pressures at work or if consumer demand has actually risen. After finding out the reason for the price jump, firms will adjust their prices accordingly, based on rational expectations. Therefore, price expectations influence the inflation rate Friedman (1968)

In addition to the theories described above, there is the supply side theory, which is also related to Monetarism and proposes that the supply of goods and services (instead of money supply) may contribute to the inflationary process. That is, if there is ‘too much money chasing too few goods’ then two solutions are possible; either decrease the money supply or increase the supply of goods and services Durevall and Sjö ( 2012). The variables for the determination of inflation in this model include the output gap (representing the deviation of actual output from desired output) and excess money (which is the difference between actual and desired money) Cheruiyot (2012) and Durevall and Sjö (2012).

Another approach to understanding the inflationary process is formulated under the Structuralist model of imported inflation Frisch (1977). This model shows that a country's dependence on external markets may bring about inflation, since heavy reliance on external variables is expected to motivate upward pressure on domestic prices. Another model from the structuralist school of thought, the Scandinavian model Frisch (1977), which seems mostly relevant to small open economies hypothesizes that inflation is influenced by world prices, wages and productivity. Frisch (1977) also mentions an augmented Scandinavian model developed by Branson and Myhrman, (1976), in which unemployment rate and expected inflation in the tradable sector are added to the determinants of inflation in the Scandinavian model.

Further development cites structural factors such as weather conditions, policies aimed at protecting certain industries or just trading policies may also influence the rate of inflation. If there's a hurricane, which damages food supply and infrastructure, then prices of goods and services will definitely shoot up Bernanke (2005). Also, in protecting certain industries, cheaper goods and services may not be allowed into the country, which results in higher prices for certain goods and services. This shows that inflation may be a consequence of weather conditions and trade protection policies Cheruiyot (2012).

## **2.3 Review of Empirical Studies**

### **2.3.1 Empirical Studies in Developed Economies**

Dhakal (2002) investigated the major determinants of the inflation rate in the United States using a vector autoregressive model that included major variables interacting with the price level in the macroeconomy. The results suggested that changes in the money supply, the wage rate, the budget deficit and energy prices are important determinants of the inflation rate in the United States. Further, the relative contribution of these factors to the variance of the forecast error of the price level is consistent with a more dominant impact for monetary changes on the inflation rate. These findings however contradict those of Baek and Koo (2009) who examined the short and long-run effects of changes in market factors such as prices of energy and agricultural commodities and exchange rate on changes in U.S. Inflation using the ARDL approach to cointegration and found money supply not significant.

Balakrishnan and Ouliaris (2006) investigated the US Inflation dynamics using a hybrid model of Traditional Phillips Curve and the New Keynesian Phillips Curve. The variables of the study included future inflation, lagged inflation, marginal cost, relative import price



deflator, output gap and external competition. The study found out past inflation and the output gap to be the main driver of United States inflation. These findings however contradict those of Pain *et al.* (2006) who studied the relationship between, on the one hand, observed changes in the inflation process in the OECD economies and, on the other hand, the integration of non-OECD economies into the global economy. They found that domestic inflation in OECD economies was increasingly affected by import prices and became less sensitive to domestic output gaps and Ueda (2009) who investigated the determinants of inflation in Japan and the United States by estimating a vector autoregression in which the four endogenous variables are inflation expectations, inflation, the short-term nominal interest rate and the output gap, with changes in energy prices and (fresh) food prices being the exogenous variables. The findings reveal that inflation expectations to lead realized inflation while output gap played a less significant role in driving the United States inflation.

Assenmacher-Wesche, Gerlach and Sekine (2007) studied monetary factors and Inflation in Japan using Dynamic Ordinary Least Square Method on an Autoregressive Distributed Lag Model. They found out that at low frequencies inflation is determined by excess supply of money, growth rate of money minus growth rate of real GDP and changes in interest rates while at high frequencies inflation is caused by the output gap. However these findings contradict those of Baek and Koo (2009) who found money supply not significant and Ueda (2009) who found output gap to be less significant.

Pami and Dua (2009) in their study Determination of Inflation in an Open Economy Phillips Curve Framework: The Case of Developed and Developing Asian Countries found out output gap, expected inflation, exchange rate to significantly and positively influence inflation in Japan. Nishizaki, Sekine and Ueno (2014), using a standard Phillips curve indicated that a decline in inflation expectations, the negative output gap, and other factors such as a decline in import prices and a higher exchange rate, all account for the chronic deflation in Japan. All these findings seem to contradict those of Ueda (2009) who found output gap to play a less significant role in driving inflation in the United States and Japan.

Jacobs and Williams (2014) looked at the Determinants of Non-tradable Inflation in Australia for the period 1990-2014. The study found out that the rate of non-tradable inflation in Australia is determined the business cycle, inflation expectations, unit labour cost, change in unemployment rate and output gap. Norman and Richards (2010) in their study Modelling Inflation in Australia obtained results that showed that unemployment rate, growth in unit labour costs and the output gap to explain the determinants of inflation in Australia. The

findings seem to contradict those of Ueda (2009) who found output gap to play a less significant role in driving inflation in the United States and Japan

Brouwer and Ericsson (1995) found out that continued low inflation in Australia is as a result of sustained low growth rates in unit labour costs, import prices and exchange rates. These findings are contrary to the findings by Dwyer and Leong (2001) who noted that unlike in the 1990's where episodes of currency depreciation usually generated an increase in inflation, they now appeared to have little or no effect on retail import prices so that, despite a significant depreciation, domestic inflation remained undisturbed.

From the reviews above, it is evident that studies on inflation in developed economies yield conflicting results as far as the monetary and non-monetary determinants of inflation are concerned. The lack of consensus implies that the monetary and non-monetary determinants of inflation in developed economies such as USA, Australia, Sweden, Japan and Spain may not yet be known. The reviewed studies also used the Autoregressive Distributed Lag Models (ARDL) and multivariate vector autoregressive (VAR) models. However, such models are based on the assumption of linearity in the data. There is now growing evidence that macroeconomic series contain nonlinearities and therefore is asymmetric (its behaviour is different during different phases of business cycle) Tiao and Tsay (1994) and Stanca (1999). There is no apriori reason to assume that the inflation model has to be linear without test for non-linear effects. This study therefore sought to fill these gaps by establishing the monetary and non-monetary determinants of inflation in the Kenyan economy and by testing for possible non-linearity in the inflation model in Kenya.

### **2.3.2 Empirical Studies in Emerging Economies**

Khan, Ahmed and Hyder (2007) conducted a study on inflation determinants in Pakistan using data from the 1972 to 2006 and found the most important determinants of inflation to be adaptive expectations, private sector credit, exchange rates and rising import prices. On the other hand Akbari and Rankaduwa (2006) conducted a study on Inflation targeting in a small emerging market economy for the period 1982-2004 a case study of Pakistan and found out that there was an insignificant relationship between interest rate, exchange rate and inflation. This is contrary to the findings by Khan, Ahmed and Hyder (2007) who singled out exchange rate to be an important determinant of inflation in Pakistan.

Likewise in Ukraine, Novikova and Volkov (2012) while modelling core inflation in Ukraine for the period 2003-2012 found the exchange rate and labor costs (nominal wage) to cause

both headline inflation and core inflation; particularly the exchange rate was found to be the key explanatory variable. This is contrary to Lissovolic (2003) who found that the long term role of exchange rate in influencing inflation has declined over time and also there is no significant long-term link between money supply and inflation. Leheyda (2005) found that the inflationary process experienced in Ukraine between 1998 and 2003 were as a result of the changes in the money supply, wage rates, exchange rates, real output and exogenous shocks, money demand, purchasing power parity and mark-up relationships. Bilan and Siliverstovs (2005) also found growth of monetary supply, change in average wage and change in inflation expectations all to be main determinants of inflation in Ukraine. These findings are contrary to those of Kirchner, Weber, Giucci (2008) who while conducting a study on Inflation in Ukraine using data 199-2008 found out Money Supply, output gap and Wages rates to have no influence on Ukrainian inflation and Novikova and Volkov (2012) who found out no significant link between money supply and inflation.

In Brazil, Matthew Carlson (2013) in his study Determinants of Hyperinflation: Case Studies from Latin America Based Economies found inflation was due to external debt and monetary base growth. The countries (including Brazil) took on excessive levels of external debt which eventually contributed to spiraling inflation. The exogenous money growth carried out by the central banks also greatly contributed to rising inflation. This is contrary to the findings of Kirchner, Weber, Giucci (2008). Still in Brazil, Serrano and Suma (2005) in their study Distribution and Cost-Push inflation in Brazil under inflation targeting, found that the inflation in Brazil between the years 1999 to 2014 were as a result of the changes in the money supply, wage rates, exchange rates and output growth contrary to Narayan and Narayan (2011) did not find any evidence of a systematic relationship between inflation and output growth in Brazil.

From the reviews above, it is evident that studies on inflation in emerging economies yield conflicting results as far as the monetary and non-monetary determinants of inflation are concerned. The lack of consensus implies that the monetary and non-monetary determinants of inflation in developed economies such as Pakistan, Ukraine and Brazil may not yet be known. The reviewed studies also used the Autoregressive Distributed Lag Models (ARDL) and multivariate vector autoregressive (VAR) models. However, such models are based on the assumption of linearity in the data. As noted earlier, there is now growing evidence that macroeconomic series contain nonlinearities and therefore is asymmetric (its behaviour is different during different phases of business cycle) Tiao and Tsay (1994) and Stanca (1999).

