THE SHORT AND LONG RUN PHILIPS CURVE WITH THE LUCAS CRITIQUE IN KENYA

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K102/CTY/PT/24470/2013

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF APPLIED ECONOMICS IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ECONOMICS (INTERNATIONAL TRADE AND FINANCE) OF KENYATTA UNIVERSITY.

APRIL, 2017
DECLARATION

This research project is my original work which has never been presented for a diploma or degree in any other institution of higher learning.

Signature:………………………………Date:……………………………………

...

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With my approval as University Supervisor, this research project has been submitted for examination.

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DEDICATION

This research paper is dedicated to my beloved father, brothers, sisters and friends who encouraged me during the study period. It is also dedicated to my lecturers for their encouragement and advice to take up this course for career development.
ACKNOWLEDGEMENT

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OPERATIONAL DEFINITION OF TERMS

Inflation: Is the persistent rise in the price of commodities over time.

Unemployment: Is the total number of able people falling under the working age seeking for a paid work.

The Phillips Curve: Is an economic concept which states that there is an inverse and stable relationship between inflation and unemployment. The curve therefore gives the relationship between the two said variables.

Short-run Phillips Curve: Given that the expected inflation and natural rate of unemployment remain constant, the relationship between inflation rate and unemployment rate is given by the Short Run Phillips curve.

Long-run Phillips Curve: Given that the economy is at full employment, the Long-run Phillips curve, which is a vertical line, presents the relationship between inflation and unemployment.

Natural Rate Hypothesis: Proposition that change in money supply growth rate leads to a temporal change in the rate of unemployment but at last it again returns to its natural rate.
### ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AD</td>
<td>Aggregate Demand</td>
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<tr>
<td>AS</td>
<td>Aggregate Supply</td>
</tr>
<tr>
<td>CBK</td>
<td>Central Bank of Kenya</td>
</tr>
<tr>
<td>CIA</td>
<td>Central Intelligence Agency</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GLS</td>
<td>Generalised Least Squares</td>
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<tr>
<td>LR</td>
<td>Long Run</td>
</tr>
<tr>
<td>NAIRCU</td>
<td>Non Accelerating Inflation Rate of Capacity Utilization</td>
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<tr>
<td>NAIRU</td>
<td>Non Accelerating Inflation Rate of Unemployment</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
</tr>
<tr>
<td>OLS</td>
<td>Ordinary Least Squares</td>
</tr>
<tr>
<td>SR</td>
<td>Short Run</td>
</tr>
<tr>
<td>TVNAIRU</td>
<td>Time Varying Non Accelerating Inflation Rate of Unemployment</td>
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<tr>
<td>USA</td>
<td>United States of America</td>
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ABSTRACT

The topic of the study was; The Short and Long Run Phillips Curve with the Lucas Critique in Kenya. This paper determined the Phillips curve in Kenya both in the short term and long-run. The non-accelerating inflation rate of unemployment was also estimated and the Lucas critique tested to proof whether it is evident in Kenya. This study was necessary in Kenya since the Kenyan rates of inflation and unemployment are both high simultaneously contrary to what Phillips curve theory explains. While using secondary type of data covering a period of 39 years from 1977 to 2015, causal type of research design was employed in this study as well as using Ordinary Least Squares method to estimate the short term (run) and long term (run) Phillips curve equations. Ordinary Least Squares method was also used to calculate the estimate of the non-accelerating inflation rate of unemployment and by use of a special formula, NAIRU estimate was calculated. Eviews statistical software was used in data analysis. Both short and long run Phillips curve equations showed an insignificant negative relationship between inflation and unemployment. Also the estimated NAIRU in Kenya was found to be 8.699 percent. It was therefore concluded that the Lucas critique is evident in Kenya. It is therefore advisable that before any policy geared to bring a balance between inflation and unemployment is implemented in Kenya, Lucas’ criticism should be taken into consideration.

KEY TERMS: Inflation, Unemployment, Phillips curve, Lucas critique and the NAIRU
CHAPTER ONE

INTRODUCTION

1.1 Background

1.1.1 The Phillips Curve

Inflation and Unemployment have always been problems characterizing macroeconomic scenes of many countries. The countries are therefore striving for a balance between the two variables that will stabilize the economy. After 1945, the trade cycle was wholly managed by the fiscal demand management tool. It was agreed that during recession and unemployment, aggregate demand needed to be stimulated but constrained during inflation. It was also believed that the two variables never existed at the same time but all these assumptions were called into question in 1958 after a research work on the same by Phillips.

Even though the hypothesis faces various criticisms, the Phillips curve still emerged to be among the major macroeconomic theory foundations. Significant role is still played by the Philips curve both empirically and in macroeconomic theory (Hart 2003:108). Its basic mechanism can easily be understood through the interaction between labor supply and labor demand. If labor demand exceeds labor supply, upward pressure is exerted on the rate of wages and this causes rise in inflation in the economy. It is easier for workers to get jobs in this kind of a situation and therefore unemployment level is low. In case there is less labor demand than labor supply, wage rates reduces due to excess supply of labor leading to a decrease in inflation in the economy. Under these circumstances, workers find it difficult to secure jobs hence high level of unemployment is recorded.
The Phillips curve suggested that any change in the unemployment level affects the level of price inflation directly. The accepted explanation of the 1960’s was that any expansionary fiscal policy that increases AD, would lead to a sequence of events, that is, increase in demand for labor since the government has increased its spending, unemployment level falling, firms start competing for workers who are in short supply and therefore raise their nominal wages and because of greater bargaining power of the workers, push for more increase in nominal wages is realized. As a result wage cost increases and firms pass on this effect in higher prices.

Money illusion might also affect the unemployed as they think that increase in wages offered in the labor market represents a real wage (Fehr & Tyran, 2001). They do not take inflation into consideration as they do not realize that higher wages offered will be eaten up. People therefore accept jobs more readily thus reducing frictional unemployment in the short run.

As given by the Phillips curve, the relationship was true for economies such as UK and US while using data of 1950s all through to 1960s when there was stability in the global economy (DeLong, 1997). The situation was not the same during 1967 to 1970 for most countries such as France, Britain and US since their inflation rates had doubled (Ormerod, 1995). This was the first sign that the trade-off given by Phillips (1958) sometimes it is not true since there is a break down in the 1970s as there is high inflation and high unemployment rates at a particular time.

Such a trade-off is not there in the long run since there is a tendency of unemployment returning to its natural rate (Friedman, 1968). If unemployment rate falls below the
NAIRU (the rate of unemployment at which inflation stabilizes), GDP becomes greater than potential production and therefore inflation is created by the self correcting mechanism of the economy. Likewise if NAIRU is below the unemployment rate, GDP is less than potential production and the pressure on the level of prices is exerted downward by the same mechanism.

According to Friedman (1968) and Phelps (1968), the inflation and unemployment tradeoff in the long run does exist not, instead unemployment is as a result of structural variables and inflation is as result of monetary factors. Since inflation increases when unemployment level falls below its natural rate and vice versa if it is above its natural rate, existence of NAIRU therefore has immediate implications on economic policies and analysis.

According to Phillips (1958), permanent low level in the rate of unemployment is realized by tolerating high rate of inflation. The sacrifice ratio measures the cost of reducing inflation as per the Phillips curve (the number of percentage points of output that have to be assumed so as to cause a reduction in inflation by one percentage point). Since in most cases this sacrifice ratio is very large, some economists therefore advice that to live with some inflation is better than incurring large costs to reduce it. As per the approach of rational expectations, the sacrifice ratio’s estimates are not reliable since they are based on adaptive expectations thus subject to Lucas critique.

Lucas (1976)’s criticism, the Phillips curve’s existence is not realistic. The trade-off is still possible between the two variables (inflation as well as unemployment) if the working group expects not the creation of an artificial condition low unemployment and
high inflation by policy makers. It is possible for the workers to foresee future inflation and therefore trouble employers to increase wages. The result will be that at the end of the day there will be both high inflation and high unemployment.

Furthermore, adaptive expectations do not consider other relevant information and they are full of systematic errors and therefore Lucas (1970s) developed an alternative theory of the Phillips curve based on rational expectations. From the study, positive correlation that arises between output and inflation is possible because of imperfect information on aggregate price level. According to Lucas (1970s), expectations-augmented Phillips curve as per Friedman (1968) as well as Phelps (1968) is therefore not realistic since it was based on imperfect information regarding aggregate prices other than prices of their own output. Phillips curve was also based on macroeconomic foundations with no regard to microeconomic theory. For example to generate price output relation, we need information from all firms in the economy something which was not considered by Phillips.

Lucas also questioned how individuals form their expectations about the future. He argued that since adaptive expectations are based on past information, they cannot therefore give accurate prediction on the future since we are living in a dynamic world. Expectations are as a result of a number of factors like future income and probability as well as economic policies pursued by the government. Lucas therefore argues that man is a rational being that makes rational decisions and therefore must act rationally in all situations. The Phillips curve also never accounted for demand and supply shocks that may prevail in the economy.
Many economists gave up on researching on the Phillips curve after this harsh criticism by Lucas in the 1970s. The Phillips curve was neglected for a period of time in the 1980s even though it remained an important tool for policy making (Debelle and Vickery 1998:384). Even though that was the case, the concern in the Phillips curve has been revived in the years of 1990s and it has become the subject of intensive debate Debelle and Vickery (1998:384). This was evident during the Journal of Economic Perspective symposium.

In the Kenyan case, unemployment and inflation relate in the following manner as presented in the below figure:

![Figure 1: Stacked line graph showing Kenyan unemployment and inflation from 1991 to 2013. Sources: CIA World Factbook (2016) and World Bank (2016)](image)

According to Economic survey (1975), There has been low Inflation rate in Kenya since independence to 1969 but a drastic change was recorded in 1970 of 7.5 percent from 2.1 percent in 1964. In 1974 and 1975 it rose to 16.3 percent and 17.8 percent respectively.
This rise was as a result of global recession, poor rainfall and increase in oil prices. As the government intervened by increasing import duties on petroleum products and sales tax on luxury commodities, inflation rose.

Even though there was a decrease in inflation in 1976 to 10.0 percent due to increase in value of coffee from the rural areas (Economic survey, 1977), there was a spike in 1982 where it rose to 22.3 percent which was as a result of oil shock and attempted military coup that worsened terms of trade leading to a reduction in investor confidence (Economic survey, 1983). In 1993 Kenya recorded the highest inflation rate ever of 46.0 percent. This resulted because there was low aggregate demand with excessive money supply and losses of value of the Kenyan shilling that reduced investor confidence (Economic survey, 1994)

Figure1 above shows how the economy has been behaving in terms of unemployment and inflation. The data shows that Kenya has exhibited constant, decreasing and increasing trends in its rate of unemployment since 1991 to 2013. Between 1991 and 1993, it has exhibited constant trend in unemployment of 10.1 percent. This is the same trend that has been exhibited between 1995 and 1997, 1999 and 2003, 2004 and 2008 as well as 2009 and 2013 of 9.9 percent, 16.6 percent, 12.7 percent and 40.0 percent respectively. The decreasing trend in unemployment is exhibited between 1994 and 1998 from 10.0 percent to 9.8 percent. It has also decreased from 16.6 percent in 1999 to 12.7 percent in 2008.

There is also an increasing trend in unemployment between 1991 to 2003 from 10.1
percent to 16.6 percent. Unemployment rate also increased from 12.7 percent in 2008 to 40.0 percent in 2013. In general Kenya has been experiencing high rate of unemployment in the recent past because of its high population growth which is growing at a faster rate compared to the growth of the economy, global economic recession which has affected most economies including Kenya whereby most Kenyan workers have faced massive lay-offs and inappropriate education system which teaches students on how to pass examinations but not how to be productive in the society. In this way students lack necessary skills required in the job market forcing employers to import human power thus leaving locals jobless.

Other factors that have contributed to Kenya’s high unemployment rate include seasonality of jobs, capacity underutilization where companies tend to produce below their capacity thereby making them to employ less than their capability, imperfections in the labor market caused by government and trade union interventions, post election violence of 2007/2008 and use of inappropriate technology whereby capital intensive technology is being used instead of using cheap labor intensive technology.

Inflation has also exhibited both increasing and decreasing trends. It increased from 20.1 percent in 1991 to 46.0 percent in 1993 and it then exhibited decreasing trend from 28.8 percent in 1994 to 5.7 in 2013. This high rate of inflation has been attributed to Kenya’s imbalance of trade whereby Kenya imports more than it exports resulting to a trade deficit. Kenya is therefore vulnerable to shocks which increase the country’s price level. For example in 2011 the current account deficit stood at 10 percent. High inflation rate has also been as a result of increased indirect taxation which has increased
production costs leading to high prices of finished goods. The decreasing value of the Kenya shilling in the recent past has also contributed to high inflation rate in Kenya since this makes imports expensive and Kenya being a net importer, prices for imports increase leading to high inflation rate.

