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**An Econometric Analysis of the Relationship between Oil Price Change and  
Inflation Dynamics in Kenya**

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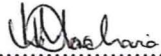
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**Declaration**

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

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## **Abstract**

The purpose of this study was to analyse the relationship between global oil price and inflation in Kenya. The specific objective of the study was to investigate the impact of fluctuations of global oil price on Kenyan inflation. This study employed the use of monthly data for all the variables for the period 2005 to 2015, which was split into two: Pre-Energy Regulatory Commission (ERC) and Post-ERC. The study conducted Stationarity tests before using a Vector Autoregressive (VAR) model to estimate the data. The analysis showed that during the first sample period of 2005 to 2010 (Pre-ERC), changes to the Brent price had no impact on inflation in Kenya. However, during the second sample period of 2011 to 2015 (Post-ERC), the Brent price was seen to impact inflation positively. This meant that any changes to the global price would result in an increase in local inflation, owing to the fact that the ERC derives local oil prices from the international oil prices. To mitigate this effect, the paper recommended that the ERC should take up more effective price controls.

**Key word:** VAR

### List of Abbreviations

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
CPI	Consumer Price Index
DF-GLS	Dickey Fuller- General Least Squares
ERC	Energy Regulatory Commission
GDP	Gross Domestic Product
IMF	International Monetary Fund
KNBS	Kenya National Bureau of Statistics
OLS	Ordinary Least Squares
OPEC	Oil Producing and Exporting Countries
PP	Phillips-Peron
PPI	Producer Price Index
SDR	Special Drawing Rights
U.K.	United Kingdom
U.S.	United States
VAR	Vector Autoregression
VECM	Vector Error Correction Model
WTP	Willingness to Pay

## Chapter 1: Introduction

### 1.1 Background of the problem

In a recent study on inflation within Kenya, Durevall and Sjou (2012) found that Kenya had experienced strong economic growth for over nearly a decade; however, inflation had become a major challenge. They further noted that high and volatile inflation was a threat to good economic performance and had negative effects on many of the poor.

Durevall and Ndung'u (1999) suggested that no single factor could be taken as the major cause of inflation in Kenya, however, exchange rate movements and changes in oil prices were the most important factors determining inflation. Their study highlighted that, in the 1970s, with the first oil price shocks and balance of payments problems, the rate of inflation began to increase from 3% (as averaged in the 1960s). This increase was accompanied by devaluations and changes in the exchange rate peg from the Sterling pound to the U.S. dollar, and to the Special Drawings Right (SDR)<sup>1</sup>.

Kotut, Menjo, & Jepkwony (2012) observed that during the period 1996 – 2011, the Kenyan economy had been subjected to exceptional oil price fluctuations that hindered its performance.

Inflation is caused by various factors ranging from macroeconomic imbalances to supply side constraints and external pressures. According to African Development Bank (2011), Kenyan oil prices seem to have accounted for 20% of the country's inflation. Kenya saw its inflation peak at 19.7% in November 2011, before dropping to 18.9% in December. This is a sharp reversal to previous years, when the authorities succeeded in bringing it down from 26% to 4% in 2010. The Central Bank attributes the persistence of inflation to supply shocks, currency depreciation and emerging demand pressures driven by rapid growth in private sector credit. In addition to this, on account of surging oil prices, the transport sub-index increased 26% year-on-year in October 2011 against 7.6% in December 2010.

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<sup>1</sup> After the collapse of the Bretton Woods system in 1973, the SDR was redefined as a basket of currencies. Today the SDR basket consists of the euro, Japanese yen, pound sterling, and U.S. dollar. The value of the SDR in terms of the U.S. dollar is determined daily and posted on the IMF's website.

This provides evidence of the significance of world oil prices, as a contributor to the high inflation rate.

### **1.2 Problem Statement**

In the recent past, Kenya has had serious fluctuations in economic activities which have had a lot of setbacks to its economic performance. The fluctuation in international oil prices, the ever rising inflation and fluctuation in other macroeconomic variables have also been experienced over the years. Oil prices, especially to petroleum oil importing countries like Kenya, have acted as a major economic burden since pricing of this crucial commodity is determined entirely by the oil exporting countries.