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### **2.3.3 Empirical Studies in Developing Economies**

Olubusoye and Oyaromade (2008) analyzed the main sources of fluctuations in inflation in Nigeria using the framework of error correction mechanism. The study found that lagged inflation, Consumer Price Index, expected inflation, import prices and real exchange rate significantly propagate the dynamics of inflationary process in Nigeria. The level of output was found to be insignificant in the parsimonious error correction model. . The level of output (Real GDP) and money supply were found to be insignificant. Ndidi (2013), in a bid to empirically examine the determinants of inflation in Nigeria used cointegration analysis on yearly data between 1970 and 2010. The study found that expected inflation, measured by the lagged term of inflation, money supply, significantly determine inflation, while trade openness, capturing the tendencies of imported inflation, income level, exchange rate and interest rate are found not to be significant both in the short-run and long-run. Kinda (2011) examined the determinants of inflation in Chad using quarterly data from 1983-2009. The study based its analysis on a single equation model and completed by a vector auto-regression model to capture inflation persistence. The result showed that the main determinants of inflation in Chad to be rainfall, foreign prices, exchange rates movements and public spending. The effects of rainfall shocks and changes in foreign prices on inflation persist during the first six quarters while changes in public spending and nominal exchange rate affect inflation during three and four quarters respectively. Rutasitara (2004) in her study exchange rate regime and Inflation in Tanzania found out Growth in Real GDP, Exchange Rate and growth in Money supply to be the main determinants of inflation in Tanzania. Laryea and Sumaila (2012) also found output level, monetary supply and exchange rate to be the main determinants of inflation in Tanzania Ndung'u (1994) estimated a monetarist model of inflation for Kenya. From the findings, the study showed that money supply growth, interest rate changes, real income growth, and lagged inflation were important factors in explaining movements in the rate of inflation in Kenya. In another study by the same author ;Ndung'u (1996) using a Granger-non-causality test to analyze inflation in Kenya for the period 1971-1995 found that monetary growth, exchange rate changes, real income growth, interest rate changes, the foreign rate of inflation and the error correction terms all have

significant effects on the rate of inflation. He further found the exchange rate to be more important than monetary factors in explaining Kenya's inflationary process. While Olubusoye and Oyaromade (2008) found output (Real GDP) and money supply to be insignificant all the other studies {Ndidi (2013) ,Kinda (2011), Rutasitara (2004) , Laryea and Sumaila (2012) , Ndung'u (1994) and Ndung'u (1996 ) found output (Real GDP) and money supply to be to be important factors determining inflation rates in respective countries. The studies did not also consider oil prices as is the case for the current study.

Barasa (2009) conducted a study on the casual relationship between inflation and exchange rates in Kenya for the period 1998 to 2008. It found out that there is a causal relationship between inflation and exchange rates in Kenya for only the US Dollar and the Great Britain Pound only. Tumkou and Caroline (2012) conducted a study on the long run relationship between interest rates and inflation in Kenya. The study investigated the relationship between expected inflation and nominal interest rates in Kenya and the extent to which the Fisher effect hypothesis holds. Using secondary data for the period 1999-2011. The study used regression analysis. The findings and analysis were in support of the existence of partial fisher effect in Kenya because both interest rates and inflation rate do not move with one on-one over the period under study Musembi (2013) examined the cointegration relationship between exchange rates, inflation and interest rates in Kenya from the periods of 1985 to 2010 The research concluded there was an existence of a long run relationship between the exchange rates and macroeconomic variables of interest rates and inflation. In addition, Durevall and Ndung'u (2001) studied the dynamics of inflation in Kenya during 1974 – 1996; a period characterized by external shocks and internal disequilibria. They found that inflation in Kenya was influenced by changes in maize-grain prices indicating a non-negligible role for agricultural supply constraints in the inflation process. They also found that the exchange rate, foreign prices and terms of trade determined inflation in the long run. Andre et al., (2013) used Forecasting and Policy Analysis Systems (FPAS) to analyze food and nonfood inflation in Kenya The study concluded that both imported and domestic food shocks are important in inflation dynamics in Kenya. Misati and Munene (2013) examined linkages between commodity price shocks and inflation based on granger causality and SVAR methods. The study found a role for food prices in explaining inflation.

Durevall and Bo Sjö (2012) examined the main drivers of inflation in Ethiopia and Kenya by developing single-equation error correction models for the Consumer Price Index in each country. The approach took into account a number of potential sources of the recent surge in

inflation, including excess money supply, exchange rates, food and non-food world prices, world energy prices and domestic agricultural supply shocks. They found that the inflation rates in both Ethiopia and Kenya are driven by similar factors; world food prices and exchange rates have a long run impact, while money growth and agricultural supply shocks have short-to-medium run effects. Ryan and Milne (1994) found that exchange rate movements and changes in oil prices were the most important factors determining inflation while the contribution from monetary variables were insignificant. All these studies of inflation in Kenya yield inconsistent results among themselves as well as in relation to global studies. For instance Ndung'u (1994), Adam et al (1996), Ndung'u (1996), Durevall and Ndung'u (2001) Barasa (2009), Durevall and Sjö (2012) Kiptui (2009), Andre et al., (2013), Mwega (2014) found interest rates, exchange rates, money supply, real GDP, food and non-food world prices, world energy prices and supply shocks to be important factors in explaining the movements in the inflation rate in Kenya. Tumkou and Caroline (2012) on the other hand found that interest rate does not affect inflation. Another study by Ryan and Milne (1994) found that the contribution from monetary variables (interest rates, money supply and world prices) were insignificant.

From the reviews above, it is evident that studies on inflation in developing economies including Kenya yield conflicting results as far as the monetary and non-monetary determinants of inflation are concerned. The lack of consensus implies that the monetary and non-monetary determinants of inflation in developing economies may not yet be known. The reviewed studies also used the Autoregressive Distributed Lag Models (ARDL) and multivariate vector autoregressive (VAR) models. However, such models are based on the assumption of linearity in the data. As noted earlier, there is now growing evidence that macroeconomic series contain nonlinearities and therefore is asymmetric (its behaviour is different during different phases of business cycle) Tiao and Tsay (1994) and Stanca (1999). There is no apriori reason to assume that the inflation model has to be linear without test for non-linear effects. This study therefore sought to fill these gaps by establishing the monetary and non-monetary determinants of inflation in the Kenyan economy and by testing for possible non-linearity in the inflation model in Kenya.

### **2.3 Chapter Summary**

This study was significantly different from previous studies in a number of ways. First While some studies, for instance, Kigume (2011), Barasa (2009), Tumkou and Caroline (2012) only considered interest rates and exchange rates, implying that they failed to include crucial factors, and effectively rendering their models deficient. This study attempted to address this gap by examining more variables (real GDP, oil price and money supply) and thus bridging this gap as well as improving the statistical reliability of the estimators in the model. Second all the studies of inflation determinants in Kenya i.e. Ndung'u (1994), Adam et al (1996), Ndung'u (1996), Durevall and Ndung'u (2001) Barasa (2009), Durevall and Sjö (2012) Kiptui (2009), Andre et al., (2013), Mwega (2014) did not include oil prices in their model. Oil prices are known to have major effect on inflation. Third, the reviewed studies also used the autoregressive Distributed Lag Models (ARDL) and multivariate vector autoregressive (VAR) models. However, such models are based on the assumption of linearity in the data. As noted earlier, there is now growing evidence that macroeconomic series contain nonlinearities and therefore is asymmetric. There is no apriori reason to assume that the inflation model has to be linear without test for non-linear effects. Finally, the study noted that the fourth gap stemmed from a geographical/contextual gap with some studies, for instance, Ndidi (2013), Kinda (2011), Olubusoye and Oyaromade (2008), Brouwer and Ericsson (1998), Pahlavani and Rahimi (2009), Akbari and Rankaduwa (2006), Qayyum (2006), Kemal (2006), Khan, Ahmed and Hyder (2007), reflecting findings from other developing (non Kenyan), emerging and developed economies. These may therefore not necessarily explain the Kenyan context. The study brought about a better understanding of inflation determination by testing for nonlinearity effects, consideration of the difference in economic environment between Kenya and other economies, and through inclusion of more variables. Through this additional knowledge this study positions itself as the first of its kind to improve decision making for policy makers who have been tasked with the work of inflation targeting and management.

## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.1 Introduction**

This chapter looked at the research methodology that was undertaken in the study carried out on the determinants of inflation in the Kenyan economy. Specifically it covers research design, study area, data sources, econometric model specification and diagnostic tests.

### **3.2 Research Design**

An explanatory research design was adopted. An explanatory research design is used to show how variables relate to each other. According to De Vaus (2001), explanatory research answers the why questions and this therefore involves developing the causal explanations among variables in a study which also according to Mugenda and Mugenda (2003) aims at establishing a cause and effect between variables.

### **3.2 The Study Area**

The study was carried out in Kenya, an East African country bordering the Indian Ocean, between Somalia and Tanzania. It borders Ethiopia to the north, South Sudan to the North West and Uganda to the West. It lies on latitude of  $1^{\circ}00'N$  and longitude of  $38^{\circ}00'E$  (The map of Kenya is annexed i). The choice of study was influenced mainly by the fact that Kenya's economy has spawned the emerging East African Community hence a study for Kenya has exemplary implications for the East African regional block and other developing countries.

### **3.3 Data Sources**

The study used data from secondary sources only. Data of all the variables during the period of 2001 to 2013 were obtained mainly from the databases of the Central Bank of Kenya and Kenya National Bureau of Statistics. These are bodies mandated to produce country's official statistics thus data reliability and validity is assured. The statistical software package EVIEWS and STATA aided in the analysis. The analyzed data has been presented using tables, figures and graphs.



### 3.4 Econometric Model Specification

To examine the determinants of inflation in Kenya, the study employed an empirical test of the relation between inflation and the determining factors. The model was adopted from Kiptui (2009) with modifications. Kiptui’s model was deficient on three fronts, first it only included two variables crude oil price and exchange rates. Secondly the model did not pay explicit attention to non-stationarity of data. Third the model assumed a linear approach. There is no apriori reason for assumption of linearity.