Generally, there was a decreasing trend in unemployment from 10.1 percent in 1991 to 10.0 percent in 1994. In the same period, inflation increased from 20.1 percent to 28.8 percent. Unemployment rate also decreased from 9.9 percent in 1995 to 9.8 percent in 1998 and at the same time, inflation increased from 1.6 percent to 6.7 percent. Again unemployment rate decreased from 16.6 percent in 1999 to 12.7 percent in 2006 with inflation rate responding by increasing from 5.7 percent to 14.5 percent during the same period. Also unemployment increased from 12.7 percent in 2007 to 40.0 percent in 2013 and inflation decreased from 9.8 percent to 5.7 percent. In summary between 1991 and 2013, unemployment increased from 10.1 percent to 40.0 percent and inflation decreased from 20.1 percent to 5.7 percent.

1.2 Problem Statement

Several studies such as Samuelson and Solow (1960), Gordon (1971), Friedman (1976), Hogan (1998) and Faruoka (2009) among others have been done on the Phillips curve in many countries to find out whether the relationship between unemployment and inflation holds as suggested by Phillips (1958) both in the short-run and in the long-run. On the other hand there is none that has ever been done in Kenya. According to CIA World Factbook (2015), the world average rates of unemployment and inflation is estimated to be about 8.4 percent and 3.9 percent respectively. From the Kenyan trend
of unemployment and inflation rates above, it can be deduced that the rates of both of these variables are high and far above the world average. According to Friedman (1968), there is no trade-off in the LR since unemployment always returns to its natural rate. A part from having a breakdown in the relationship in 1970s (Ormerod, 1995), (Lucas 1976) has also criticized the existence of Phillips curve citing many reasons, among them being the use of adaptive expectations in its derivation.

High rates of unemployment and inflation coupled with Lucas’ criticism on the existence of Phillips curve makes it unclear whether it holds in Kenya. The purpose of this study therefore was to determine Kenya’s SR and LR Phillips curve so as to estimate its NAIRU and test whether the Lucas critique is evident.

1.3 Research Questions

The study questions were:

i. What is the Short Run Phillips equation in Kenya?

ii. What is the Long Run Phillips equation in Kenya?

iii. What is the estimate of the Non Accelerating Inflation Rate of Unemployment in Kenya?

1.4 Objectives of the Study

The study objectives were:

i. Determination of the Short Run Phillips equation in Kenya.


iii. Estimating the Non Accelerating Inflation Rate of Unemployment in Kenya.
1.5 Rationale and Justification of the Study

This study was carried out to determine the SR and LR Phillips curve in Kenya so as to test whether the Lucas critique is evident. This is as a result of the fact that Kenya has been experiencing high rates of unemployment and inflation simultaneously contrary to Phillips curve theory. Since NAIRU is associated with the LR Phillips curve, it was also estimated. With a specific estimate of the NAIRU, policy makers in Kenya can use it as a tool while making macroeconomic policies in various financial institutions like Central Bank and various public ministries such as ministry of finance and planning.

1.6 Scope of the Study

The scope of this study was within the entire Kenyan economy. Secondary data of relevant variables were used to determine SR and LR Phillips. The study covered a period of 39 years from 1977 to 2015. This period was appropriate to this study since there is no study that has been carried out on the same throughout this period and data was available.

1.7 Organization of the Study

This research project is structured into five chapters. The present chapter presents background on the Phillips curve, problem statement, research questions and objectives. Chapter two presents the literature review both theoretical and empirical on the Phillips curve, the study methodology is covered by chapter three, chapter four presents analysis of data, results as well as the discussion and the summary, conclusion and recommendations of this research are captured in chapter five.
CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction
This chapter captures theoretical literature, empirical literature as well as literature over view concerning SR and LR Phillips curve. The NAIRU concept is also discussed at length. Under theoretical literature, the study captures the SR Phillips curve, LR Phillips curve, reconciliation of the SR and LR Phillips curve and its relation to AS/AD model and the evolution of the natural rate of unemployment concept (NAIRU).

2.2 Theoretical Literature

2.2.1 The SR Phillips Curve
The SR trade-off between the two variables is among the most commonly used macroeconomic tools of monetary policy design and implementation (Gordon, 1997).

The SR Phillips curve relates wage inflation and unemployment. The first assumption in its construction is that the rate of percentage increase of wage rate is as a result of the magnitude of excess labor demand. Wage rate adjustment equation can therefore be represented as:

\[ W = f(N^d - N^s) \quad f' > 0 \]

Labor demand as well as supply are also as a result of the level of wage rate. For a complete labor market model, empirical estimates for labor demand, labor supply and wage adjustment function are required but since it is difficult to obtain empirical estimates for labor demand and supply, the excess demand expression is transformed
into unemployment (Phillips 1958). Wage adjustment function can be obtained independent of labor demand and supply functions. Excess supply is:

\[ N^s - N^d = - N^d - N^s \] .......2.2

Wage rate adjustment equation 2.1 is therefore rewritten as:

\[ W = -f (N^s - N^d) \] .......2.3

Unemployment rate \( u = \frac{U}{L} \) is introduced as a proxy for excess supply and it is directly related to excess supply. From this relationship it is evident that there is positive unemployment even when there is labor market equilibrium or when excess supply is zero. Equation 2.3 becomes:

\[ W = g u ; \quad g' < 0 \] .......2.4

Equation 2.4 presents Phillips curve in the short run as given by Philips (1958) and since wage rate falls as excess supply increases, it also falls as unemployment rate increases and vice versa. Since money wage demands do not respond to expectations of price increase, the addition of inflation expectations to the Phillips curve forms expectations-augmented Phillips curve which shows that for a certain level of unemployment, the faster the rate at which prices are expected to rise, the faster the money wage demands will rise. The equation is presented as below:

\[ W = g u + Pe \] .......2.5

The Expectations-Augmented Phillips curve resulted because of fierce criticism on the initial Phillips curve as shown in equation 2.4 above by the Monetarists like Milton
Friedman. Each SR Phillips curve was drawn being based on the assumption of a given expected inflation rate (Friedman 1968).

The expectations-augmented Phillips shifts upwards as price expectations increases and this is because there is a decrease in labor supply as demand for leisure increases thus raising g(u), forcing employers to offer larger wage increases so as to achieve same amount of labor as before the change in tastes. The idea of adaptive expectations was introduced by Friedman (1968) and argued that people expect higher average rate of inflation in the future if they see and experience higher prices in their daily lives. They therefore incorporate these changing expectations into their wage payment bargaining through their trade unions. Since wages depend on prices and prices depend on wages, any price inflation triggers a high pay claim which in turn causes production costs to rise thus causing market prices of many commodities to rise.

According to Friedman (1968)’s expectations-augmented Phillips curve, any government attempt to cause a reduction in the unemployment rate at a level below its natural rate by increasing aggregate demand will have insignificant success in the LR but the effect will be to increase inflation which also increases inflationary expectations. Monetarists believe that inflation can best be controlled by the control of money and credit. In addition to this, inflation expectations can be reduced by credible policies put on top of inflation which leads to a downward shift of the SR Phillips curve.

The Linear Expectations –augmented SR Phillips curve assumes the following form:

\[ \pi_t = \pi_t^e + \gamma \ (u^* - u_t) + \epsilon_t \]  \hspace{1cm} 2.6

Where; \( \pi_t \) is the inflation rate at time period \( t \); \( \pi_t^e \) is the inflation expectations at time
period $t$; $u^*$ is the NAIRU; $u_t$ is the unemployment rate at time period $t$ and $\varepsilon_t$ is the error term at period $t$.

From equation 2.6, the SR trade-off between unemployment and inflation is taken to be constant over time even though the Phillips curve’s slope is predicted to be a function of macro-economic conditions by quite a number of theoretical models of price setting behavior.

If we assume that $u^*$ is constant, then equation 2.6 changes to equation 2.7 as below:

$$\pi_t = \alpha + \pi_t^e + \gamma u_t + \varepsilon_t$$

Where $\alpha = \gamma u^*$. This assumption is not realistic since NAIRU has been found to vary with time (Apel and Jansson, 1997) thus NAIRU will be estimated in this study using the Kalman's Filter. According to Neo-Classicals, SR Phillips curve is not stable due to the role of LR expectations.

2.2.2 The LR Phillips Curve

The Phillips curve hypothesis has had strong criticism since 1960s even though it is empirically supported with strong theoretical foundation. According to Islam et al. (2003:107), there was a strong debate over the Phillips curve hypothesis and therefore since its inception, it has been debated. Friedman (1968) as well as Phelps (1967) are among the economists who have laid criticism on the hypothesis by saying that the trade-off between these variables, unemployment and inflation is not evident. The argument is that in the short run it is possible to have a negative relationship between the variables but not in the long term.

They argue that since SR consequence of price stabilization policy sometimes may have
adverse effects on the rate of unemployment, policy makers may therefore commit themselves towards this policy and the rate of unemployment would adjust itself and stabilize just around the optimal level of unemployment in the LR. It is therefore possible for policy makers to carry out their monetary policy without considering adverse effects on rates of unemployment.

Friedman (1970) also gave same argument that the Phillips curve trade-off is just a SR occurrence since it was observed that there was a simultaneous high level of both inflation and unemployment. In the long run therefore, the unemployment and inflation trade-off does not exist, implying that central banks should first consider the normal rate of unemployment before setting their employment goals. Employment goals should always be below the normal rate of unemployment.

According to Cashell (2004), unemployment rates moves closer to the equilibrium level called natural rate of unemployment or the NAIRU in the long run. Price equation that preserves constant income shares is written as:

\[ P = W - \frac{\dot{y}}{N} + e \]

In this case \( \dot{P} \) is price inflation, \( \dot{W} \) is wage inflation, \( \dot{y} \) is economic growth (GDP), \( N \) is population, \( (\dot{y}/N) \) is the productivity growth and \( e \) represents cost push disturbances. If \( e = 0 \), then equation 6 links wages and prices such that the Phillips curve is stated in terms of prices and wages. If we combine equation 2.5 and 2.8, we see how price wage spiral works and the LR Phillips curve is derived. Substituting therefore equation 2.5 for \( \dot{W} \)
into equation 2.8 gives us the price inflation version of the Phillips curve given as below:

\[ P = g u + P_e - y_N + e \] ..............................2.9

In the LR, \( P = P^e \) and \( e \) is assumed to be zero. Equation 2.9 therefore becomes:

\[ g u - y_N = 0 \text{ or } g u = y_N \] ..................................................2.10

Equation 2.10 gives the LR Phillips curve which shows that the so called ‘natural rate of unemployment’ equals productivity growth. Tobin et al (1997) called it NAIRU meaning that at NAIRU, inflation remains constant, any unemployment level below the NAIRU results to high inflation and any unemployment level above the NAIRU results to low inflation.

According to Gordon (1997), the concept of NAIRU is closely associated with the inflation and unemployment SR trade-off and it is evident from the general form of expectations-augmented Phillips curve presented as below:

\[ \pi_t - \pi_t^e = \beta L \pi_{t-1} - \pi_{t-1}^e + \gamma L u_{t-1} - u_{t-1}^* + \delta L X_t + \varepsilon_t \] .................2.11

Where, \( \pi_t \) and \( \pi_t^e \) represent realized inflation and expected inflation respectively, \( \beta L \), \( \gamma L \) and \( \delta L \) represent the polynomials in their lag operators, \( u_{t-1}^* \) is the NAIRU at time period \( t \), \( X_t \) is a vector of supply shocks and \( \varepsilon_t \) is the disturbance term which
is taken to be being normal with a mean of zero and a constant variance of $\sigma^2_\varepsilon$. $\varepsilon$ caters for those shocks from the supply side that leads to a shift of the trade-off between the two said variables (inflation and unemployment) such as variation in exchange rates and import prices.

To estimate the above equation, two key issues are being considered, that is, specifying the inflation expectations and modeling of the unobserved NAIRU. According to Staiger et al (1997), expectations follow a random walk ($\pi_t^e = \pi_{t-1}$) such that $\pi_t - \pi_t^e = \Delta \pi_t$. According to King and Watson (1994), Staiger et al (2001) as well as Gordon (1997), it is widely accepted that modeling of the NAIRU is time varying. NAIRU therefore follows a random walk process, that is,

$$u^*_t = u^*_{t-1} + \nu_t$$

Where $\nu_t$ is the disturbance term which is assumed to be i.i.d. normal with zero mean and constant variance $\sigma^2_\nu$ and also uncorrelated with $\varepsilon_t$. Equations 2.11 and 2.12 can be estimated by the maximum likelihood method using the Kalman filter. Kalman filter method is advantageous since it generates standard errors for the NAIRU estimates.