The level of petroleum consumed in a country depends on several factors which among them includes its prices and the level of economic activity, which have been constantly fluctuating in Kenya. To be able to draw policy measures on petroleum price control, it is necessary to establish the interrelationship between the macroeconomic variables, in particular inflation, and global oil price fluctuation.

This study set out to investigate the possible relationship between global oil prices and inflation in Kenya, and as a result, key research questions emerged (section 1.4).

### **1.3 Purpose of this study**

The purpose of this study was to provide an assessment of the impact of fluctuation in global oil prices on economic performance in Kenya; by analysing the relationship between these prices and inflation in Kenya.

### **1.4 Research Questions**

While examining the variables affecting inflation, in particular the global oil price, this study sought to address these questions: (1) Does global oil price change have an effect on inflation in Kenya, (2) If so, is the impact positive or negative; and lastly (3) Based on the research findings, what drawings can be made on the effectiveness of ERC in setting oil prices in Kenya.

### **1.5 Rationale of the study**

This study is of significance as it helps in outlining the link between global oil prices and inflation in Kenya. Findings obtained from this paper would be most beneficial to the Energy Regulatory Commission, as they would provide useful information on whether or not ERC had been successful in setting local oil prices in the past, thus minimizing the global oil price shocks to the country.

The study examined the local oil prices within Nairobi, inflation faced by the country as a whole, and sought to establish what effects the Brent price had on inflation.

### **1.6 Scope and Limitations of the study**

This study used time series data for the period 2005 to 2015. The study only looked at the possible relationship between global oil price and inflation with Nairobi as the sample.

### **1.7 Chapter summary**

This chapter introduced the research topic under study and presented useful background information on the possible link between the global oil price and inflation. It highlighted the objective of the research, the empirical approach that was taken up in carrying out the analysis, as well as the benefactors of the research findings.

The rest of the paper is organized as follows: Chapter 2 provides a critical review of past related studies and a summary of the Literature Review and Chapter 3 lays out the empirical model for carrying out data analysis. In Chapter 4 the relevant data and results on each of the three regression models are provided, and in Chapter 5, germane discussions, conclusions and recommendations are made.

## Chapter 2: Literature Review

In the past, research has been done to establish a relationship between exogenous shocks such as oil price changes and the macroeconomic variables of an economy. Looking at the U.S. economy, Hooker (1999) argues that oil price changes made a substantial direct contribution to core inflation before 1980, but resulted in little or no pass-through since that time. The study begins by estimating two simple Phillips curves for the CPI<sup>2</sup> less food and energy, and for the same index with all items included. The estimates are with quarterly data, seasonally adjusted CPIs and unemployment rates, and the contemporaneous change in the PPI<sup>3</sup> for crude oil. Evidence suggests that monetary policy has become less accommodative of oil price shocks, perhaps sufficiently so as to prevent oil price changes from passing directly into core inflation. This paper concurs with findings from Hooker (1999), owing to the establishment of the ERC so as to set the maximum wholesale and retail prices of petroleum products that would protect the local oil market from shocks arising from changes in international oil prices.

Studies on the effects of oil price changes on inflation across different countries have also been conducted, in an attempt to estimate a relationship between these variables. LeBlanc and Chinn (2004) estimate the effects of oil price change on inflation for the U.S., U.K., Germany, France and Japan (G5 countries<sup>4</sup>), but this time using an augmented Phillips curve framework. The study supplements the traditional Phillips curve approach, taking into account the growing body of evidence suggesting that oil prices may have asymmetric and nonlinear effects on output and that structural instabilities may exist in those relationships. Key variables used include CPI, unemployment rate (as a measure of economic slack<sup>5</sup>), nominal crude oil prices and interest rates. The statistical estimates suggest that current oil price increases are likely to have only a modest effect on inflation in the U.S., Japan and Europe. Oil price increases of as much as 10% will lead to direct inflationary increases of about 0.1-0.8% in the U.S. and Europe.