Based on the theoretical discussions in the previous chapter the long run equation is specified as follows:

$$\pi_t = \alpha_0 + \beta_0 Ms_t + \beta_1 i_t + \beta_2 rGDP_t + \beta_3 l\pi_t + \beta_4 rEX_t + \beta_5 Y_t + \mu_t \dots \dots \dots (3.1)$$

Where,  $\pi$  = inflation;

$Ms$  = Money Supply;

$i$  = Interest rate;

$rGDP$  = Real Income;

$l\pi$  = Lagged Inflation;

$rEX$  = Real Exchange rate,

$Y$  = Oil Price .                       $t$  = One year lag

$\alpha$  and  $\beta$  are the parameters to be estimated associated with the regression model.

$\mu$  = Error term    Where:  $\mu_t \sim IID(0, \sigma_\mu^2)$

### 3.5 Diagnostic Tests

The pre-estimation tests of unit root and multicollinearity were conducted. Time series data generally assumes stationarity among variables. A time series is stationary if its mean, variance and autocovariances are independent of time. It was therefore important to test

whether the variables in the model are stationary so as to avoid the problems associated with regression analysis of time series data where variables are non-stationary. As explained in Gujarati and Porter (2009), the non-random behavior of time series data undermine the usefulness of the standard econometric methods applied without considering time series properties. Regression on such data is thus expected to be spurious and inconsistent thereby causing a common time trend.

### 3.5.1 Test for Multicollinearity:

The test for Multicollinearity was conducted to establish whether the independent variables are correlated. In this case the study used correlation matrix as well as the variance inflation factors to establish whether Multicollinearity existed. According to Williams, Grajales and Kurkiewicz (2013), multicollinearity refers to the presence of correlations between the predictor variables. In severe cases of perfect correlations between predictor variables, multicollinearity can imply that a unique least squares solution to a regression analysis cannot be computed (Field, 2009). Multicollinearity inflates the standard errors and confidence intervals leading to unstable estimates of the coefficients for individual predictors Belsley, Kuh, and Welsch (1980). The variance inflation factors (VIF) Method was used. According to Field (2009) VIF values in excess of 10 is an indication of the presence of multicollinearity. The results of the test are presented in Table 4.2 below. The sum of the variance inflation factors is 8.17 which are below 10 and thus according to Field (2009) there is no multicollinearity.

**Table 4.2: Variance Inflation Analysis test for Multicollinearity.**

```
. vif
```

| Variable     | VIF  | 1/VIF    |
|--------------|------|----------|
| Interest_R~e | 2.50 | 0.400063 |
| reerchanges  | 1.89 | 0.528710 |
| M3Growth     | 1.88 | 0.530713 |
| Price_Index  | 1.36 | 0.735235 |
| laginflation | 1.12 | 0.893741 |
| rgdpgrowth   | 1.05 | 0.947879 |
| Mean VIF     | 1.63 |          |

### 3.5.2 Test for Normality:

Jarque-Bera statistic normality test was carried out to ensure that the variables used in the analysis are normally distributed. The test utilizes the mean, standard deviation based coefficient of skewness and kurtosis to check whether the residuals are consistent or not. Under the null hypothesis of a normal distribution, the Jarque-Bera statistic is distributed with

2 degrees of freedom. The reported Probability is the probability that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null. A small probability value leads to the rejection of the null hypothesis of a normal distribution.

### 3.5.3 Test for Heteroscedasticity:

The error terms/residuals from a regression model should have a constant variance (Homoskedastic) and thus to ascertain whether the residuals meet this criteria the study used the White's test for Heteroskedasticity where the null hypothesis under this test is that residuals are Homoskedastic. To test for Heteroskedasticity the fitted values are plotted against the residuals as indicated in figure 4.6. It shows that the error terms are evenly spread above and below the reference line. The results were further confirmed using the White's test where the null hypothesis in the test is that error terms have a constant variance (i.e. should be Homoskedastic).

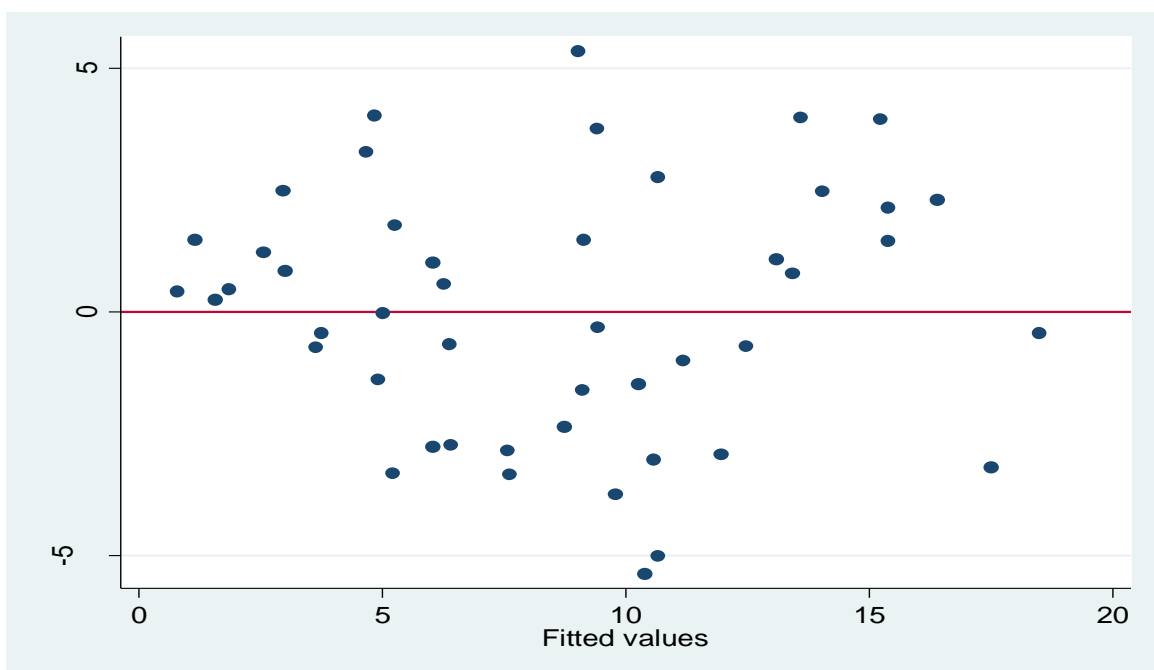


Figure 4.6: Residuals Plot for Heteroskedasticity.

The results in the Table 4.5 below indicate that the error terms are Homoskedastic, given that the p-value is greater than the 5% and thus no violation of the Ordinary Least Squares assumption of constant variance of residuals.

**Table 4.5: Heteroskedasticity Test Results**

```
. imtest, white

White's test for Ho: homoskedasticity
      against Ha: unrestricted heteroskedasticity

      chi2(27)      =      30.65
      Prob > chi2   =      0.2860
```

**3.5.4 Test for Autocorrelation:**

The residuals from regression should not be auto-correlated and thus the study tested for autocorrelation using the Breusch-Godfrey (BG) test. In this case the null hypothesis of the test is that the residuals do not suffer from autocorrelation. If auto-correlation is found to exist this is corrected by adding the lags of the variables into the model.

To establish whether or not the residual are serially correlated over time, a Breusch-Godfrey LM test was conducted. The null hypothesis is that no first order serial /auto correlation exists. The results are as indicated in Table 4.6 below and therefore the null hypothesis of no autocorrelation is accepted and that residuals are not auto correlated (p-value=0.0033).

**Table 4.6: Serial Correlation Tests**

```
. estat bgodfrey

Breusch-Godfrey LM test for autocorrelation
```

| lags (p) | chi2  | df | Prob > chi2 |
|----------|-------|----|-------------|
| 1        | 2.276 | 1  | 0.1314      |

H0: no serial correlation

**3.5.5 Unit Root Tests**

This study used the Augmented Dickey-Fuller (ADF) test for formal unit root tests to determine the existence or otherwise of unit roots in the series. The order of integration of different variables was also determined by first differencing the change in various variables on a one year lag of the variable and the error term. This is done based on three main

regressions: Augmented Dickey Fuller tests with intercept only, intercept and trend and finally 1<sup>st</sup> difference. This outcome is presented in table 4.3.

**Table 4.3: Unit Root Tests**

|   | <b>Inflation</b> | <b>M3growth</b>          |                   | <b>CBR</b> | <b>RGDP Growth</b> | <b>REER change</b> | <b>Oilpr change</b> |
|---|------------------|--------------------------|-------------------|------------|--------------------|--------------------|---------------------|
|   | Intercept        | Intercept                | Intercept & trend | Intercept  | Intercept          | Intercept          | Intercept           |
| ADF Statistic   | -3.535551        | -2.580690                | -2.87013          | -3.056830  | -2.969811          | -3.140577          | -3.931400           |
| Critical Values   |                  |                          |                   |            |                    |                    |                     |
| 1%  | -3.5745          | -3.5745                  | -4.1630           | -3.5745    | -3.5745            | -3.5745            | -3.5745             |
| 5%  | -2.9241          | -2.9241                  | -3.5066           | -2.9241    | -2.9241            | -2.9241            | -2.9241             |
| 1 <sup>st</sup> diff.   | -                | [-5.84292]<br>{-3.57}*** | -                 | -          | -                  | -                  | -                   |
| Durbin Watson   | 2.200886         | 2.037121<br>(1.955914)   | 2.012476          | 1.982323   | 2.015811           | 1.946357           | 2.080146            |
| Remark  | 1(0)**           | 1(1)***                  |                   | 1(0)**     | 1(0)**             | 1(0)**             | 1(0)***             |
| <p><b>Notes:</b> *** &amp; ** denotes the level of significance at 1% and 5% level respectively; Durbin Watson values in brackets are those for stationary series after 1<sup>st</sup> difference; [] gives the ADF statistic for first difference while {} represents the critical value of the differenced variable</p> |                  |                          |                   |            |                    |                    |                     |

From Table 4.3, the results of the unit root test show that all the series are integrated of order zero(I (0)) with the exception of the money supply growth (M3growth) which is of order one (1(0)). This implies that apart from the later, all the variables do not have unit root problem i.e. all the series are stationary at levels. The next step is therefore is to proceed to difference M3growth to make it stationary. On first difference the series becomes stationary at 1% significant level. Further, from the Durbin Watson values for all the stationary series, the results are reliable and do not have autocorrelation problems as the DW statistics for all values are either slightly below or above 2.