In the LR, the Phillips curve shows that the trade-off between unemployment and inflation is not evident. The inflation rate is not affected by the unemployment rate and therefore policies are more flexible than in the SR. Since the LR Phillips curve exists at the natural rate of unemployment, structural changes that have an effect on the natural rate of unemployment will also cause a shift in the LR Phillips curve. Increase in NAIRU leads to a shift in the LR Phillips curve to the right and decrease in NAIRU.
leads to a shift in the LR Phillips curve to the left. Shift in the Phillips curve is as a result of the inflationary expectations.

2.2.3 Reconciling the LR and SR Phillips curve and its relation to AS/AD

If the government or central bank introduces an expansionary policy to reduce unemployment, in the SR if the policy is successful, inflation results and unemployment decreases. In the LR, the new inflation rate becomes the new expected inflation rate and finally the economy returns to its natural rate of unemployment.

Again assume that the government or central bank employs contractionary policy to reduce inflation. In the SR if the policy is successful, disinflation results and unemployment increases. In the LR, the new inflation rate is the new expected rate of inflation and once again the economy returns to its natural rate of unemployment. Despite the policy employed by either the government or the central bank, in the long run the economy always returns to its natural rate.

Any change in the AS/AD model can be seen in the Phillips curve. The AS/AD model is assumed to be static but the Phillips curve changes over time. AS/AD model shows one time changes in the price level as either deflation or inflation but the Phillips curve shows continuous change in price level as either increased disinflation or inflation. Increase in aggregate demand as a result of employment of expansionary policy leads to increase in output thus reducing unemployment and increasing inflation. Also if there is a decrease in aggregate demand as a result of employment of contractionary policy, output decreases thus increasing unemployment and decreasing inflation.
Increase in SR aggregate supply as a result of decrease in inflationary expectations leads to an increase in output thus causing a decrease in both unemployment and inflation. This leads to a shift of the SR Phillips curve down and to the left (disinflation). On the other hand decrease in SR aggregate supply as a result of increase in inflationary expectations leads to a decrease in output thus causing an increase in both unemployment and inflation. This leads to a shift of the SR Phillips curve up and to the right (stagflation).

2.2.4 Evolution of Natural Rate of Unemployment Theory

Natural rate of unemployment refers to the unemployment rate when the labor market is at equilibrium and it is the difference between those willing to have a job at the current wage rate and those willing and able to have a job. It usually arises as a result of supply side factors. It includes frictional and structural unemployment.

According to Danilo Freitas (2010), theoretically there are three macroeconomic frameworks namely Keynesian, post-Keynesian and new classical and therefore the natural rate of unemployment can be argued as a pivotal concept that tries to bring a difference among the three. Natural rate of unemployment is believed to exist. For instance, “As per my opinion, in any society you might think of, there might be something called a natural level of unemployment. That for any structure of the labor market, some natural level of unemployment exists whereby real wages tend to behave in line with productivity. If in any case you try to ensure that unemployment is below its natural level using monetary measures, then a perpetual inflation results at a continuous increasing rate” (Friedman, 1966b).
The ‘natural rate of unemployment’ therefore is a concept that dates back to Friedman (1968) and Phelps (1967). The traditional Phillips Curve was replaced with the Augmented Phillips Curve. The Phillips curve leads to a dilemma as revealed by the inflation-unemployment trade-off in the long run and considering inflation expectations to form wage results to a less favorable outcome, that is, there is a certain level of unemployment that is independent to any given level of inflation but consistent with a given constant level of inflation. This is the natural rate of unemployment and if actual unemployment is less than this natural level of unemployment, inflation level increases.

Also Milton Friedman (1968) while addressing a presidential lecture to the American Association of Economics, employed the term ‘natural rate of unemployment’ so as to express the idea that unemployment is as a result of real economic forces only and therefore cannot be pegged by any monetary authority. He therefore gives the natural rate of unemployment definition as below:

“To some extent, natural rate of unemployment can be explained as a level of unemployment that can result from the equations of the walrasian system of general equilibrium, given that the actual structural characteristics of both the commodity and labor markets are embedded in them. This includes stochastic variability in demand and supply, imperfections in the market, mobility costs, gathering information costs about vacancies of jobs and availabilities of labor and many other factors”. (Friedman, 1968:8).

Natural rate of unemployment is therefore as a result of frictions, rigidities and
imperfections both in the labor and commodity markets. These factors affect the clearing position in the economy as far as the walrasian general equilibrium is concerned. Unemployment therefore results when the labor market fails to clear.

This idea of ‘natural rate of unemployment’ was developed by Edmund Phelps (1967, 1968) while working independently and simultaneously. Both authors had one basic idea as mentioned earlier by Friedman (1968), that the economic policy cannot be used as a tool of pegging the unemployment in the economy more especially in the long-run.

Until 1960s, unemployment was taken to be as a result of aggregate demand problem, but not as a result of imperfections in the goods or labor markets. The economic policies therefore used to be enacted using demand oriented prescriptions as the benchmark (Sloan, 1985: 90). These demand oriented policies had a back up from some of the theoretical frameworks and at that time they were backed by the Phillips curve as a result of Phillips (1958). Phillips (1958) gave rise to a trade-off between wage inflation unemployment rate. After sometime this trade-off was modified by Samuelson and Solow (1960) and it became a trade-off between rate of unemployment and price inflation rate. Since then, this has been the standard version in the economics literature. This framework is being used as a basis of fine-tuning policies that aim at bringing better understanding of this trade-off.

Even though that was the case, the inflation during the late 1960s and stagflation of the 1970s weakened the use of this framework together with its demand-oriented policies and this created room for other macroeconomic theories that led to the creation of a
conducive environment of adopting the ‘natural rate of unemployment’ concept as explained in other theoretical models. For instance according to Hoover (1988:27), the study of Lucas and Rapping (1969a) is the first paper that is supposed to be called ‘new classical’ since it remarked Friedman’s (1968) natural rate of unemployment concept as the basis of its analysis. On the other side of the coin, Tobin (1997) argues that Keynesian models adopted NAIRU instead of the natural rate of unemployment to explain the question that exists in the inflation/unemployment relationship. The NAIRU and the natural rate of unemployment concepts are therefore important in the current economics despite the fact that Galbraith (1997) questions their use as the guiding tools of making economic decisions, citing the reason that they do not take into consideration the positive effects of demand stimuli on economic growth and labor productivity.

‘I have no doubt that the NAIRU is a very useful concept for analysis. As a theory, it is useful to understand what causes inflation. It is also useful in empirical analysis since it can be used as a benchmark for forecasting changes that might take place in the inflation rate. And, it is important since it acts as a general guideline when thinking about policies in macroeconomics’. (Stiglitz, 1997).

According to Stiglitz (1997), natural rate of unemployment concept is of great importance when making macroeconomic policies despite a contrary opinion from Galbraith (1997) who argues that its use as the guiding tool of making economic decisions can be misleading since it does not take into consideration the positive effects of demand stimuli on economic growth and labor productivity.
The Augmented Phillips curve according to Turner et al (2001), is the most simple theoretical framework that can be used to incorporate the concept of NAIRU in a transparent manner. This framework is consistent with other structural models. The ‘triangle model’ was also put forward by Gordon (1997) and in this model three factors are considered when determining inflation. These factors include inertia or expectations, supply factors and demand pressure as proxied by the unemployment gap.

The NAIRU concept (natural rate of unemployment) is therefore related to inflation even though there is a slow movement of inflation expectations, meaning that effects of supply shocks and demand pressures build up into the inflation process in a gradual manner. According to (Turner et al., 2001, p. 173), it is probable that unemployment is significant not just by considering its level only but by also considering its movements in the recent past. It is therefore a point of great importance to identify three concepts for NAIRU that are distinct to each other but having the same idea, that is, having the NAIRU not qualified by any adjective, short-term NAIRU and the long-term NAIRU. The only difference between the three concepts is as a result of the time horizon to which they refer.

2.3 Empirical Literature

Phillips (1958), published the results of his study that was conducted in Great Britain on the historical relationship between inflation and unemployment. The study considered data of unemployment and changes in wage levels from 1861 to 1957 and it was observed that there is an inverse relationship between wage inflation and employment. As the unemployment rate decreases, inflation rate increases and vice
versa. This is true in the Short-Run thus giving rise to a Short-Run Phillips curve. The implication of the relationship in the economy was that policy makers need to exploit the trade-off and reduce unemployment rate at the cost of increased inflation rate.

According to Samuelson and Solow (1960), the relationship between these two macroeconomic variables (unemployment and inflation) as suggested by Phillips was found to be true. The study was carried out in the United States and the conclusion was that there is an inverse relationship between unemployment and inflation in the country. The existence of a negative trade-off between these two variables was further confirmed by Solow (1970) and Gordon (1971). The study employed macroeconomic data of the U.S of both before and after 1970s and the outcome was termed as the Solow-Gordon affirmation of the Phillips curve hypothesis.

Friedman (1976), carried same study on the relationship between unemployment and inflation but it was found out that both unemployment and inflation were high at the same time (a condition called stagflation). This study disapproved the study of Phillips (1958) because unemployment rate and inflation rate were found to be independent and this gave rise to a Long-Run Phillips curve. In the 1960s, average rate of inflation increased from 2.5 percent to 7.0 percent in the 1970s. During the same period the unemployment rate never fell but increased from about 4 percent to more than 6 percent.

After harsh criticism by Lucas in the 1970s and Friedman (1976) study, King and Watson (1994) tested the Phillips curve hypothesis. The study employed post-war
macroeconomic data of the U.S and it was found out that there was an empirical support of the trade-off as suggested by Phillips (1958) in the country. They argued that it is possible to have a negative relationship if noises are eliminated from data in the LR and SR.

Even though the rate of inflation seem to have been over predicted by the traditional Phillips curve, Hogan (1998) while using macroeconomic data of the U.S between 1960 and 1993, the negative relationship between these variables (unemployment and inflation) in the U.S was found to be true. The study found out that there is a significant and negative relationship between the two macroeconomic variables.

DiNardo (1999) also examined the Phillips curve relationship by employing panel data analysis of 9 OECD countries (Organisation for Economic Cooperation and Development). This study used both Ordinary Least Squares and Generalised Least Squares methods to determine the common Phillips curve in these 9 OECD countries. It was found out that there is a significant negative relationship between relative unemployment and relative inflation. In addition, Turner and Seghezza (1999) also carried out a study on the Phillips curve using macroeconomic data from the early 1970s to 1997 in 21 OECD countries using panel data analysis method. Instead of using OLS and GLS methods, the study employed the SURE method (Seemingly Unrelated Estimation). The overall result provided a very strong support of the Phillips curve in these 21 OECD countries.

King and Watson (1994) and Fair (2000) determined the LR trade-off between
unemployment and inflation. It was found out that there was a significant increase in the amount of inflation after 1970 that was to be maintained so as to achieve a given decrease of unemployment. A trade-off between the two variables was realized at low levels of inflation such as those prevailed in the 1950s, 1960s and 1990s but no trade-off was realized when the inflation rates were high.

Dickens and Perry (2000) and Akerlof et al (1996) also found out that there is a trade-off between inflation and unemployment. There is a significant cost of permanently low rate of inflation in terms of permanently high rate of unemployment. From both studies, it was found out that the rate of unemployment increases at a large magnitude when inflation is reduced to zero. For example when there is a permanent decrease in inflation to zero from 2.0 percent in the benchmark simulation, unemployment increases by 1.5 percent. By using the estimated Phillips curve benchmark, there is a permanent increase in unemployment by 2.6 percent and a decrease in inflation from 2.5 percent to zero leads to an increase in unemployment of 1.5 percent when using the ignored expectations simulations (Akerlof, Dickens and Perry, 2000, p. 18). According to (Akerlof, Dickens and Perry 2000), the preferred estimates of the empirical model show that moderate inflation reduces unemployment rate by values between 1.9 and 3.0 percentage points from what it would have been if there were no inflation at all. Even though the size of this trade-offs depend on different parameter values and equations estimated, all estimates and simulations arrive at the same conclusion that when inflation is low, a significant permanent trade-off between unemployment and inflation is realized.
Time series data was used by Tang and Lean (2007) for a period between 1971 and 2004 in Malaysia to test the Phillips curve stability. The study found out that the results supported the negative relationship between unemployment and inflation both in the SR and in the LR. This study was linked to another study of Furuoka (2007) that also estimated the relationship between the two variables, that is, unemployment and inflation in the same country but in this case considering data of between 1973 and 2004. Just as in the case of Tang and Lean (2007), the empirical results show that there is both a LR and causal relationship between these variables.