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<sup>2</sup>This is a measure of changes in the price level of a basket of consumer goods and services bought by households.

<sup>3</sup> A measure of the average changes in prices received by domestic producers for their output.

<sup>4</sup> These are the five industrialized nations, which meet periodically, so as to achieve a cooperative effort on the international economic and monetary issues.

<sup>5</sup> This is a measure of the quantity of unemployed resources in an economy.

Based on the fact that the G5 countries are oil importers, any oil price change as a result of oil demand or oil supply shock would have an impact on the economies. However, the extent of impact would vary as the economies are not the same.

Some researchers, in an effort to build on studies on the macroeconomics effects of oil price shocks, also estimate the changes over time in the nature and size of these effects. Blanchard and Gali (2007) provide evidence for the U.S., France, Germany, U.K., Italy and Japan using a 6-variable VAR. The model makes use of data on the nominal price of oil (in dollars), the inflation measures – CPI, GDP deflator and wages, and two quantities – GDP and employment. Findings from the analysis conclude that, except for Japan (and to some extent, for Germany), an increase in the price of oil leads to more wage and price inflation, and to a decrease in employment and output for some time. However, the effects of oil price shocks have changed over time, with steadily smaller effects on prices and wages, as well as on output and employment. Plausible causes for these changes include: 1) A decrease in real wage rigidities, 2) Increased credibility of monetary policy, and 3) Decrease in the share of oil in consumption and in production. Although changes in oil prices affect inflation, it is true to say that government intervention plays a role in ensuring minimal oil price pass-through into inflation. Additionally, the extent to which an oil price shock affects inflation is also dependent on the amount of oil used in consumption and in production, in a particular country.

The impact of exogenous shocks such as world oil price change on macroeconomic variables, like inflation, may vary from country to country. Kilian (2008a) compares the effects of exogenous shocks to global crude oil production on seven major industrialized economies, referred to as G7<sup>6</sup>. The countries under observation are U.S.A., Canada, Japan, Germany, France, Italy and U.K. The paper partially focuses on responses, such as CPI inflation, a fall in the real wage, higher short term interest rates and a depreciating currency with respect to the dollar, of the different economies to the exogenous oil supply disruptions. Based on quarterly data for 1971.I to 2004.III, the study carries out a simple linear regression, designed to shed light on the dynamic effects of exogenous oil supply shocks on output, inflation and other macroeconomic aggregates in the G7 countries.

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<sup>6</sup> A forum of the world's seven most industrialized economies.

Evidence suggests that an exogenous oil supply causes a temporary reduction in real GDP growth that is concentrated in quarters 4 through 8, after the shock.

Turning to CPI inflation, there is some heterogeneity among the G7 countries, in that in the U.S. and Italy, exogenous oil supply disruptions tend to cause sharp spikes in the CPI inflation. In France, the response is hump-shaped from the second through the fifth quarter, while in Canada, the U.K., and Germany (and to a much lesser extent Japan), the responses are characterized by repeated spikes. This study agrees with the results from Kilian (2008a) as the heterogeneity among the countries could have arisen due to the different states in economy for each country. Moreover, each country might have implemented best suited policies so as to safeguard itself against the oil supply shocks.

There are few studies relating to the effect of oil price change on inflation in Kenya. Kiptui (2009) examines oil prices-inflation nexus in Kenya and seeks to determine whether oil price pass-through was comparable with that reported in recent studies on other economies. The study suggests that understanding the pass-through of oil prices to inflation will help monetary authorities anticipate effects of oil price shocks on inflation. It adds that, looking at the Kenyan situation, oil prices seem to be highly correlated with inflation, quite visible in the period following liberalization. This study concurs with the above results as Kenya is a net importer of oil, hence any disruptions within the global oil market would to some extent have an impact on its inflation.