### 3.6 Cointegration Results

Given that the ADF test results indicate that all the variables except money supply growth (M3growth) are stationary at levels, there was no need investigating whether there are any cointegrating relationships among the variables. Moreover, since the dependent variable (inflation) is a stationary series, there is no need for cointegration tests hence; Error Correction Model (ECM) is not required in this kind of analysis. Further, in this analysis, the lag of inflation (dependent variable) is included into the right hand side of the equation (explanatory variables). As a result, the model changes from a static model to a dynamic model.

### 3.7 The expected signs of the coefficients

**Table 3.1: Expected Results and Literature source**

| Variable                    | Description     | Expected sign and Literature source        |
|-----------------------------|-----------------|--|
| Real Gross Domestic Product | Kenya Shillings | +ve( Positive)- AfDB (2011)                |
| Interest rate               | Percentages     | -ve (Negative) - Durevall and Sjö (2012).  |
| Money Supply                | Kenya Shillings | + ve (Positive) - Durevall and Sjö (2012). |
| Real Exchange Rate          | Percentages     | +ve (Positive) - Ndung'u (1994)            |
| Oil price                   | Kenya Shillings | + ve (Positive) - Durevall and Sjö (2012). |

## CHAPTER FOUR: RESULTS AND DISCUSSION

### 4.0 Introduction

This chapter presents the results of analysis, the discussion and findings from the study on the determinants of inflation in the Kenyan Economy.

### 4.1 Descriptive Statistics

**Table 4.1: Summary of Descriptive Statistics on Determinants of Inflation in Kenya**

|                    | <b>Inflation</b> | <b>CBR</b> | <b>REER</b> | <b>Oil prices</b> | <b>M3Growth</b> | <b>GDPGrowth</b> |
|--------------------|------------------|------------|-------------|-------------------|-----------------|------------------|
| <b>Mean</b>        | 8.520775         | 10.33642   | 84.13906    | 62.06830          | 13.82814        | 4.300737         |
| <b>Median</b>      | 7.056471         | 9.810000   | 78.66000    | 59.22000          | 14.44339        | 4.883819         |
| <b>Maximum</b>     | 19.19126         | 18.47000   | 107.0800    | 123.0300          | 28.34999        | 8.375225         |
| <b>Minimum</b>     | 1.219512         | 4.180000   | 64.91000    | 19.48000          | 0.115910        | -2.460530        |
| <b>Std. Dev.</b>   | 5.250176         | 3.904636   | 13.70645    | 33.27166          | 6.791644        | 2.628617         |
| <b>Skewness</b>    | 0.580609         | 0.445150   | 0.246200    | 0.403897          | -0.318968       | -0.459430        |
| <b>Kurtosis</b>    | 2.113829         | 2.301731   | 1.501057    | 1.826416          | 2.579919        | 2.437014         |
| <b>Jarque-Bera</b> | 4.356354         | 2.827139   | 5.497179    | 4.482544          | 1.191172        | 2.370902         |
| <b>Probability</b> | 0.113248         | 0.243273   | 0.064018    | 0.106323          | 0.551239        | 0.305608         |

From table 4.1 it is evident that most of the macroeconomic variables have not been stable over the period but rather fluctuating. The highest inflation rate experienced in the country over the period is 19.2% with the least being 1.2%. From the average inflation value during the period (8.5%), the target of 5% has not been realized. On the real exchange rates, the mean over the period is 84.1. Highest real exchange rate during the period is 107 and the least is 64.9. Equally, real GDP growth rate, Central bank interest rate money supply growth and oil prices have been fluctuating. During the study period the nation realized the highest growth rate of 8.4% and least value of -2.5%. This is also way below the anticipated economic growth of double digit as the average growth mean for the period remains 4.3%. Similarly, while CBR has stabilized around 10.3%, it has varied between a minimum of 4.2% and a high of 18.5%. Likewise, during the same period, money supply growth has varied between 0.12% and 28% with a mean of 13.8%. In the same way, oil prices have been fluctuating between 123 and 19 with an average of 62.

## 4.2 Trend Analysis

This section presents the trend analysis of Inflation Rate, GDP, Exchange Rates, Interest Rates and the Money Supply illustrating the pattern of movement of the variables under study.

### 4.2.1 Trend Analysis for Exchange Rates

Figure 4.1 indicates that Exchange rates remained steady from 2001 to 2003 before dropping gradually in the subsequent years from 2004 to 2008. This subsequent drop is attributable mainly to the strong economic growth posted during this period and thus positively impacting on the performance of the exchange rates as well. However in the period 2009 to 2013 there is a rise in the exchange rates due to a slump in economic growth that was orchestrated by the effects of post-election violence.

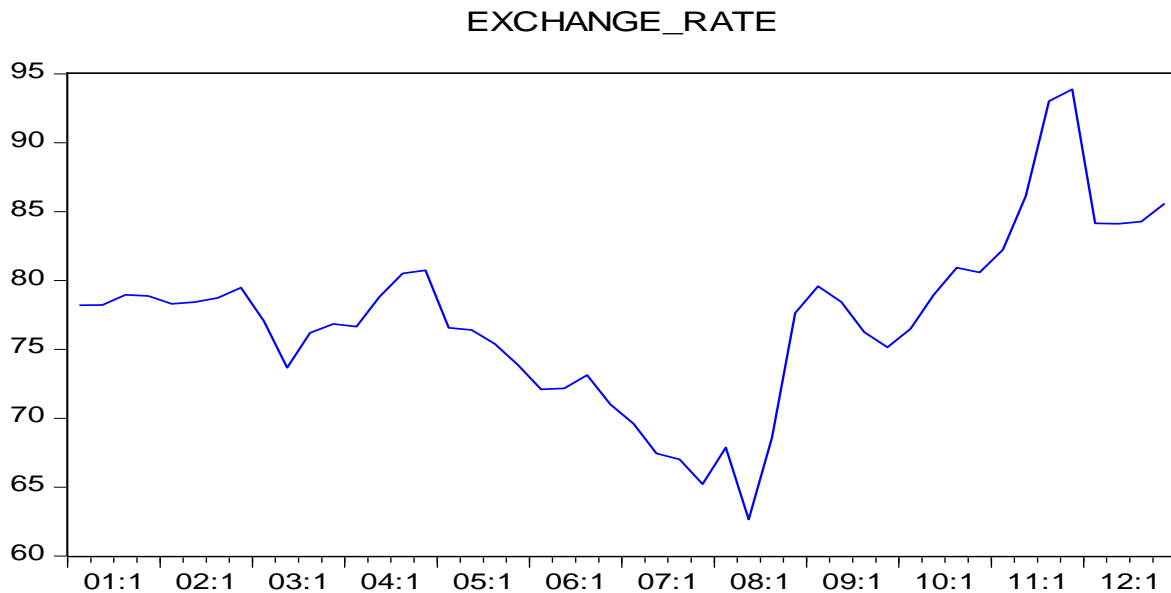


Figure 4.1 Quarterly trend for Exchange Rates analysis from 2001 to 2013

### 4.2.2 Trend Analysis for Real GDP

Figure 4.2 indicates that real GDP gradually increased from 2002 to 2007 before significantly dropping in the subsequent years from 2008 to 2009 due to the negative effects of post-election violence. The economy resumed a recovery path which saw the real GDP rise in the years 2009 to 2011 before slightly declining again in 2012 due to uncertainties occasioned by the pending 2013 elections and transition into a new political regime.





Figure 4.2: Quarterly trend for real GDP analysis from 2001 to 2013

### 4.2.3 Trend Analysis for Inflation Rate

Figure 4.3 indicates that the general trend of inflation rate has been fluctuating. Between the years 2001 and 2002, there was a decline in inflation rate. This was attributed to the tightened monetary policy by the Central Bank of Bank which saw the shilling stabilizing and interest rates declining. From the year 2003 to 2005, inflation rate rose gradually due to increasing food and fuel prices then stabilized between the year 2006 and 2007. However there was a sharp increase in inflation rate in the year 2008 to 2010 occasioned by internal shocks (post-elections disruptions, unfavourable weather conditions and high cost of food and fuel prices) and external shocks (high crude oil prices and global financial crisis). The tightening of monetary policy, together with an easing in global food and fuel prices, saw the levels of inflation come under control in 2012.