Another study by Furuoka (2009) estimated the Phillips curve in 5 ASEAN countries by analyzing using panel data. The study employed Ordinary Least Squares method and it was found out that that trade-off relationship in these selected ASEAN countries namely; Malaysia, Singapore, Indonesia, Thailand and Philippines is not evident. It was believed that one of the reasons that made this (no common Phillips curve) possible was that in these countries there was heterogeneity amongst them. For example Singapore is a very small country but very wealthy. This difference in economic strength in these ASEAN economies prevented the realization of relationship between inflation and unemployment rates which was significant as suggested by Phillips (1958).

Many studies have been carried out in South Africa to determine its Phillips curve. For example Hodge (2002:424-9) estimated the Philips curve for South Africa after reviewing early studies on the same by Krogh (1967) as well as Gallaway, Koshal and Chapin (1970). The other studies that were reviewed include Hume (1971), Truu (1975) and Levin and Horn (1987). Hodge estimated the trade-off using annual data of between
1983 and 1998 even though long run trend for unemployment was not estimated. The study therefore never employed a time varying NAIRU. From the results it was found out that there is no evidence of a negative relationship between inflation and unemployment.

Nell (2000: 16-17) also determined South Africa’s Phillips curve for two different periods, that is, the accelerating inflation period of between 1971Q1 and 1985Q4 and the decelerating inflation period of between 1986Q1 and 1997Q2. The study found out that during the accelerating inflation period, both overall output gap and negative output gap were statistically significant but the positive output gap was not significant. The Phillips curve trade-off therefore holds during the accelerating period when the economy overheats (negative output gap). During the decelerating inflation period, the results are reversed.

In addition to these studies, Vaona, A. (2013) explored how inflation and unemployment are connected using two models unique from each other both in the short and long runs with fair wages. It was found out that more inflation causes a decrease in unemployment rate. In the short run, a stronger effect on unemployment by inflation is as a result of monetary expansion which is aided by rise in investment. A new theoretical foundation is therefore provided that concludes a negative relationship between inflation and unemployment both in the short and long runs.

The study of Benati, L. (2015) also in the United States of America, United Kingdom, Euro area, Australia and Canada was carried out to explore the trade-off between inflation and unemployment in the long run in after the second world war. Two
approaches namely; cointegration methods and non-cointegrated methods were used based on either restrictions in the long-run or a combination of both the long-run and sign restrictions. It was found out that in the long-run, the evidence of a non-vertical trade-off was not clear. Uncertainty was also found to be significant.

Another study by Blanchard, O. (2016), carried out a study in the United States of America to investigate the behavior of Phillips curve in the recent past but using data of as earlier as 1960s. It was found out that the recent Phillips curve is well as that of the past that a negative relationship between inflation and unemployment still exist. Also as compared to the past, recent inflation expectations are more anchored, the curve’s slope has declined substantially and the residual’s standard error is large. These four conclusions affect the monetary policy in different ways.

As a result of many studies on the Phillips curve, the NAIRU for many countries has been estimated and various deductions made to confirm that even though there is a trade-off in the SR, in the LR the Philips curve is vertical. For example Gordon (1997) while estimating the time-varying natural rate of unemployment for the economy of USA by employing different inflation indices, the realized results show that when the coefficients on the inflation inertia variable are added together, they are almost a unity. It is also found out that the unemployment gap coefficients are always of the correct sign and highly significant. Austria experienced the lowest NAIRU and Spain experienced the highest NAIRU.

Mc Morrow and Roeger (2000) also estimated time varying NAIRU for the European member states using the hybrid form of both Gordon’s triangle model and of the
Bargaining framework. Non linear least squares regression method was used to give estimates of the study. It was found out that there was an even split in the Member States between those states that experiences an increase in the NAIRU and those with a decline from 1990 to 1999.

Richardson et al (2000) used the Phillips curve approach with the Kalman filter method to estimate the natural rate of unemployment across the 21 OECD countries together with New Zealand between 1980 and start of 1999. In the SR there was a trade-off between the two variables (unemployment and inflation) but there was no such a trade-off in the LR and therefore their NAIRUs were estimated. The NAIRU in the medium term was adjusted for supply shocks in the short term that were expected to have a zero value between a period of one or two years. They took real import prices and change in real prices of oil as their main short term supply shocks since for many countries they were found to be statistically significant.

Same methodology was followed by Laubach (2001) as that used by Richardson et al (2000) but differentiates it from the latter by considering the effect of allowing for drift in the NAIRU specification and also the effect of assuming stationary process in the unemployment gap. With the exclusion of Japan and Australia, the study estimates the natural rate of unemployment for the G7 countries between 1971 and 1998. In this study it was found out that the precision of estimates improved considerably when unemployment gap is taken to be stationary. Laubach (2001) took commodity prices and nominal exchange rate as the short term supply shocks and considered GDP deflator and CPI as the two measures of inflation. The study also found evidence
strengthening the existence of NAIRU and precise error bands that were reasonable for US and to some extent Canada. Even though that was the case, the study found out that to greater degree the data for Europe were too imprecise to explain the existence of the NAIRU, let alone its existence.

Eaqub and Ward (2001) estimated constant and time varying natural rate of unemployment for New Zealand over a period of 1977 to 1999 using the Kalman filter, recursive least squares and ordinary least squares. They realized that the reduced form estimates of the time varying NAIRU using the Kalman filter were more satisfactory than those realized from other methods. The study considered one supply shock (real non-oil import prices), one measure of inflation and private consumption deflator. Unemployment gap, real non oil import prices and lagged inflation were found to be statistically significant in explaining inflation.

According to Hirose and Kamada (2002), an estimate for time-varying natural rate of unemployment for Japan was about 4.0 percent in the 1980s and a downward trend has been observed between 1992 and 2002. The data from 1983 quarter 2 to 2002 quarter 2 were used. Since 2000, the Phillips curve parameters are unstable. The study suggests that while using natural rate of unemployment estimates as a guiding tool for macroeconomic policy, considerable caution must be taken.

Greenslade, et al. (2003) also carried out an estimation of time varying natural rate of unemployment for UK between 1963 and 2000 using the Kalman Filter. It is clear from the study that the NAIRU reached its highest value in the mid-1980s and then started to
fall. It was also found that the natural rate of unemployment was above the actual rate of unemployment in the second half of 1990s. The rate of unemployment falls below the natural rate of unemployment during times of economic expansion and since the unemployment gap now becomes negative, there is an upward pressure on inflation.

Another study which was carried out was that of Stephanides (2006). The study used maximum likelihood (Kalman filter) and the non-linear least squares to estimate the constant and time varying natural rate of unemployment in three countries, that is, USA, European union and Japan. From the study’s findings, the natural rate of unemployment estimates are not measured with small uncertainty. It was also found out that specifications and variability across the countries was very extensive.

In addition to this, Zasova (2009) estimated NAIRU and NAIRCU (Non Accelerating Inflation rate of capacity utilization) for Latvia. The study used both structural and the reduced-form of the Kalman filter. It was found out that TVNAIRU for Latvia decreased from 14.3 percent to 7.4 percent at the beginning of 1997 and end of 1998 respectively. From the end of 2005 to the midst of 2008, it was observed that the time varying natural rate of unemployment exceeded the actual rate of unemployment meaning that there was a rise in inflation rate in Latvia during that particular period.

Also Gianella et al (2009) estimated NAIRU for Germany from 1970 to 2007 using Kalman filter as an estimating technique from the relationship of the Phillips curve in the state-space framework. The study used time-varying inflation so as to control the inflation part not affected by cyclical component of unemployment. Also to address the problem of simultaneity in the estimations of the Phillips curve, the shifts in the relative
volatility of shocks to inflation and unemployment were used. The method used by Rigobon and Sack (2003) was also used in this study to yield precise estimates. It was found that the natural rate of unemployment ranges between 1.7 percent and 8.2 percent.

Epstein and Macchiarelli (2010) also estimated NAIRU for the economy of Poland between 1995 and 2008 using the Kalman filter estimating technique. It was found out that the estimated unemployment gap was in harmony with the Poland post reform business cycle. In many occasions state space models or Kalman (1960) and Kalman and Bucky (1961) have been used to capture the TV-NAIRU. Even though that is the case, many studies have suggested that there must be a considerable caution while using estimates of NAIRU as the guiding principle when making economic policies.

The most recent study from Africa is that of Elalaoui et. al. (2014). In this study, Morocco’s Phillips curve was determined and its NAIRU was estimated using the Phillips curve framework (Triangular model approach) from the first quarter of 1998 to the fourth quarter of 2012. The Kalman filter technique was used to estimate the NAIRU. It was found out that the NAIRU average estimate was 10.8 percent for the whole sample. At the end of the sample period, the estimated NAIRU was found to range between 9.02 percent and 8.80 percent. However using HP filter at the end of the same period, NAIRU estimate was found to range between 9.0 percent and 8.7 percent.

The study of Szabó, L. T. (2015) estimated NAIRU for Hungary using different estimation methods to determine the best estimation technique which can be appropriate
to Hungary. The NAIRU’s revisionary property and the unemployment gap’s forecast
capacity are also examined. Using data of 1993 to 2014, the Hodrick- Prescott filter
which is a purely statistical tool was used together with the Kalman filter which is a
semi-structural approach. Kalman filter was used the most as compared to the Hodrick-
Prescott filter because it is best suited in estimating unobserved variable. It was found
out that there has been a decrease in NAIRU for the recent years, a decrease which is as
a result of factors such as risk premium, persons employed in the construction industry,
unemployment in the long term and total factor productivity.

According to (Cui et. al 2016), estimating NAIRU for Berlin is of great significance as
far as understanding the joint dynamics of inflation expectation, inflation and
unemployment are concerned. Using the inflation expectation data, the New Keynesian
Phillips Curve was employed to estimate the NAIRU. The estimated NAIRU under
circumstances of survey data was compared to a situation with absence of survey data
and it was found out that the unemployment gap and the NAIRU vary significantly in
these two situations. It is also found out that the estimated NAIRU is very close to
unemployment rate with the exception of times when there is high rate of inflation in
late 1970s. The results lead to a conclusion that monetary policies are more effective
than fiscal policies.

In addition to these NAIRU studies, (Gechert et. al. 2016)’s study in the European
Commission, used Kalman filter to estimate the NAIRU to find out whether it delivers
to the economy. It was found out that NAIRU affects estimates of output gap since it is
one of the key components of potential output. The European commission therefore
decided to change the specification of the NAIRU of many countries including Spain where it was changed to 20.7 percent from 26.6 percent. In general, NAIRU is predominantly determined by actual rate of unemployment. Also the study of Elkayam et al. (2016) in Israel used the state space model to estimate the time-varying Non-Accelerating Inflation Rate of Unemployment. This study covered a period of twenty one years from 1992 to 2013. While using the Kalman Filter to estimate NAIRU, the estimated NAIRU is found to vary fairly. The estimated NAIRU was also found to fit well in a Beveridge curve thus helping in the identification of an inverse relationship between unemployment and job opportunities which is the expectation of a structural unemployment.

2.4 Literature Overview

The SR Phillips curve theory links wage inflation and level of unemployment. With the help of the SR Phillips equation, unemployment rate in the SR can be determined. In the LR, Phillips curve links price inflation and level of unemployment. Since price expectations are found to be the same as actual prices, the LR level of unemployment which is the NAIRU is found to be equal to productivity growth and can therefore be estimated.

The ‘natural rate of unemployment’ has been empirically tested and it has been found to exist in any economy. Most studies on the determination of the Phillips curve both in the short-run and the long-run has been done in many countries more especially in Europe and USA and a few in Africa like South Africa and Morocco. These countries have also estimated their natural rate of unemployment which has proved to be of great
significance in making macroeconomic policies in their respective economies. It is also evident that for those countries that have determined their Phillips curve and estimated their ‘natural rate of unemployment’, the unemployment level has been maintained at a low level. Being aware of their natural rate, might be the reason of their low level of unemployment since appropriate policies towards achieving full employment can be formulated and implemented. For example in the USA where there has been quite a number of studies on the Phillips curve and estimation of the NAIRU, the level of unemployment has been maintained at a low level as compared to Kenya which has never determined its Phillips curve and even its natural rate of unemployment.