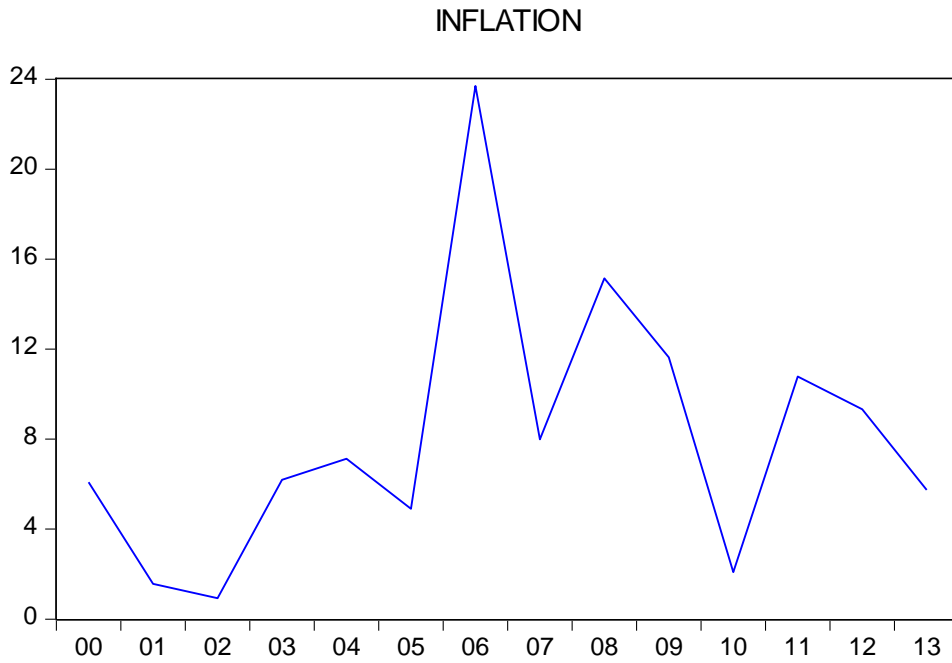


Figure 4.3: Quarterly trend for Inflation Rate analysis from 2001 to 2013

#### 4.2.4 Trend Analysis for Interest Rates

Figure 4.4 show that interest rates have been declining from the year 2001 to 2004. This decline was associated with the tightening of monetary policies by the central bank .Between the year 2005 and 2011; interest rate rose gradually and reached its peak in the year 2012.

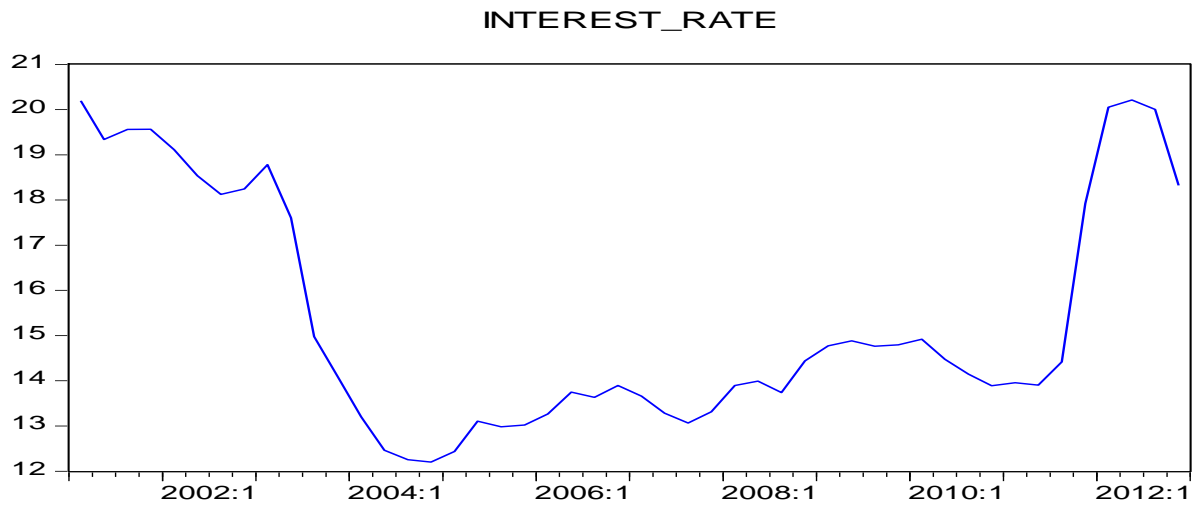


Figure 4.4: Quarterly trend for Interest Rate analysis from 2001 to 2013

## 4.5 Empirical Results on the Determinants of Inflation

The results on the Determinants of Inflation are presented in Table 4.7 below.

**Table 4.7: Regression Results on the Determinants of Inflation**

```
. reg inflation Interest_Rate M3Growth rgdpgrowth reerchanges Price_Index laginflation
```

| Source   | SS         | df | MS         | Number of obs = | 47     |
|----------|------------|----|------------|-----------------|--------|
| Model    | 995.814939 | 6  | 165.969157 | F( 6, 40) =     | 21.89  |
| Residual | 303.315521 | 40 | 7.58288803 | Prob > F =      | 0.0000 |
|          |            |    |            | R-squared =     | 0.7665 |
|          |            |    |            | Adj R-squared = | 0.7315 |
| Total    | 1299.13046 | 46 | 28.2419665 | Root MSE =      | 2.7537 |

| inflation     | Coef.     | Std. Err. | t     | P> t  | [95% Conf. Interval] |
|---------------|-----------|-----------|-------|-------|----------------------|
| Interest_Rate | -.2694861 | .1769741  | -1.52 | 0.136 | -.6271641 .0881919   |
| M3Growth      | .0485987  | .082202   | 0.59  | 0.558 | -.1175378 .2147351   |
| rgdpgrowth    | -.5150369 | .1567125  | -3.29 | 0.002 | -.8317647 -.198309   |
| reerchanges   | -.057322  | .0925976  | -0.62 | 0.539 | -.2444688 .1298248   |
| Price_Index   | .0375336  | .0153427  | 2.45  | 0.019 | .0065248 .0685423    |
| laginflation  | .7876078  | .0815265  | 9.66  | 0.000 | .6228367 .9523789    |
| _cons         | 5.01719   | 2.562744  | 1.96  | 0.057 | -.1623078 10.19669   |

### 4.5.1 Regression Results on the Monetary Determinants of Inflation Rate

The regression results in table 4.7 show that money supply growth does not have a significant relationship with inflation rate ( $\beta = 0.0485987$ ) and ( $P=0.558$ ) related to inflation rate. (The results mean that all those variables which have a P value of below 0.05 are significant for the study and determine inflation while those variables whose P values were above 0.05 are statistically insignificant and have little effect on inflation rate in Kenya). This finding is consistent with the results of Olubusoye and Oyaromade (2008) but inconsistent with Ndung'u (1996), Rutasitara (2004), Kinda (2011), Laryea and Sumaila (2012) and Ndidi (2013) who all found that there existed a significant relationship between money supply growth and inflation. The results also show that interest rate and exchange rates do not have a significant relationship with inflation rate ( $\beta = -0.2694861$ ) and ( $P=0.136$ ) and ( $\beta = -0.57322$ ) and ( $P=0.539$ ) respectively. These results are however inconsistent Ndung'u (1996), Durevall and Ndung'u (2001) Barasa (2009), Durevall and Sjö (2012) Kiptui (2009), Andre et al., (2013), Mwega (2014) who all found that there existed a significant relationship between both interest rates, exchange rates and inflation.

#### 4.5.2 Regression Results on the Non-Monetary Determinants of Inflation Rate

The regression results in table 4.7 show that real GDP growth affect Inflation Rate. More specifically Real GDP growth is negatively ( $\beta = -0.5150369$ ) and significantly ( $P=0.0020$ ) related to inflation rate. This implies that a unit increase in Real GDP results into a reduction of inflation by 0.515 units. (The results also mean that all those variables which have a P value of below 0.05 are significant for the study and determine inflation while those variables whose P values were above 0.05 are statistically insignificant and have little effect on inflation rate in Kenya). This finding is consistent with the results of Ndung'u (1996), Rutasitara (2004), Kemal (2006), Gerlach and Sekine (2007), Kigume (2011), Assenmacher-Wesche, Laryea and Sumaila (2012) who all found that there existed a significant and inverse relationship between inflation and real GDP (income level).

Further, the results show that Oil price fluctuations (changes in oil prices) are positively ( $\beta = 0.03753$ ) and significantly ( $P=0.019$ ) related to inflation rates. This implies that a unit increase in the price of oil would result into a 0.03753 increase in the levels of inflation. This implies that a wide fluctuation in the prices of oil would eventually result to an increase in the levels of inflation. These findings are consistent with those of Olubusoye and Oyaromade (2008) who also found that petroleum prices propagate the dynamics of inflationary process in Nigeria. The results from this study are also consistent with those of Baek and Koo (2009) and Dhakal (2002) who found a significant and positive relation between energy prices and inflation rate in the United States and Ueda (2009) for United States and Japan.

The study also established that the previous period's inflation rate (lag inflation rate) positively ( $\beta=0.78760$ ) and significantly ( $P=0.0000$ ) affected inflation rates of the current period. The results mean that a unit increase in previous period's (lagged inflation rate) leads to a 0.7876 increase in the current inflation rates. This implies that higher inflation rates of the previous period would translate to a higher inflation rate in the current period and therefore current inflation is contributed to by past inflation meaning that failure to control inflation today worsens the inflation rates the coming year. These results are consistent with those of Balakrishnan and Ouliaris (2006), who found out past inflation to be the main driver of United States inflation, Ndidi (2013) who while examining the determinants of inflation in Nigeria found previous inflation, measured by the lagged term of inflation to significantly determine inflation and Pahlavani and Rahimi (2009) who also found out the lagged inflation to be one of the main determinants of inflation in Iran. The adjusted R-squared (0.77) shows that 77% of the changes in inflation are well explained by the explanatory variables.

### 4.5.3 Non-Linearity of the Inflation Model

When linear regression is conducted the assumption is always that there exists a linear relationship between the predictor and the predicted variables. If this assumption is violated, the linear regression will try to fit a straight line to data that does not follow a straight line. Most inflation models estimated usually adopt a linear approach and thus this study sought to establish whether the inflation model does follow the linear relationship or it follows a non-linear structure. To achieve this there are two ways that non-linearity can be added to an OLS model. The most common one is to add the quadratic version of a continuous variable to the model. The second is to decompose the x-variable into a set of dummy variables. The study used the first approach where the quadratic terms of the predictor variables were included in the model. The results for the test of non-linearity are presented in the table 4.8.

**Table 4.8: Non-Linearity Test of the Inflation Model**

| Source   | SS         | df | MS         |                 |        |  |
|----------|------------|----|------------|-----------------|--------|--|
| Model    | 1037.49898 | 11 | 94.3180889 | Number of obs = | 47     |  |
| Residual | 261.631482 | 35 | 7.4751852  | F( 11, 35) =    | 12.62  |  |
| Total    | 1299.13046 | 46 | 28.2419665 | Prob > F =      | 0.0000 |  |
|          |            |    |            | R-squared =     | 0.7986 |  |
|          |            |    |            | Adj R-squared = | 0.7353 |  |
|          |            |    |            | Root MSE =      | 2.7341 |  |

| inflation       | Coef.     | Std. Err. | t     | P> t  | [95% Conf. Interval] |          |
|-----------------|-----------|-----------|-------|-------|----------------------|----------|
| M3Growth        | -.161329  | .2507968  | -0.64 | 0.524 | -.6704735            | .3478154 |
| Interest_Rate   | .0184779  | .723336   | 0.03  | 0.980 | -1.449972            | 1.486928 |
| Price_Index     | .0371244  | .0159035  | 2.33  | 0.025 | .0048386             | .0694102 |
| rgdpgrowth      | .2613947  | .4945106  | 0.53  | 0.600 | -.7425151            | 1.265305 |
| reerchanges     | -.0409408 | .1217379  | -0.34 | 0.739 | -.2880819            | .2062003 |
| laginflation    | .0271578  | .4239879  | 0.06  | 0.949 | -.8335834            | .887899  |
| squaredM3       | .0059831  | .0083215  | 0.72  | 0.477 | -.0109104            | .0228766 |
| squaredInterest | -.0225828 | .0311905  | -0.72 | 0.474 | -.0859028            | .0407372 |
| squaredrGDP     | -.093993  | .0606271  | -1.55 | 0.130 | -.2170725            | .0290866 |
| squaredREER     | .0088042  | .0112177  | 0.78  | 0.438 | -.0139689            | .0315772 |
| squaredlaginf   | .0369946  | .0202066  | 1.83  | 0.076 | -.004027             | .0780162 |
| _cons           | 7.649217  | 5.40383   | 1.42  | 0.166 | -3.321142            | 18.61958 |

The coefficient of squared terms of the predictor variables is clearly statistically insignificant. This indicates that the relationship between inflation and the predictor variables is linear in nature hence no non-linear relationship exists in the model (P Values are insignificant because they are all above 0.05).

## **CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 Summary of Findings**

This Chapter presents the summary of the findings in line with the objectives of the study.

The first objective of the study was to determine monetary determinants of inflation in the Kenyan Economy. The results revealed that money supply growth, Foreign Exchange rate and interest rate do not have a significant relationship with inflation. This is inconsistent with the findings of the study by Ndung'u (1996), Rutasitara (2004), Barasa (2009), Kiptui (2009) Kinda (2011), Laryea and Sumaila (2012), Durevall and Sjö (2012), Ndidi (2013), Andre et al., (2013) and Mwega (2014) who all found that money supply growth, exchange rate changes and interest rate changes all have significant effects on the rate of inflation.

The second objective of the study was to investigate Non-monetary determinants of inflation in the Kenyan Economy. The results revealed that real GDP growth is negatively and significantly related to inflation rate. The results also revealed that oil price fluctuations (changes in oil prices) are positively related to inflation rates. The previous period's inflation rate (lag inflation rate) was also found to be positively and significantly affecting inflation rates of the current period. These results imply that Price fluctuations and Lag inflation rates greatly affect inflation rate positively while real GDP growth affects inflation rate negatively.

These findings are consistent with those of the study by Olubusoye and Oyaromade (2008) that analyzed the main sources of fluctuations in inflation in Nigeria and found out that lagged inflation and petroleum prices were among the factors that significantly propagate the dynamics of inflationary process in Nigeria and Ndung'u (1996), Rutasitara (2004), Kemal (2006), Gerlach and Sekine (2007), Kigume (2011), Assenmacher-Wesche, Laryea and Sumaila (2012) who all found that there existed a significant and inverse relationship between inflation and real GDP growth.

Lastly the third objective of the study was to test for possibility of non-linearity in the inflation model in Kenya. The results revealed that the inflation model exhibits a linear structure as the coefficients of squared terms of the predictor variables were found to be statistically insignificant.

## **5.2 Conclusions**

Based on the findings above the study concluded that Money supply growth, Foreign Exchange rate and interest rate do not affect inflation. From these findings, the study therefore asserts that there is no significant relationship between Money supply growth, Foreign Exchange rate and interest rate and inflation.

The study also concluded that real GDP growth, oil price fluctuations (changes in oil prices) and the previous period's inflation rate (lag inflation rate) are the main factors that affect inflation in Kenya. From these findings, the study therefore asserts that there is a significant relationship between real GDP growth, price fluctuations (changes in oil prices) and the previous period's inflation rate (lag inflation rate) and inflation.

Finally the study concluded that Kenyan inflation model exhibits a linear structure. Most inflation models estimated usually adopt a linear approach and thus this study obtained similar results.

## **5.3 Recommendations**

Several policy implications emanate from the study. First focus for policy makers should be growing the Real GDP as way of controlling the inflation rate. The results indicate real GDP growth to be a significant determinant of inflation rate during the study period. An increase in real GDP leads to a decrease in inflation rate. Therefore policies geared towards increasing capital formation can be used to spur GDP growth. Capital formation has a positive relationship with GDP growth such that GDP growth will also rises with an increase in Capital formation. To encourage capital formation Government Fiscal policies such as reinstating the investment tax credit can be applied. An investment tax credit subsidizes investment by allowing businesses to deduct a percentage of their investment from their taxes. Another fiscal policy favoured by many economists involves replacing capital income taxation by consumption taxation. The taxation of capital income retards capital formation because the returns to saving and investment are distorted.

The second focus area for policy makers is containing price fluctuation (changes in oil prices). According to the results, price fluctuations (changes in oil prices) are also significant determinants of inflation rate. An increase in Oil prices leads to an increase in inflation rate. Therefore policy makers should adopt stabilization policies to deal with economic shocks that may put short-run pressure on factors that drive inflation. The stabilization policies should aim to cushion frequent price fluctuations or put it under control. For instance, because of its

wide utilization in the manufacturing sector; oil prices affect the prices of other commodities and the cost of transport. Thus, the central bank might require every oil distributor to hedge for their exposure to oil price fluctuations in derivative markets in an effort to cushion the economy against price instability introduced by oil price changes.

#### **5.4 Limitations of the study**

This study used few variables that are growth in money supply, real GDP growth, interest rates, Exchange rate and lagged inflation. The study left out variables like Increase in disposable income, Expansion of Credit, Deficit Financing, Black money spending, Expansion of the Private Sector ,Increasing Public Expenditures, Industrial Disputes, Natural Calamities Artificial Scarcities and Global factors which might be determinants inflation. The study also used data from secondary sources only which were not exhaustive. The study could have also included primary data from households and organizations on what they think determine inflation.

#### **5.5 Suggestions for further research.**

The study sought to investigate the monetary and non-monetary determinants of inflation in Kenya. However due to data unavailability, time and resource constraints only five variables were analyzed. Future studies should therefore build on this by including more variables like the macroeconomic factors (Increase in disposable income, Expansion of Credit, Deficit Financing, Black money spending, Expansion of the Private Sector, Increasing Public Expenditures, Industrial Disputes, Natural Calamities, Artificial Scarcities and Global factors) that affect inflation on a separate scope so as to unearth the determinants of inflation rate in much detail. A similar study can also be conducted by collecting data from both secondary and primary sources then analyzing it using panel data analysis.



## References

- Abdel-Rahman, A. M. M. (1998). Determinants of Inflation and Its Instability. *Economica Internazionale*, 51(2), 459-472.
- African Development Bank. (2011). *Inflation Dynamics in Selected East African Countries: Ethiopia, Kenya, Tanzania and Uganda*. Tunis, African Development Bank.
- Akbari, A. and Rankaduwa, W. (2006). Inflation targeting in a small emerging market economy: The case of Pakistan. *SBP Research Bulletin*, 2(1), 169-190.
- Andre, B. et al., (2013). *Forecasting and Monetary Policy Analysis in Low-Income Countries: Food and non-Food Inflation in Kenya*. (Working Paper No 13/61). Washington: International Monetary Fund.
- Assenmacher-Wesche, K. Gerlach, S. and Sekine, T. (2007). *Monetary Factors and Inflation in Japan*. (Working Paper No.2007-13). Zurich: Swiss National Bank.
- Baek, J and Koo, W. (2009) *Analyzing Factors Affecting US Food Price Inflation* Paper at International Agricultural Trade Symposium, Seattle Washington.
- Balakrishnan, R and Ouliaris, S. (2006) *U.S. Inflation Dynamics: What Drives Them Over Different Frequencies?* (Working Paper No 159). Washington: International Monetary Fund.
- Barasa, O. (2009). *A study on Casual Relationship between Inflation and Exchange rates in Kenya*. (Unpublished Doctoral Dissertation). University of Nairobi, Kenya.
- Belsely, D .A., Kuh,E. and Welsch, R.E. (1980). *Regression Diagonistics: Identifying Influential Data and Sources of Collinearity*. New York: John Wiley and Sons.
- Bernanke, B.S. (2005 February). *Inflation in Latin America–A New Era?* Paper presented at The Stanford Institute for Economic Policy Research Economic Summit, Stanford California.
- Bilan, O. and Siliverstovs, B. (2005) *Inflation Dynamics in the Transitory Economy of Ukraine*. (Working Paper No. 28). Kiev: Institute for Economic Research and Policy Consulting.
- Branson, W. H., and Myhrman, J. (1976). Inflation in Open Economies: Supply-Determined versus Demand-Determined Models. *European Economic Review*, 7(1), 15-34.