The reality of the Phillips curve has been criticized by other economists and even though it has proved to be real in most of the countries, still it is not evident in others. Since its inception in 1958, the relationship between these variables as they were depicted has been changing from time to time. For example the trade-off between inflation and unemployment was evident in the 1950s and 1960s whereby the short-run Phillips curve played a very important role in the discussions of macroeconomic policy. There was a breakdown in the relationship in the 1970s before starting reappearing again in 1986 and again disappearing in the late 1990s. This continual change in the relationship between unemployment and inflation has left some economists in dilemma whether the Phillips curve really holds or not and if it holds, it holds under what conditions. In countries where it is not supported, the Lucas critique has become evident thus posing a question whether it is also evident in Kenya or not. Currently both Kenyan inflation and unemployment are high and therefore the determination of Phillips curve
in the short-run and the long-run is necessary. The estimation of the non accelerating inflation rate of unemployment will be of great significance also as far as making of the macroeconomic policies are concerned. This kind of study is therefore necessary in Kenya.
CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter captures the research design as well as the theoretical framework, also model specification, definition and measurement of variables, study area, type of data used and its source as well as data analysis.

3.2 Research Design

To realize the objectives of this study, causal type of research design was used. A part from identifying the cause and effect variables, another objective of this type of research design was to identify the nature of cause-and-effect relationship between inflation and unemployment. Despite its weaknesses, this design was appropriate for this study since it played an instrumental role in identifying the reason behind the trade-off in the Phillips curve as suggested by Phillips (1958). Studies with this type of design also allow for systematic selection of subjects because of greater levels of internal validity they are associated with.

3.3 Theoretical Framework: Expectations augmented Phillips Curve

The Phillips Curve Framework which relates inflation and unemployment is the most popular framework used in determining the SR and LR Phillips curve so as to estimate the NAIRU. Despite its simplicity, it is flexible and for this reason, it has been used by many economists such as Congressional Budget Office (1994), Staiger et al. (1996), Gordon (1997), Stock and Watson (1997) as well as Ball and Mankiw (2002).
The theoretical short run Phillips curve equation was presented as:

$$w_t - w_t^e = \phi + \eta \Delta w_{t-1} + \sigma \Delta u_{t-1} + \Phi \Delta var_{t-1} + \epsilon_t$$

\[\epsilon_t \sim N(0, \sigma^2_{\epsilon}) \] \hspace{1cm} 3.1

Where:

- $w_t$ is the wage inflation rate in the current period.
- $w_t^e$ is the expected wage inflation rate in the current period.
- $\Delta$ indicates first difference of the respective variable.
- $u_{t-1}$ is the unemployment rate in the previous period.
- $var_{t-1}$ are other variables in the previous period that affect unexpected wage inflation rate in the current period.
- $\phi$ is a constant.
- $\eta$ is the coefficient of wage inflation in the previous period that measures the change in unexpected wage inflation in the current period while holding other factors constant.
- $\sigma$ is the coefficient of unemployment rate in the previous period that measures the change in unexpected wage inflation in the current period while holding other factors constant.
- $\Phi$ is the coefficient of other variables in the previous period that measures the change in unexpected wage inflation in the current period while holding other factors constant.
- $\epsilon_t$ is the error term in the current period.

The theoretical long run Phillips curve equation was presented as:

$$\pi_t = \alpha + \beta u_t + \gamma var_t + \epsilon_t$$

\[\epsilon_t \sim N(0, \sigma^2_{\epsilon}) \] \hspace{1cm} 3.2

Where:

- $\pi_t$ is the price inflation rate in the current period.
\( u_t \) is the current unemployment rate.

\( var_t \) are other variables that affect price inflation rate in the current period.

\( \alpha \) is a constant.

\( \beta \) is the coefficient of unemployment rate in the current period that measures the change in price inflation with respect to change in unemployment rate while holding other factors constant.

\( \gamma \) is the coefficient of other variables that measures the change in price inflation with respect to change in those variables while holding other factors constant.

\( \varepsilon_t \) is the error term in the current period.

The theoretical NAIRU equations were presented as:

\[
\pi_t - \pi^e_t = \alpha \ L \ \pi_{t-1} - \pi^{e}_{t-1} + \beta \ L \ u_t - u^e_t + \gamma \ L \ X_t + \varepsilon_t
\]

\( \varepsilon_t \sim N(0, \sigma^2_{\varepsilon}) \) .................................................................3.3

\[
\pi_t - \pi^e_t = \sum_{j=1}^{i} \alpha_j H^{j-1} t + \alpha \ L \ \pi_{t-1} - \pi^{e}_{t-1} + \beta \ L \ u_t + \gamma \ L \ X_t + \varepsilon_t \sim N(0, \sigma^2_{\varepsilon}) \) ..................................................3.4

\[
u_t = \frac{-\sum_{j=1}^{i} \alpha_j H^{j-1}(t)}{\beta} \) ..................................................................................3.5

Equation 3.3 is the Phillips curve equation as used by Gordon (1997) to estimate NAIRU. Since equation 3.3 is difficult to estimate because of the non linearity in the parameters, the equation when NAIRU is varying was rewritten as 3.4 which was used to estimate the coefficients that were needed to calculate NAIRU using equation 3.5.

Where,

\( \pi_t - \pi^e_t = \) Unexpected price inflation rate at time period \( t \).
\( \pi_t \) = Price inflation rate at time period t.

\( \pi^e_t \) = Expected price inflation rate at time period t - picked up by the lagged inflation (\( \pi_{t-1} \))

\( X_t \) = Supply shocks at time period t.

\( (u_t - u^e_t) \) = Unemployment gap at time t which gives the demand component.

\( \pi_{t-1} - \pi^e_{t-1} \) = Inertia

\( u_t \) = NAIRU at time t

\( u_t \) = Unemployment rate at time t.

\( \epsilon_t \) = Random exogenous event which is iid, that is, normally distributed with a mean of zero and variance \( \sigma^2_\epsilon \).

\( \sum_{j=1}^i a_j H^{j-1}(t) \) = Is a constant and where \( H^i \) is the Hermite polynomial of order i. Both Hermite polynomials and orthogonal polynomials have properties which make them suitable for flexible-form estimation (De Boor 1978)

Controlling for the temporary supply shocks enabled this study to calculate NAIRU which is compatible with constant inflation during absence of temporary supply shocks.

Unemployment gap is the demand component (shocks related to supply) and lagged inflation or inflation expectations picks up the inertia effect.

**3.4 Empirical Model Specification**

To realize the objectives of this study, four empirical models were specified.

The empirical short run Phillips model was presented as:

\[
\Delta w_t = \phi + \eta \Delta w_{t-1} + \sigma \Delta u_{t-1} + \phi_1 \Delta op_{t-1} + \phi_2 \Delta ex_{t-1} + \phi_3 \Delta pd_{t-1} + \phi_4 \Delta dum_{t-1} + \epsilon_t \\
\epsilon_t \sim \mathcal{N}(0, \sigma^2_\epsilon)
\]

Where;
\( op \) is crude oil prices, \( ex \) is exchange rate, \( pd \) is public debt and \( dum \) is the dummy variable.

The long run Phillips model was specified as below:

\[
\pi_t = \alpha + \beta u_t + \gamma_1 op_t + \gamma_2 ex_t + \gamma_3 pd_t + \gamma_4 dum_t + \epsilon_t
\]

\( \epsilon_t \sim N(0, \sigma^2) \) ..................................................3.7

The dummy variable represent economic crises that might have caused a temporary shift in the economy (drought).

The NAIRU models were specified as below:

\[
\Delta \pi_t = \sum_{j=1}^{i} a_j \pi^{j-1}(t) + \alpha \Delta \pi_{t-1} + \beta \Delta u_t + \gamma_1 \Delta op_t + \gamma_2 \Delta ex_t + \gamma_3 \Delta pd_t + \gamma_4 \Delta dum_t + \epsilon_t
\]

\( \epsilon_t \sim N(0, \sigma^2) \) ..............................................................................................................3.8

\[
u_t = \frac{\sum_{j=1}^{i} a_j \pi^{j-1}(t)}{\beta} \] ..............................................................................................................3.9

The unemployment gap enters in equation 3.8 as lagged values so as to avoid simultaneity. The number of lags of \( \pi_{t-1} - \pi_{t-1}^c \) included in the model depended on the significance of auto-correlated errors as well as significance of the last lag included in the model.
### 3.5 Definition and Measurement of Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Measurement</th>
</tr>
</thead>
</table>
| **Inflation rate (π)**          | Percentage change of the CPI over a one year period.                      | \[
\frac{\text{CPI}_2 - \text{CPI}_1}{\text{CPI}_1} \times 100
\]                   |
| **Unemployment rate (u)**       | Proportion of the total labor force that does not have jobs but are available and seeking for jobs. | \[
\frac{Tun}{Lf} \times 100
\]                                 |
| **Dummy-drought (dum)**         | An artificial variable which is created to represent an attribute with two distinct categories over a one year period | If present = 1; If absent = 0                                                 |
| **Exchange rate growth rate**   | Change in price of Kenya’s currency in terms of a dollar.                 | \[
\frac{\text{Ksh}}{\text{\$}} \frac{\text{ex}_t - \text{ex}_{t-1}}{\text{ex}_{t-1}} \times 100
\]   |
| **Crude oil prices growth rate**| Change in Price per barrel over a one year period                         | \[
\frac{\text{x}_t - \text{x}_{t-1}}{\text{x}_{t-1}} \times 100
\]                                 |
| **Public debt growth rate**     | Change in the amount of money a country owes lenders outside of itself.   | \[
\frac{\text{pd}_t - \text{pd}_{t-1}}{\text{pd}_{t-1}} \times 100
\]                                 |

Where;

CPI<sub>2</sub> is consumer price index in the current year and CPI<sub>1</sub> is consumer price index in the previous year. According to Kenya National Bureau of Statistics, the Consumer Price Index is calculated using the Laspeyres formula below:

\[
I_t = \sum_{i=1}^{n} W_i \frac{P_{ti}}{P_{0i}}
\]

Where; \( I_t \) is the index at time \( t \), \( P_{ti} \) is the price of the \( i^{th} \) commodity at time \( t \), \( P_{0i} \) is the price of the \( i^{th} \) commodity at the base period and \( W_i \) is the weight of the \( i^{th} \) commodity.

According to CIA World Factbook, the unemployment rate is measured as a percentage.
of the labor force that does not have jobs. Where; \( T_u \) is total number of unemployed persons above 16 years and \( L_f \) is the labor force containing both employed and the unemployed persons above 16 years. \( x_t \) is the price of crude oil per barrel in the current period and \( x_{t-1} \) is price of crude oil per barrel in the previous period.

The dummy variable represented drought whose occurrence or non occurrence has an effect on the dependent variable. If it occurs it is given a value of 1 and if it fails to occur it is given a value of 0. \( e_{x_t} \) is the exchange rate in the current period and \( e_{x_{t-1}} \) is the exchange rate in the previous period. According to Central Bank of Kenya, the exchange rate between Kenya’s currency and US dollar is the price of Kenya’s currency in terms of a US dollar. Where; Ksh represents Kenya Shilling and $ represents US dollar. \( p_d_t \) is the public debt in the current period and \( p_d_{t-1} \) is the public debt in the previous period.

3.6 Estimating Methods

The short run and long run Philips curve equations were estimated using the Ordinary Least Squares method. This is because the two equations satisfied all the assumptions of OLS. The first NAIRU equation was also estimated using Ordinary Least Squares method because it also satisfies all OLS assumptions. Using coefficients estimated using first NAIRU equation, second NAIRU equation was used to calculate NAIRU.

3.7 Diagnostic Tests

Various model diagnostic tests were carried out. They include Unit root test using Augmented Dickey-Fuller (ADF) tests based on Schwarz Info Criterion (SIC) to test the
stability of the series, Descriptive statistics to test for volatility of the variables, Wald test which was used to test the significance of independent variables as a group, normality test using Jarque- Bera statistic, heteroscedasticity test using Breusch-Pagan-Godfrey test, Ramsey Reset Test to test various specification errors, Chow Forecast Test to test the structural change of coefficients, and Recursive Coefficient Estimates test to test the stability of the variables.

ADF test was used because this is the simplest approach used to test for a unit root more especially in the case of autoregression. The Wald test was used because it is easy to calculate and the confidence interval has a closed form. Jarque- Bera test was used to test normality because it is simple and is still applicable when time series data is used. Breusch- Godfrey test was used because it is applicable when a lagged dependent variable is used as an explanatory variable and it takes into account higher order of autocorrelation. Ramsey Reset test was used because it does not require us to know whether the independent variables are causing the problem. Both Chow Forecast test and Recursive Coefficient Estimates test were used in this study because they are both simple to use and that it is possible to split the data set in case of Chow Forecast test.