- Brooks, C. (1996). Testing for nonlinearities in daily sterling exchange rates. *Journal for Applied Financial Economics* 6, 307–317.
- Brouwer, G. and Ericsson, N.R. (1995). *Modeling Inflation in Australia*, Research Discussion Paper 9510, Melbourne: Reserve Bank of Australia.
- Carlson, M. (2013) .*Determinants of Hyperinflation: Case Studies from Latin America Based Economies. (Unpublished Economics Senior Thesis).*
- Cheruiyot, J. K. (2012). *Effectiveness of monetary policy tools in countering inflation in Kenya* (Unpublished Doctoral Dissertation). University of Nairobi, Kenya.
- Delgado, M. A., and Robinson, P. M. (1994). New methods for the analysis of long-memory time-series: Application to Spanish inflation. *Journal of Forecasting*, 13(2), 97-107.
- Damian, M. (2010). The Impact of Financial Crisis upon the Inflationary Process in Romania. *International Journal of Business and Social Science*, 3(10), 267-274.
- De Vaus, D.A. (2001). *Research Design in Social Science*. New Delhi: Sage Publications
- Dhakal, D. (2002). *Determinants of Inflation Rate in the United States: A VAR Investigation*. Illinois: Elsevier Inc.
- Dua, P. (2009). *Determination of Inflation in an Open Economy Phillips Curve Framework: The Case of Developed and Developing Asian Countries*. Centre for Development Economics (Working Paper No 178). Delhi: University of Delhi.
- Durevall,D., and Sjö,B.(2012).*The Dynamics of Inflation in Ethiopia and Kenya*.Tunis:African Development Bank.
- Durevall and Ndung'u (2001): A Dynamic Model of Inflation for Kenya. ” *Journal of African Economies* 10 (1), 92.
- Durevall,D., and Ndung'u,S.(1999).*A Dynamic Model for Inflation in Kenya:1974-1996*(Working Paper No 99).Washington: International Monetary Fund.
- Dwyer, J. and Leong, K. (2001). *Changes in the Determinants of Inflation in Australia*. (Research Discussion Paper No. 2001-02). Sydney: Reserve Bank of Australia.
- Easterly, W., and Fischer, S. (2001). Inflation and the Poor. *Journal of Money, Credit and Banking*, 33(2), 160-178.
- Field, A. (2009).*Discovering Statistics*. New York: Sage Publishers.

- Friedman, M. (1968), "The Role of Monetary Policy". *The American Economic Review*, 58(1), 1-17.
- Frisch, H. (1977). Inflation Theory 1963-1975: A "Second Generation" Survey. *Journal of Economic Literature*, 15(4), 1289-1317.
- Gujarati, D.N. and Porter, D.C. (2009). *Basic Econometrics* (5<sup>th</sup> ed). New York: McGraw Hill
- Hellwig, C. (2002). Public announcements, adjustment delays and the business cycle. Unpublished paper, UCLA.
- Hendry, D.F. (2001). Modeling UK Inflation: 1875-1991. *Journal of Applied Econometrics*, 16(3), 255-75.
- Hinich, M. J. and Patterson, D.M. (1985) Evidence of nonlinearity in daily stock returns, *Journal of Business and Economic Statistics*, 3(1), 69-77.
- Hussain, M. (2005). "Inflation and Growth: Estimation of Threshold Point for Pakistan". *Pakistan Business Review*, 13(6), 1-15
- International Monetary Fund. (2014). *Selected Issues Paper on Sweden* IMF Country Report No. 14/262 Washington: International Monetary Fund.
- Jacobs, D. and Williams, T. (2014). *Determinants of Non-tradables Inflation in Australia*. (Bulletin Quarter Four No 14). Sydney: Reserve Bank of Australia.
- Kemal, M. A. (2006). Is inflation in Pakistan a monetary phenomenon? *The Pakistan Development Review*, 45(2), 213-220.
- Keynes, J.M. (1936). *The General Theory of Interest Employment and Money*. London: Palgrave MacMillan.
- Khan, A. A., Ahmed, Q. M., and Hyder, K. (2007). *Determinants of recent inflation in Pakistan*. (MPRA Paper No.16254). Karachi: Social Policy and Development Centre
- Khan, M. (2005). *Inflation and growth in MCD Countries*. Unpublished Manuscript. Washington, DC: International Monetary Fund.
- Kigume, R.W. (2011). *The Relationship between Inflation and Economic Growth in Kenya 1963-2003*. (Unpublished Doctoral Thesis). Kenyatta University, Kenya.
- Kiptui, M. (2009). *Oil Price Pass-Through into Inflation in Kenya*. Nairobi: Kenya School of Monetary Research Centre.

- Kinda, T. (2011). *Modeling Inflation in Chad*. (Working Paper No: WP/11/57). Washington: International Monetary Fund.
- Kinyua, J.K. (2001) *Monetary Policy for Kenya: Evolution and Current Framework*. Nairobi: Central Bank of Kenya.
- Kirchner, R., Weber, E. and Giucci, R. (2008). *Inflation in Ukraine: Results and Policy Implications of an Empirical Study*. (Policy Paper Series PP/05/2008), Kiev: Institute for Economic Research and Policy Consulting.
- Laidler, D. (2005). “*Keynes and the Birth of Modern Macroeconomics*”. (Working Paper No 20052), Western Ontario: Economic Policy Research Institute, University of Western Ontario.
- Laryea, A and Sumaila,R. (2012). *Determinants of Inflation in Tanzania*. (Working Paper 2001: 12), Bergen, Norway: Chr. Michelsen Institute Development Studies and Human Rights.
- Leheyda, N. (2005) *.Determinants of Inflation in Ukraine: A Cointegration Approach*. Mimeo: Centre for Doctoral Studies in Economics and Management, University of Mannheim.
- Lissovolik, B. (2003). *Determinants of Inflation in Transition Economy: Case of Ukraine*. (Working Paper No. 03/126). Washington: International Monetary Fund.
- Loening, J. L., Durevall, D., and Ayalew, B.Y. (2009). *Inflation Dynamics and Food Prices in an Agricultural Economy: The case of Ethiopia*. (Policy Research Working Paper No 4696).Addis-Ababa, World Bank African Region Agricultural Development Unit.
- Misati, R. and Munene, O. (2013). Second Round Effects and Pass-Through of Food Prices to Inflation in Kenya. *International Journal of Food and Agricultural Economics* 3(3), 75-87
- Mishkin, F. S. (2005). *Inflation Targeting*. Cambridge: Columbia University and National Bureau of Economic Research.
- Mishra, P., Montiel, J., and Spilimbergo, A. (2010). “*Monetary Transmission in Low Income Countries*”. (Working Paper No. 10/223). Washington: International Monetary Fund.
- Mugenda, O.M and Mugenda, A.G. (2003). *Research Methods Quantitative and Qualitative Approaches*. Nairobi: Acts Press.

- Musembi, C. (2013). *A Cointegration between Exchange Rates, Inflation and Interest rates in Kenya* (Unpublished MA – Thesis): Western Illinois University.
- Mwega, F. (2014). *A Note on Term Structure and Inflationary Expectations in Kenya*. (Working Paper). Nairobi: Central Bank of Kenya
- Narayan, P.K. and Narayan, S. (2011). *The Inflation-Output Nexus: Empirical Evidence from India, Brazil and South Africa*. (Financial Econometrics Series Working Papers 2011/06), Victoria: University of Australia.
- Ndung'u, N. (1994). A Monetarist Model of Inflation: Kenyan Case. *African Development Review*, 6(2), 109-136.
- Ndung'u, N. (1996). *Inflation in Kenya: An Empirical Analysis*. (Working Paper No.514). Institute of Development Studies: University of Nairobi.
- Ndung'u, N. (1999). *Monetary and exchange rate policy in Kenya*. (AERC Research Paper No 94). Nairobi Kenya: African Economic Research Consortium.
- Nishizaki, K., Sekine, T. and Ueno, Y. (2014), Chronic Deflation in Japan. *Asian Economic Policy Review*, 9(2), 20–39.
- Norman, D. and Richards, A. (2010). *Modelling in Inflation*. (Research Discussion Paper No. 2010-03). Sydney: Reserve Bank of Australia.
- Novikova, N. and Volkov, D. (2012). *Modelling Core Inflation in Ukraine in 2003-2012*. (Working Paper No.12/12E). London: Economics Education and Research Consortium
- Olubusoye, O.E., and Oyaromade, R. (2008). Modeling the Inflation Process in Nigeria. (AERC Research Paper No 182). Nairobi Kenya: African Economic Research Consortium.
- Pahlavani, M., and Rahimi, M. (2009). Sources of inflation in Iran: an application of the ARDL approach. *International Journal of Applied Econometrics and Quantitative Studies*, 6(1), 61-76.
- Pain, N. et al. (2006). *Globalisation and Inflation in the OECD Economies*. (Working Paper No. 524) OECD Economics Department
- Qayyum, A. (2006). Money, Inflation, and Growth in Pakistan. *The Pakistan Development Review*, 45(2), 203-212.
- Romer, D. (2009). *Advanced Macroeconomics*. New York: McGraw-Hill
- Rutasitara, L. (2004). *Exchange Rate Regimes and Inflation in Tanzania*. (AERC Research Paper No. 138.) Nairobi: African Economic Research Consortium,