3.8 Study Area

The entire Kenyan economy was considered in this study so as to realize its objectives since all the variables that were used have an influence in the whole economy. Even though that was the case, data was collected from designated institutions.
3.9 Data Type, Collection and Source

Secondary type of data was used in this study which was collected from the already published documents readily available in World Bank, Kenya National Bureau of Statistics, CIA World Factbook, Federal Reserve Bank of St. Lous, Central Bank of Kenya and from Disaster Management Centers.

3.10 Data Analysis and Presentation

Raw data collected was modified and tested before it was ready for analysis. Eviews statistical software was used to analyze data. Tables and graphs were used for presentation of results.
CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction
The chapter captures data analysis of the study, results as well as discussion. It begins by outlining diagnostic tests, and then presents Phillips curve in the short run, Phillips curve in the long run, the non accelerating inflation rate of unemployment and the discussion of findings.

4.2 General Diagnostic Tests

4.2.1 Descriptive Statistics
Descriptive statistics gives the minimum value, maximum value, mean and standard deviation of variables used in the study.

<table>
<thead>
<tr>
<th>Table 4.1: Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Year</td>
</tr>
<tr>
<td>Price inflation</td>
</tr>
<tr>
<td>Wage inflation</td>
</tr>
<tr>
<td>Unemployment</td>
</tr>
<tr>
<td>Oil prices</td>
</tr>
<tr>
<td>Public debt</td>
</tr>
<tr>
<td>Exchange rate</td>
</tr>
<tr>
<td>Dummy</td>
</tr>
</tbody>
</table>
The data ranges from 1977 to 2015. The total number of observations for each variable is 39. The mean rate of price inflation rate was found to be 11.91 percent and a standard deviation of 8.13 percent, minimum value of 1.60 percent and 46.00 percent as the maximum value. The mean rate for wage inflation, unemployment, crude oil prices, public debt, exchange rate and the dummy was found to be 15.41 percent, 62.73 percent, 6.99 percent, 17.51 percent, 7.34 percent and 10.26 percent respectively. Their respective standard deviations are; 14.26 percent, 14.01 percent, 27.29 percent, 20.59 percent, 14.80 percent and 30.74 percent. Also their respective minimum values are; -24.43 percent, 40.17 percent, -46.36 percent, -10.11 percent, -8.24 percent and 0.00 percent respectively. The maximum values were also found to be 82.76 percent, 78.83 percent, 67.89 percent, 92.38 percent, 80.03 percent and 100 percent for wage inflation rate, unemployment rate, crude oil prices, public debt, exchange rate and the dummy respectively.

![Figure 2: Trend of price inflation, public debt growth rate and unemployment rate](image-url)

Figure 2: Trend of price inflation, public debt growth rate and unemployment rate
From figures 2 and 3 above the dummy variable varies greatly followed by growth in crude oil prices, growth in public debt, growth in exchange rate, wage inflation rate, unemployment rate and price inflation rate. The highest values for price inflation and wage inflation were recorded in 1993 and 2013 respectively. The highest level of unemployment rate was recorded in 1978, 1993, 2010 and 2012. Highest values for growth in crude oil prices, public debt and exchange rate were recorded in 1979, 1993 and 1993 respectively.

With the exception of some years like 1979, 1986, 2000 and 2009, unemployment rate varies smoothly. Price inflation is found to vary smoothly just like wage inflation even though there was a sharp rise in wage inflation in 2013 followed by a sharp fall. Exchange rate also varies smoothly a part from having a sharp rise in 1993 and then a sharp fall to 1994 before continuing with the normal trend. The dummy remains at zero with the exception in 1978, 1993, 2010 and 2013 where it rises sharply to 1.00.
4.2.2 Granger Causality Test Results

Various statistical softwares are being used to calculate a granger causality test but in this study eviews statistical software was used. This test was run so as to establish the direction of the relationship between various variables used in this study such as price inflation, wage inflation, unemployment rate, oil prices growth rate, public debt growth rate and exchange rate growth rate. The null hypothesis that one of the variables granger causes not one another is not accepted if the p-value for the effect of one variable on another is less than 5.00 percent. If more than 5.00 percent it is not rejected. From Table 4.2 below, it is evident that that the p-value for the effect of one variable on another is more than 5.00 percent and therefore the null hypotheses that one of the variables does not granger cause one another cannot be rejected.

Table 4.2: Granger Causality Tests

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAGE_INFLATION Granger Causes not PRICE_INFLATION</td>
<td>37</td>
<td>0.12533</td>
<td>0.8826</td>
</tr>
<tr>
<td>PRICE_INFLATION Granger Causes not WAGE_INFLATION</td>
<td>37</td>
<td>1.55703</td>
<td>0.2263</td>
</tr>
<tr>
<td>UNEMPLOYMENT Granger Causes not PRICE_INFLATION</td>
<td>37</td>
<td>2.16312</td>
<td>0.1315</td>
</tr>
<tr>
<td>PRICE_INFLATION Granger Causes not UNEMPLOYMENT</td>
<td>37</td>
<td>0.38327</td>
<td>0.6847</td>
</tr>
<tr>
<td>PUBLIC_DEBT Granger Causes not PRICE_INFLATION</td>
<td>37</td>
<td>0.12533</td>
<td>0.3940</td>
</tr>
<tr>
<td>PRICE_INFLATION Granger Causes not PUBLIC_DEBT</td>
<td>37</td>
<td>1.55703</td>
<td>0.2291</td>
</tr>
<tr>
<td>OIL_PRICES Granger Causes not PRICE_INFLATION</td>
<td>37</td>
<td>0.12533</td>
<td>0.4255</td>
</tr>
<tr>
<td>PRICE_INFLATION Granger Causes not OIL_PRICES</td>
<td>37</td>
<td>1.55703</td>
<td>0.2125</td>
</tr>
</tbody>
</table>
### 4.2.3 Correlation Test Results

The main essence of this correlation matrix as presented in Table 4.3 was to test whether the independent variables such as price inflation, wage inflation, unemployment rate, public debt growth rate, crude oil prices growth rate as well as exchange rate growth rate and the dummy correlate with one another.
### Table 4.3: Correlation Matrix of Variables

<table>
<thead>
<tr>
<th></th>
<th>Price Inflation</th>
<th>Wage Inflation</th>
<th>Unemployment Rate</th>
<th>Public Debt Growth Rate</th>
<th>Oil Prices Growth Rate</th>
<th>Exchange Rate Growth Rate</th>
<th>Dummy drought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price Inflation</td>
<td>1.0000</td>
<td>0.0173</td>
<td>0.3436</td>
<td>0.4517</td>
<td>-0.1414</td>
<td>0.7289</td>
<td>0.2575</td>
</tr>
<tr>
<td>Wage Inflation</td>
<td>0.0173</td>
<td>1.0000</td>
<td>0.0206</td>
<td>-0.0118</td>
<td>0.0086</td>
<td>-0.0067</td>
<td>-0.0481</td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>0.3436</td>
<td>0.0206</td>
<td>1.0000</td>
<td>0.1794</td>
<td>-0.0215</td>
<td>0.2218</td>
<td>-0.0900</td>
</tr>
<tr>
<td>Public Debt Growth Rate</td>
<td>0.4517</td>
<td>-0.0118</td>
<td>0.1794</td>
<td>1.0000</td>
<td>-0.2262</td>
<td>0.6252</td>
<td>0.3118</td>
</tr>
<tr>
<td>Oil Prices Growth Rate</td>
<td>-0.1414</td>
<td>0.0086</td>
<td>-0.0215</td>
<td>-0.2262</td>
<td>1.0000</td>
<td>-0.2081</td>
<td>-0.0146</td>
</tr>
<tr>
<td>Oil Prices Growth Rate</td>
<td>0.7289</td>
<td>-0.0067</td>
<td>0.2218</td>
<td>0.6252</td>
<td>-0.2081</td>
<td>1.0000</td>
<td>0.2411</td>
</tr>
<tr>
<td>Dummy drought</td>
<td>0.2575</td>
<td>-0.0481</td>
<td>-0.0900</td>
<td>0.3118</td>
<td>-0.0145</td>
<td>0.2412</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

It was found out that no variable had perfect or high correlation with one another and therefore there were no serial correlation. Meaning that there were no spurious results when OLS regression was run.

### 4.3 Model Diagnostic Tests

The model diagnostic tests that were carried out in this study include; Unit root test (stationality test), Wald test, Omitted variable test, Normality test, Heteroskedasticity test, Ramsey reset test, Chow forecast test and Recursive coefficient estimates test.

#### 4.3.1 Stationarity Test Results

Unit root tests involved the use of Augmented Dickey-Fuller (ADF) tests with lag length selection based on the Schwarz Info Criterion (SIC). Tables 4.4, 4.5, and 4.6
presents short run, long run and NAIRU stationarity results. The variable is said to be stationary if its p-value is less than 5.0 percent and t-Statistic is more than 2.0 in absolute terms.

**Table 4.4: Short Run Stationarity Tests**

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-Statistic (critical value at 5% level)</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change current wage-inflation</td>
<td>-2.948404</td>
<td>0.0011</td>
</tr>
<tr>
<td>Change previous wage-inflation</td>
<td>-2.936942</td>
<td>0.0000</td>
</tr>
<tr>
<td>Change previous unemployment-rate</td>
<td>-2.941145</td>
<td>0.0000</td>
</tr>
<tr>
<td>Change previous public debt rate of growth</td>
<td>-2.936942</td>
<td>0.0003</td>
</tr>
<tr>
<td>Change previous oil prices rate of growth</td>
<td>-2.936942</td>
<td>0.0000</td>
</tr>
<tr>
<td>Change previous exchange-rate of growth</td>
<td>-2.936942</td>
<td>0.0000</td>
</tr>
<tr>
<td>Dummy - drought</td>
<td>-2.938987</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

With the exception of change in previous unemployment rate, which was stationary at first order difference, all other variables were stationary at levels.

**Table 4.5: Long Run Stationarity Tests**

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-Statistic (critical value at 5% level)</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current price-inflation</td>
<td>-2.936942</td>
<td>0.0007</td>
</tr>
</tbody>
</table>
Current unemployment-rate  -2.943427  0.0000
Current public debt rate of growth  -2.936942  0.0000
Current oil prices rate of growth  -2.936942  0.0000
Current exchange-rate growth rate  -2.936942  0.0001
Dummy - drought  -2.936942  0.0022

With the exception of current unemployment rate, which was stationary at second order difference, all other variables were stationary at levels.

Table 4.6: NAIRU Stationarity Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-Statistic (critical value at 5% level)</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in current price inflation</td>
<td>-2.936942</td>
<td>0.0001</td>
</tr>
<tr>
<td>Change in previous price inflation</td>
<td>-2.943427</td>
<td>0.0000</td>
</tr>
<tr>
<td>Change in current unemployment-rate</td>
<td>-2.936942</td>
<td>0.0000</td>
</tr>
<tr>
<td>Change in current public debt rate of growth</td>
<td>-2.936942</td>
<td>0.0000</td>
</tr>
<tr>
<td>Change in current oil prices rate of growth</td>
<td>-2.936942</td>
<td>0.0001</td>
</tr>
<tr>
<td>Change in current exchange-rate growth rate</td>
<td>-2.936942</td>
<td>0.0022</td>
</tr>
</tbody>
</table>
All other variables were stationary at levels apart from change in current rate of unemployment which was stationary at second order difference.

### 4.3.2 Wald Tests
In a statistical model, Wald test is carried out to test the significance of particular independent variables. In case the Wald test for a particular independent variables or group of independent variables is significant, then the conclusion is that the variable parameters are not zero and therefore need to be included in the model. If the test is not significant, the null hypothesis is accepted and therefore concluded that some of the variables have no significant effect on the dependent variable. In this case it is possible to exclude those variables in the model.

**Table 4.7: Short Run Wald test results**

<table>
<thead>
<tr>
<th>Test statistic</th>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>14.5506</td>
<td>(7, 32)</td>
<td>0.0000</td>
</tr>
<tr>
<td>Chi-square</td>
<td>101.867</td>
<td>7</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

The conclusion in this case is that all the independent variables are significant since the F-statistic p-value and the Chi-square p-value are all less than 1.0 percent and therefore need to be included in the model. In case of Long Run and NAIRU models, Wald test results are as below:
Table 4.8: Long Run-Wald test results

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>59.36353</td>
<td>(6, 33)</td>
<td>0.0000</td>
</tr>
<tr>
<td>Chi-square</td>
<td>356.1812</td>
<td>6</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Table 4.9: NAIRU Wald test results

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>18.28572</td>
<td>(7, 32)</td>
<td>0.0000</td>
</tr>
<tr>
<td>Chi-square</td>
<td>128.0000</td>
<td>7</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

It can be concluded from the above Tables 4.8 and 4.9 that the F-statistic and Chi-square p-values are less than 1.0 percent and therefore the null hypothesis is rejected and all variables included in their respective models. The variables have a significant effect on their respective dependent variables.

4.3.3 Normality Test

This test is carried out so as to find out whether the residuals are normally distributed. The Jarque-Bera statistic should be insignificant and the histogram bell-shaped for it to be concluded that the residuals are normally distributed.

Table 4.10: Short Run Normality test results

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.14e-17</td>
<td>0.0048</td>
<td>-0.3046</td>
<td>0.3407</td>
<td>0.11153</td>
<td>0.13965</td>
<td>4.97708</td>
<td>6.47866</td>
<td>0.03919</td>
</tr>
</tbody>
</table>
It can be concluded from Table 4.10 above that the short run residuals are normally distributed since the corresponding p-value is not more than 5.0 percent and therefore the null hypothesis that the residuals are normally distributed is not rejected. In addition to this, the histogram is bell shaped as shown below:

![Short Run Bell-shaped histogram](image)

**Figure 4: Short Run Bell-shaped histogram**

The Long Run and NAIRU normality results can also be shown below in the Tables 4.11 and 4.12 respectively. Their respective p-values are 55.21 percent and 29.71 percent respectively, meaning that they are more than the accepted value for normality of 5.0 percent.

**Table 4.11: Long Run Normality test results**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
<th>Std Dev</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5.16e-18</td>
<td>0.0015</td>
<td>-0.07246</td>
<td>0.0841</td>
<td>0.04187</td>
<td>-0.05348</td>
<td>2.15163</td>
<td>1.188147</td>
<td>0.55207</td>
</tr>
</tbody>
</table>
The Long Run and NAIRU models therefore show an indication of non normality in their residuals since the null hypothesis of normality is rejected. Since this is a normal case when observations of less than 100 are used, the study still employed ordinary least squares method to estimate the models.
4.3.4. Heteroscedasticity Test

Heteroscedasticity test is carried out to find out whether the variance of the error terms that appears in the regression functions of the population are the same. Using the Breusch-Pagan-Godfrey test, the results are as below:

Table 4.13: Short Run Heteroscedasticity Test Results

<table>
<thead>
<tr>
<th></th>
<th>F-statistic</th>
<th>Prob. F(6,32)</th>
<th>Chi-Square (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obs*R-squared</td>
<td>25.81737</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>Scaled explained SS</td>
<td>32.32278</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>43.27273</td>
<td>0.0000</td>
<td></td>
</tr>
</tbody>
</table>

In this case the null hypothesis of homoscedasticity is rejected since the p-value is less than 0.05. There is therefore the problem of heteroscedasticity in the short run. In this case heteroscedasticity will be removed through log transformation of the variables. But since some of the variables have a negative value, log transformation is not possible and therefore the estimation using OLS will still be used but using HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000). Other models (Long Run and NAIRU) when tested gives the results as below.

Table 4.14: Long Run Heteroscedasticity Test Results

<table>
<thead>
<tr>
<th></th>
<th>F-statistic</th>
<th>Prob. F(5,33)</th>
<th>Chi-Square (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obs*R-squared</td>
<td>0.883976</td>
<td>0.5028</td>
<td></td>
</tr>
<tr>
<td>Scaled explained SS</td>
<td>4.606516</td>
<td>0.4658</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.899133</td>
<td>0.8629</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.15: NAIRU Heteroscedasticity Test Results

<table>
<thead>
<tr>
<th></th>
<th>F-statistic</th>
<th>Prob. F(6,32)</th>
<th>Chi-Square (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.137419</td>
<td>0.3636</td>
<td></td>
</tr>
</tbody>
</table>
Both the Long Run and NAIRU models show an indication of homoscedasticity in their respective residuals which is desirable. There is therefore no heteroscedasticity in this case since their respective p-values are more than 5.0 percent.

### 4.3.5 Ramsey Reset Test

This test is carried out to test various types of specification errors. They include: omitted variables, incorrect functional form and correlation between explanatory variables and the disturbance term. If the p - value is less than 5.0 percent (the significance level), then the null hypothesis is not accepted and the model is said to be well specified. In case the p - value is more than 5.0 percent (the significance level), then the null hypothesis is accepted and the model is said to be misspecified.

<table>
<thead>
<tr>
<th>Table 4.16: Short Run Ramsey Reset Test Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Likelihood ratio</td>
</tr>
</tbody>
</table>

From Table 4.16 above, the short run model was found to be well specified since the F-statistic’s p - value is less than 5.0 percent (the significance level). The same result is realized in the long run model as shown below in Table 4.17.

<table>
<thead>
<tr>
<th>Table 4.17: Long Run Ramsey Reset Test Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Value</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>F-statistic</td>
</tr>
<tr>
<td>Likelihood ratio</td>
</tr>
</tbody>
</table>

**Table 4.18: NAIRU Ramsey Reset Test Summary**

4.3.6 Chow Forecast Test
This test is used to assess the coefficient stability in a multiple linear regression model by splitting data using break points. In other words it is used to test whether there are structural changes in the model. The null hypothesis tested in this case is that there is no structural change in the coefficients. The null hypothesis will be rejected if the p-value is less than 5.0 percent.

**Table 4.19: Short Run Chow Forecast Test Summary**

<table>
<thead>
<tr>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>30.79763</td>
<td>(31, 6)</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>267.6364</td>
<td>31</td>
</tr>
</tbody>
</table>

The p-value for the F-statistic in this case is 0.1418, meaning that it is more than 5.0 percent.

**Table 4.20: Long Run Chow Forecast Test Summary**

<table>
<thead>
<tr>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>1.039022</td>
<td>(26, 7)</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>61.65429</td>
<td>26</td>
</tr>
</tbody>
</table>

The p-value also in this case for the F-statistic is 0.5218, meaning that it is more than the significance level of 5.0 percent. The same result is realized for the NAIRU as presented in table 21 where the p-value is 0.8529. If the p-value is more than 5.0
percent, the null hypothesis that there is no structural change cannot be rejected. If otherwise, the null hypothesis that there is no structural change is rejected.

**Table 4.21: NAIRU Chow Forecast Test Summary**

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>0.387611</td>
<td>(5, 27)</td>
<td>0.8529</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>2.703505</td>
<td>5</td>
<td>0.7456</td>
</tr>
</tbody>
</table>

From Tables 4.19, 4.20 and 4.21 above, the Chow Forecast test results gives evidence that the null hypothesis that there is no structural change can be accepted. In both models, that is, short run, long run and NAIRU, their F-statistic p-values are more than 5.0 percent and therefore the test concludes that there is no structural change in the coefficient.

**4.3.7 Recursive Coefficient Estimates Test**

This test is used to test the stability of the variables used in the model. It enables one to trace out estimates evolution for whichever the coefficient as sample data used in the estimation increases. On the either side of the estimated coefficients are two standard error bands. An indication of instability is evident if there is a significant variation of the coefficient when more data is being added to the equation used in estimation. A sign of no stability is evident if the blue line lies outside the two red lines.
Figure 7: Short Run Variable Stability

As presented in Figure 7, the blue line lies between the two red lines. The same result is realized when the Long Run and NAIRU models are tested as presented in Figures 8 and 9.

Figure 8: Long Run Variable Stability
Figure 9: NAIRU Variable Stability

The tests therefore conclude that the variables that were used in this study for all the models are stable.

4.4 Results of the Short Run Phillips Curve

The first objective was to determine the short run Phillips equation as presented in Table 4.22.

Table 4.22: Short Run Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage inflation rate</td>
<td>-1.237094</td>
<td>0.203246</td>
<td>-6.086689</td>
<td>0.0000</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>-2.056483</td>
<td>1.614766</td>
<td>-1.273548</td>
<td>0.2120</td>
</tr>
<tr>
<td>Public debt growth-rate</td>
<td>-1.212506</td>
<td>0.169620</td>
<td>-7.148360</td>
<td>0.0000</td>
</tr>
<tr>
<td>Oil prices growth-rate</td>
<td>-1.356778</td>
<td>0.310174</td>
<td>-4.374240</td>
<td>0.0001</td>
</tr>
<tr>
<td>Exchange rate-growth rate</td>
<td>0.921404</td>
<td>3.763635</td>
<td>0.244818</td>
<td>0.8082</td>
</tr>
<tr>
<td>Dummy</td>
<td>0.325970</td>
<td>0.219131</td>
<td>1.487558</td>
<td>0.1467</td>
</tr>
<tr>
<td>Constant</td>
<td>0.156879</td>
<td>0.038339</td>
<td>4.091899</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

Unexpected wage inflation depends on change of the previous wage inflation, change of the previous rate of unemployment, change of the previous rate of crude oil prices,
change of the previous rate of public debt, change of the previous rate of exchange rate and the dummy. It was found out that three out of the six independent variables were statistically significant. In addition, the constant was also found to be statistically significant since their respective p-values were found to be less than 0.05 and their t-statistic more than 2.0 in absolute terms. It is only the change of the previous rate of unemployment change of the previous rate of exchange rate and the dummy (drought) that were found to be statistically insignificant since their p-values are more than 0.05 and their t-statistic less than 2.0 in absolute terms.

Given that all independent variables are zero, unexpected wage inflation equals to 0.156879 units. If one of the variables such as change in the previous wage inflation, change of the previous rate of unemployment, change of the previous rate of public debt, change of the previous rate of crude oil prices and change of the previous rate of exchange rate changes by 1.0 unit with a 1.0 unit occurrence of the dummy with all other variables remaining constant, unexpected wage inflation changes by 1.237094, 2.056483, 1.212505, 1.3567780, 0.921404 and 0.325970 units respectively. Meaning that if one of the variables such as change of the previous wage inflation, change of the previous rate of unemployment, change of the previous rate of public debt, change of the previous rate of crude oil prices and change of the previous rate of exchange rate increases by 1.0 unit with a 1.0 unit occurrence of the dummy ceteris par bus, unexpected wage inflation decreases by 1.237094, 2.056483, 1.212505, 1.356778 units respectively and increase in unexpected wage inflation by 0.921404 and 0.325970 units respectively. 71.61 percent of the changes in the independent variables is explained by
the dependent variable since adjusted r squared is 71.6113 percent.

4.5 Results of the Long Run Phillips Curve.
The second objective was to determine the long run Phillips equation as presented in Table 4.23 below.

Table 4.23: Long Run Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate</td>
<td>-0.057022</td>
<td>0.450427</td>
<td>-0.126594</td>
<td>0.9000</td>
</tr>
<tr>
<td>Oil prices growth-rate</td>
<td>0.058666</td>
<td>0.027635</td>
<td>2.122847</td>
<td>0.0414</td>
</tr>
<tr>
<td>Public debt-growth rate</td>
<td>0.027877</td>
<td>0.046532</td>
<td>0.599081</td>
<td>0.5532</td>
</tr>
<tr>
<td>Exchange rate-growth rate</td>
<td>0.483218</td>
<td>0.064393</td>
<td>7.504240</td>
<td>0.0000</td>
</tr>
<tr>
<td>Dummy- drought</td>
<td>0.112929</td>
<td>0.028140</td>
<td>4.013088</td>
<td>0.0003</td>
</tr>
<tr>
<td>Constant</td>
<td>0.057976</td>
<td>0.013583</td>
<td>4.268414</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

Price inflation depends on unemployment rate, crude oil prices growth rate, public debt growth rate, growth rate in exchange rate and the dummy. It was found out that three out of the five independent variables were statistically significant. In addition, the constant was also found to be statistically significant since their respective p – values were found to be less than 0.05 and their t-statistic more than 2.0 in absolute terms.

Unemployment rate and public debt growth that were found to be statistically insignificant since their p – values are more than 0.05 and their t-statistic less than 2.0 in absolute terms.