- Ryan, T. and Milne, W.J. (1994). Analyzing Inflation in Developing Countries: An Econometric Study of Kenya *Journal of Development Studies* 31(1)134-156.
- Serrano, F. and Suma, R. (2005). *Distribution and Cost-Push Inflation in Brazil under Inflation Targeting 1999-2014*. *Investigación Económica*, 71 (282) p. 55-92.
- Shyh, W. C. (2010). Regime Non-Stationarity and Non-linearity in Inflation Rates: Evidence from OECD countries. . *International Research Journal of Finance and Economics*
- Social Policy Development Centre. (2004). “*Combating Poverty: Is Growth Sufficient?*” Karachi Pakistan: Social Policy Development Centre.
- Sovuthea, H. (2013). “Governments Response to Inflation Crisis and Global Financial Crisis”. (Working Paper No 73). Cambodia: Cambodia Development Research Institute (CRDI).
- Stanca, L. (1999). Asymmetries and Nonlinearities in Italian Macroeconomic Fluctuations. *Journal of Applied Economics*, 31(1), 483–491.
- Svensson, L.E. (2000). “Open-Economy Inflation Targeting”. *Journal of International Economics*, 50(1), 155-183.
- Tiao, G. C. and Tsay, R. S. (1994), Some advances in non-linear and adaptive modelling in time-series. *Journal of Forecasting*. 13(1): 109–131.
- Thomas, L. B. (1999). Survey measures of expected US inflation. *The Journal of Economic Perspectives*, 13(4), 125-144.
- Totonchi, J. (2011 February). Macroeconomic Theories of Inflation. *International Proceeding on Economics Development & Finance Research*, Singapore: IACSIT Press.
- Tumkou, C. (2012). *The long run relationship between interest rates and inflation in Kenya*. (Unpublished Doctoral Thesis), University of Nairobi: Kenya
- United Nations Development Programme, (2010). Human Development Report 2010: Sustainability and Equity: A Better Future for All. Retrieved from <http://hdr.undp.org/en/reports/global/hdr2011/>
- U.S Federal Reserve. (2012). *Why does Federal Reserve Aim for Two Percent Inflation over Time*, Washington: U.S Federal Reserve.

- Ueda, K. (2009) “Determinants of Household’ Inflation Expectation” (Discussion Paper No. 2009-E-8), Tokyo Institute for Monetary and Economic Studies, Bank of Japan.
- Williams, N.M., Grajales, G.A., and Kurkiewicz,D. (2013).Assumptions of Regression. *Practical Assessment, Research and Evaluation*, 18(1), 1-14.
- World Bank. (2014). *World Bank Development Indicators*. Washington: The World Bank Group. Retrieved from: <http://data.worldbank.org/data-catalog/world-development-indicators>.
- Yildirim, E (2004), *Counting and Constructing Boolean Functions with Particular Difference Distribution Vectors*. (Unpublished Master’s thesis). The Graduate School of Applied Mathematics, The Middle East Technical University, Turkey.

## Appendices

### Appendix i: Map of Kenya





## Appendix ii: Data used for Analysis.

|        | Infl     | m3growth | cbr   | oilprchange | rgdpgrowth | reerchanges | reer   |
|--------|----------|----------|-------|-------------|------------|-------------|--------|
| Mar-01 | 10.54997 | 4.073537 | 18.01 | -4.05199    | 2.047472   | -3.82891    | 102.98 |
| Jun-01 | 6.836735 | 1.127351 | 15.36 | 2.202314    | 6.24505    | -2.68406    | 102.97 |
| Sep-01 | 3.776874 | 0.11591  | 15.36 | -7.28073    | 6.476884   | 1.728907    | 102.97 |
| Dec-01 | 2.317564 | 4.371847 | 14.38 | -29.1379    | 3.216645   | -4.766      | 99.71  |
| Mar-02 | 1.219512 | 1.701789 | 13.54 | -13.8645    | 4.12751    | -2.89377    | 100    |
| Jun-02 | 1.814709 | 2.052484 | 14.42 | -16.6545    | 0.235352   | -2.02001    | 100.89 |
| Sep-02 | 1.903695 | 9.34053  | 11.19 | -1.13221    | -2.46053   | -1.91318    | 101    |
| Dec-02 | 2.901535 | 1.736598 | 13.05 | 22.38193    | 0.467431   | 0.922676    | 100.63 |
| Mar-03 | 7.955632 | 2.228049 | 12.89 | 13.69103    | -0.52865   | 0.84        | 100.84 |
| Jun-03 | 13.4334  | 13.66683 | 8.03  | 16.08238    | 0.44609    | -8.77193    | 92.04  |
| Sep-03 | 9.029304 | 9.700096 | 4.18  | 2.585888    | 6.5535     | -5.0297     | 95.92  |
| Dec-03 | 8.786611 | 19.59578 | 4.25  | 23.99329    | 5.181506   | -1.72911    | 98.89  |
| Mar-04 | 9.105403 | 22.09122 | 4.58  | 28.19365    | 6.948448   | -2.98493    | 97.83  |
| Jun-04 | 6.037049 | 14.37142 | 5.33  | 33.37108    | 5.009535   | 5.888744    | 97.46  |
| Sep-04 | 14.3793  | 14.10623 | 5.24  | 41.33958    | 3.213611   | -1.4804     | 94.52  |
| Dec-04 | 17.59197 | 14.07675 | 8.68  | 36.77267    | 5.312463   | -4.65163    | 94.29  |
| Mar-05 | 14.32051 | 12.80822 | 11.49 | 44.96985    | 1.995849   | -7.90146    | 90.17  |
| Jun-05 | 14.20995 | 14.44461 | 11.61 | 68.97821    | 7.331151   | -12.9899    | 84.81  |
| Sep-05 | 7.548832 | 7.170265 | 10.59 | 23.82166    | 8.375225   | -5.04762    | 89.73  |
| Dec-05 | 4.280432 | 9.635376 | 11.03 | 40.04452    | 5.94835    | -12.5464    | 82.46  |
| Mar-06 | 8.87658  | 11.14798 | 10.95 | 31.28284    | 5.987436   | -13.4406    | 77.99  |
| Jun-06 | 4.725485 | 11.83025 | 9.93  | 14.37186    | 6.217944   | -5.79009    | 79.89  |
| Sep-06 | 4.997952 | 20.42908 | 9.92  | 43.31276    | 8.187914   | -9.59545    | 81.12  |
| Dec-06 | 7.05032  | 20.11347 | 10    | 3.444013    | 4.883819   | -7.252      | 76.48  |
| Mar-07 | 3.274198 | 21.78745 | 9.5   | 14.3405     | 7.076297   | -1.32068    | 76.96  |
| Jun-07 | 2.621283 | 10.2327  | 9.81  | -3.93966    | 8.311802   | -2.12793    | 78.19  |
| Sep-07 | 5.436338 | 16.40201 | 8.67  | 7.207466    | 6.341946   | -7.08826    | 75.37  |
| Dec-07 | 5.719745 | 13.43495 | 8.75  | 50.33293    | 6.382084   | -3.2296     | 74.01  |
| Mar-08 | 10.62271 | 16.41267 | 8.75  | 40.76127    | 1.130057   | -3.9501     | 73.92  |
| Jun-08 | 17.53717 | 28.34999 | 8.83  | 87.57433    | 2.203272   | -15.0914    | 66.39  |
| Sep-08 | 18.0708  | 17.80833 | 9     | 57.53315    | 2.575575   | -6.9789     | 70.11  |
| Dec-08 | 18.70105 | 18.21784 | 8.83  | -38.3873    | 0.225341   | -3.48602    | 71.43  |
| Mar-09 | 14.1699  | 11.50904 | 8.42  | -52.2172    | 6.174354   | -3.35498    | 71.44  |
| Jun-09 | 10.18488 | 10.3633  | 8.08  | -51.8654    | 1.865909   | 7.109504    | 71.11  |
| Sep-09 | 7.501045 | 14.78769 | 7.75  | -40.8314    | 1.8966     | 0.898588    | 70.74  |
| Dec-09 | 5.644097 | 14.93163 | 7.25  | 40.70046    | 1.230731   | -1.17598    | 70.59  |
| Mar-10 | 5.020502 | 20.6559  | 6.92  | 66.24024    | 1.436322   | -0.83987    | 70.84  |
| Jun-10 | 3.669905 | 23.99312 | 6.75  | 33.65417    | 6.063401   | 0.92814     | 71.77  |
| Sep-10 | 3.323615 | 24.76033 | 6     | 7.04023     | 7.242682   | 4.749788    | 74.19  |
| Dec-10 | 3.843567 | 23.12392 | 6     | 13.10101    | 8.302384   | 6.176512    | 74.95  |
| Mar-11 | 7.056471 | 20.15701 | 5.75  | 35.51585    | 4.832578   | 4.926595    | 74.33  |

|        |          |          |       |          |          |          |       |
|--------|----------|----------|-------|----------|----------|----------|-------|
| Jun-11 | 13.16611 | 16.8243  | 5.92  | 45.90019 | 3.538737 | 5.029957 | 75.38 |
| Sep-11 | 16.51618 | 17.9695  | 6.17  | 49.39597 | 4.00085  | 6.153846 | 78.66 |
| Dec-11 | 19.19126 | 19.35618 | 8.08  | 29.38724 | 5.127383 | 0.200133 | 75.13 |
| Mar-12 | 16.84754 | 15.60395 | 17.5  | 16.02502 | 3.907842 | -10.9377 | 66.28 |
| Jun-12 | 11.76815 | 15.37976 | 18    | -4.98788 | 4.512545 | -13.8896 | 64.91 |
| Sep-12 | 6.377139 | 13.56645 | 17.5  | -1.5274  | 4.592413 | -16.2599 | 65.87 |
| Dec-12 | 3.524571 | 14.44339 | 14.17 | 0.286482 | 5.147977 | -10.9321 | 66.89 |
| Mar-13 | 4.08039  | 15.57178 | 10.5  | -6.70261 | 5.197006 | -0.58912 | 65.81 |