Given that all independent variables are zero, price inflation equals to 0.057976 units. Holding all other variables constant, Change of one of the variables such as rate of
unemployment, crude oil prices growth rate, public debt growth rate and exchange rate growth rate by 1.0 unit with a 1.0 unit occurrence of the dummy, price inflation changes by 0.057022, 0.058666, 0.027877, 0.483218, and 0.112929 units respectively. Meaning that if all other variables are kept constant, 1.0 unit increase in any one of the variables such as rate of unemployment, crude oil prices growth rate, public debt growth rate and exchange rate growth rate with a 1.0 unit occurrence of the dummy, price inflation decreases by 0.057022 units and increases by 0.058666, 0.027877, 0.483218 and 0.112929 units respectively. 73.94 percent of the changes in the independent variables is explained by the dependent variable (price inflation) since adjusted r squared is 73.9386 percent.

**4.6 Results for Non Accelerating Rate of Unemployment.**
The third objective was to estimate the NAIRU using results presented in Table 4.24 and the NAIRU formula as presented in equation 3.9.

**Table 4.24: NAIRU Results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>-0.036692</td>
<td>0.170670</td>
<td>-0.214991</td>
<td>0.8311</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>0.080422</td>
<td>1.010058</td>
<td>0.079621</td>
<td>0.9370</td>
</tr>
<tr>
<td>Oil prices growth-rate</td>
<td>0.006111</td>
<td>0.037354</td>
<td>0.163602</td>
<td>0.8711</td>
</tr>
<tr>
<td>Public debt-growth rate</td>
<td>-0.029149</td>
<td>0.052707</td>
<td>-0.553036</td>
<td>0.5841</td>
</tr>
<tr>
<td>Exchange rate-growth rate</td>
<td>0.415765</td>
<td>0.082979</td>
<td>5.010472</td>
<td>0.0000</td>
</tr>
<tr>
<td>Dummy - drought</td>
<td>-0.646616</td>
<td>0.080155</td>
<td>-8.067054</td>
<td>0.0000</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.006996</td>
<td>0.012010</td>
<td>-0.582506</td>
<td>0.5643</td>
</tr>
</tbody>
</table>

Change in current price inflation depends on change in price inflation of the previous year, change in current rate of unemployment, change in current crude oil prices,
change in current growth rate of public debt, change in current exchange rate and the dummy. It was found out that only the dummy and exchange rate were statistically significant since their respective p – values were found to be less than 0.05 and their t-statistic more than 2.0 in absolute terms. The other variables together with the constant were statistically insignificant since their p – values are more than 0.05 and their t-statistic less than 2.0 in absolute terms.

Given that all independent variables are zero, change in current price inflation equals to -0.006996 units. Holding all other variables constant, change in any one of the variables such as change in price inflation of the previous year, change in current rate of unemployment, change in current crude oil prices growth rate, change in current growth rate of public debt and change in current exchange rate growth rate with a 1.0 unit occurrence of the dummy, leads to a change in current price inflation by 0.036692, 0.080422, 0.006111, 0.029149, 0.415765 and 0.646616 units respectively. Meaning that if all other variables are kept constant, a 1.0 unit increase in any one of the variables such as change in price inflation of the previous year, change in current rate of unemployment, change in current crude oil prices, change in current growth rate of public debt and change in current exchange rate with a 100.0 percent occurrence of the dummy leads to a decrease in change in current price inflation by 0.036692 units, increase by 0.080422 and 0.0061110 units, decrease by 0.029149 units, increase by 0.415765 units and decrease by 0.646616 units respectively. About 75.63 percent of the changes in the independent variables is explained by the dependent variable (change in current price inflation) since adjusted R squared is 75.6345 percent.
Using equation 3.4 as presented below:

\[ u_t = \frac{\sum_{j=1}^{t} a_j H^{j+1}(t)}{\beta} \]

The NAIRU estimate can therefore be formulated as:

\[ u_t = \frac{-0.006996}{0.080422} \]

= 0.08699 units.

= 8.699 percent.

The estimate of the non accelerating rate of unemployment in Kenya is therefore 8.699 percent.

4.7 Discussion of the Findings
It is evident from the study that there is no serial correlation between the variables and that they do not granger cause one another according to the correlation and granger causality tests that have been done on the available data. It was also found out that the variables after their modification to suit their respective models; it was evident that most of the variables were stationary at levels with exception of a few like unemployment rate. Other model diagnostic tests reveal the suitability of the models used in this study.

It was found out that unexpected wage inflation rate in the current period relates negatively with the unexpected wage inflation in the past period, unexpected rate of unemployment in the previous period, unexpected public debt growth rate in the previous period and unexpected crude oil prices growth rate in the previous period. A
positive relationship was observed with the unexpected exchange rate in the previous period and the dummy variable. Even though the relationship was negative between the two said variables, wage inflation and unemployment rate, which agrees with the findings of John DiNardo and Mark Moore (1999), the effect was found to be insignificant. Negative effect of previous wage inflation on current wage inflation is significant and this is possible because when employers realize that they increased wages of their employees at a high level in the previous year, in the current year they are likely to reduce their increasing rate of wages to their employees.

In the same way the government will tend to reduce its increasing rate of wages to employees in the current period if it realizes that there was an increase in public debt and crude oil prices. This happens so as to divert some of the funds to repay public debt as well as importing more oil since Kenya is purely an oil importer economy. The positive effect of exchange rate on wage inflation is not significant likewise to the dummy whose effect on wage inflation is also not significant, meaning that if at any point there is a natural disaster in the economy (drought), wage inflation in the current year increases by 0.325970 units. This is possible since employees may demand an immediate increase in wages or compensation from insurance companies so as to cater for the losses incurred as a result of drought. This is the situation in Kenya in the short term.

The situation changes in the long term since in this case it is no longer wage inflation that is used but price inflation. It is also assumed that there are no expectations in the long run and therefore using similar variables as used in the short term, the nature of the
relationship changes. For example the negative relationship which was observed between wage inflation and public debt together with crude oil prices in the short term, is not observed in the long term where we observe a non negative relationship between price inflation and public debt together with crude oil prices. Even though there is also a negative effect of unemployment rate on price inflation in the long run just as in the short run, the effect is also not significant and this agrees with the findings of Friedman and Phelps (1968), which states that in the long term there is no such a trade off, since unemployment rate goes back to its natural rate and inflation is just a monetary phenomenon.

The positive effect of prices of crude oil on price inflation is possible since any increase in oil prices will cause an increase in prices of common products so as to cater for high costs incurred in importing oil. This translates to price inflation in the long term. Also in the long term (run) the effect of exchange rate on price inflation is positive and it is significant unlike in the short run together with the dummy. This is possible since when there is an increase in exchange rate, the currency value decreases and this makes imports expensive. Since Kenya is a net importer, to compensate for this loss prices of commodities increase leading to increased price inflation. The occurrence of a natural disaster also causes increase in price inflation by 0.112929 units since it takes time to recover from the loss caused by a natural disaster today. The effect of unemployment rate on price inflation is also negative just like in the short term but it is insignificant.

Considering the variables as used in analyzing of non accelerating inflation rate of unemployment in Kenya, it is only the exchange rate and the dummy (drought)
variables that were found to be significant. Even though that is the case, the major objective in this case was not to investigate the nature of the but to calculate an estimate of the non accelerating inflation rate of unemployment. The Kenyan NAIRU was found to stand at 8.699 percent, meaning that Kenya still has a challenge as far as the unemployment rate is concerned which currently stands at more than 40.0 percent. This is comparable to findings of Elalaoui et. al. (2014) in Morocco whose NAIRU was found to range between 8.80 percent and 9.02 percent.
CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction
The chapter captures the summary as per the research findings, the conclusion of the study, recommendations to policy makers and other parties who might find findings of this study appropriate and areas for further study.

5.2 Summary
Various diagnostic tests were carried out in this study to check the appropriateness of the models, data and variables that were used. Among the tests that were carried out include; stationarity tests, descriptive statistics, granger causality tests, correlation tests, Wald tests, normality tests, heteroscedasticity tests, Ramsey reset tests, chow forecast tests and recursive estimates tests. Stationarity tests shows that after the variables have been modified to fit their models both in the short run, long run and NAIRU, with the exception of unemployment rate that needed differencing, all other variables are stationary at levels.

Descriptive tests show that most of the variables are highly volatile. The dummy variable was found to be highly volatile followed by oil prices growth rate, public debt growth rate, exchange rate growth rate, wage inflation, unemployment rate and price inflation. Granger causality tests show that there is no variable which granger causes any other variable. Also from correlation tests, it is clear that there was no serious collinearity between the variables and therefore making it possible to carry out a regression analysis. Other model diagnostic tests such as Wald test, normality test,
heteroscedasticity test, Ramsey reset test, chow forecast test and recursive coefficient estimate test reveal that all ordinary least squares assumptions are satisfied and that there is stability in the series. Ordinary least squares method was therefore used to estimate the models.

In the short run, it was found out that wage inflation in the current period relates negatively with wage inflation in the previous period, unemployment rate, public debt and crude oil prices. The relationship is positive with variables like exchange rate and the dummy (drought). In the long run, with the exception of unemployment rate, all other independent variables were found to relate negatively with price inflation.

Considering the NAIRU model, change in current price inflation was found to relate negatively with change in price inflation of the previous period, change in current public debt and change in current dummy (drought) variables. The relationship was found to be positive with variables such as change in current unemployment rate, crude oil prices and exchange rate. The estimated value of non accelerating natural rate of unemployment in Kenya was found to be 8.699 percent.

5.3 Conclusion
The study concludes that the inverse relationship between two variables, that is, wage inflation rate and unemployment rate, in the short run according to Phillips (1958) is not evident in Kenya since the relationship is not significant even though it is negative. This is because the corresponding p-value is 0.2120 which is more than 0.05 and the t-statistic is -1.273548 which less than 2.0 in absolute terms.
The study also concludes that even in the long run, Phillips (1958)’s explanation is not evident since the relationship is also not significant even though it was found to be negative because the p-value is more than 0.05 and the t-statistic is less than 2.0 in absolute terms. This agrees with Friedman (1968) where the relationship does not exist in the long run since unemployment rate returns to its natural rate and inflation is just determined by monetary factors.

The study further concludes that since the estimate of Kenya’s non accelerating inflation rate of unemployment is 8.699 percent, then even if Kenya was to be at full employment level, still an unemployment rate of 8.699 percent which is also the natural rate of unemployment is inevitable.

According to (Lucas 1976), the Phillips (1958)’s explanation is not applicable in either scenarios whether short run or long run. Another conclusion of the study therefore is that the Lucas critique seem to be evident in Kenya and Phillips (1958)’s explanation does not hold. Finally, the major determinants of wage inflation in the short run are previous wage inflation, public debt, and crude oil prices. In the long run, major determinants of price inflation are crude oil prices, exchange rate and the dummy (drought).

5.4 Recommendations

The government together with the private sector needs to put more emphasis in the continuous training of workers on the emerging technology, so as to impart the necessary skills to deal with structural factors of unemployment. Better pay for workers
can also play a significant role in curbing frictional factors of unemployment. It is evident that Kenyan workers are poorly paid since Kenya has been experiencing frequent strikes in the recent past from various sectors such as education and health. If these factors are well dealt with, natural rate of unemployment (NAIRU) will reduce translating to overall decrease in the rate of unemployment.

It is also advisable to the government to reduce use of crude oil as the main source of energy but also make use of other alternative sources like renewable sources of energy (solar, wind as well as geothermal) since its effect is significant on inflation both in all cases be it short run or long run. These renewable sources of energy are readily available and therefore need not to be imported just like crude oil. They are therefore cheaper than crude oil since the only cost to be incurred is the initial cost of installation of necessary facilities and some maintenance costs.

The Central Bank of Kenya needs to keep the exchange rate stable since any increase of exchange rate leads to an increase in price inflation in the long run. This can be done by regulating various monetary factors like keeping interest rates at optimal rate which is favorable to both lenders and borrowers. Failure to this, the economy is destabilized and the cost of living increases.

On the other hand, the government has to reduce its rate of borrowing more especially the external borrowing since this leads to accumulation of interest charges so as to reduce public debt whose increase leads to an increase in price inflation in the long run.
Since occurrence of the dummy (drought) increases both wage inflation and price inflation, appropriate measures should be taken by the government to prevent devastating effects of drought like digging of boreholes to enhance irrigation in dry areas.

5.6 Areas for Further Study
Studies need to explore more on the determination of Phillips curve equation in the short run, Phillips curve equation in the long run and NAIRU estimation as time goes by since the growth rate of the variables keeps on changing from time to time.

More independent variables that determines inflation need to be explored since this will help policy makers to know which variables to control so as to keep inflation at the appropriate rate.

Since there are many methods of estimating NAIRU, it is logical that these methods also need to be explored so as to affirm the NAIRU estimate of this study.
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APPENDICES

Appendix I: Inflation and Unemployment rates from 1991 to 2013

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