Liberalization within a market may also contribute to the impact of oil price change on inflation. In Kiptui (2009), a closer examination of the relationship between oil prices and inflation shows that over the 1967-2007 period, the correlation between inflation and oil prices in domestic currency (i.e. dollar prices per barrel multiplied by the nominal exchange rate) was 0.61; the correlation between inflation and oil prices in dollar values was 0.36, while that between inflation and the exchange rate was 0.17. Therefore oil prices were correlated with inflation. Computation of rolling correlation coefficients showed that correlation between changes in oil prices and inflation was on a downward trend till the early 90's, but started to rise just after liberalization, contrary to findings in some studies that pass-through has recently been declining.

Given that liberalization allows for free market forces to determine prices for goods and services, and no government intervention, an adjustment in global oil prices would have an impact on the demand and supply of commodities in the local market. In addition to this, price wars between major Oil Producing and Exporting Countries (OPEC) may have arisen, thus leading to disequilibrium in the global oil market which in turn would have affected oil importing countries, Kenya included.

There are various ways of estimating oil price pass-through into inflation. Kiptui (2009) begins by estimating the effect of oil prices using a traditional Phillips Curve with one lag of inflation, the output gap, and the percentage change in oil prices; where the inflation rate of a certain item is regressed on past values of itself and other variables, such as oil prices in dollar values, oil prices in domestic currency and the nominal exchange rates. The estimation results indicate that changes in oil prices have had significant effects on inflation. Other findings are that inflation has been significantly influenced by exchange rate changes and changes in aggregate demand conditions as captured by the output gap. The measure of oil price pass-through to inflation is found to be 0.05 in the short run and 0.10 in the long run, much lower compared to exchange rate pass-through of 0.32 in the short run and 0.64 in the long run. It implies that a 10% increase in oil prices leads to only 0.5% increase in inflation in the short run and 1% in the long run. Oil price pass-through is therefore low and incomplete, consistent with findings in other studies. As seen earlier, there indeed exists a link between oil price change and inflation, although one that changes over time given the impact of the underlying shocks.

The role of oil prices on macroeconomic performance of a country is also another way of observing a possible relationship between oil prices and macroeconomic variables. Kotut, Menjo, & Jepkwony (2012) argue that the macroeconomic variables (oil performance, real exchange rate and inflation rate) all have statistical significant impact on performance of the Kenyan economy. The oil consumption amount is determined by the Willingness to Pay (WTP) by the consumer; this indicates the value that the consumer attaches for an energy product. For the estimation of the VAR model, the dependent variable was Gross Domestic Product (GDP), while Urban oil prices, inflation and exchange rates incorporated the independent variables.

After the establishment of the existence of a long run association between the variables, we proceed to estimate the VAR model, and this yields satisfactory test statistics.

The goodness of fit variable ( $R^2$ ) shows that the exogenous variables account for 76.73% of the variations of economic performance in the short run. Judging from this statistic, it would be true to conclude that oil price changes do have a significant impact on the country's economic performance, inflation targeting being a component.

Government intervention within the oil market may also be used as an indicator of a possible relationship between oil prices and inflation. Orondoh (2014) claims that, by regulating and dictating market prices for oil products in Kenya, the Energy Regulatory Commission (ERC) will help reduce and stabilize the CPI inflation in the country. The study adopts four exogenous variables, namely oil prices, dollar exchange rate, one-period lagged interest rates and foreign remittances, while inflation being the endogenous variable.

Spanning the monthly data from October 2008 to February 2010 for period one, and March 2013 to February 2014 for period two, the proposal takes up a single equation regression model using OLS estimation. These two time horizons correspond to time without oil price controls and time of oil price controls, respectively. The results are as follows: Under period two, inflation has shown less volatility compared to the dispersion shown in period one, as measured by the standard deviation. It is also observed that in period one, inflation and oil price have a weak negative relationship while in period two, the relationship is positive though weak. However, the other variables, dollar exchange rate and foreign remittances, exhibit a weak relationship with inflation in both time periods. Hence it is safe to say that oil price change does have an impact on inflation, however, the degree of impact is mitigated by the government through the set local oil trading prices.

Kenya is a net importer of refined oil, meaning any shocks (oil demand and oil supply shocks) that arise within the global oil market may have an impact on the economy. While adopting a VAR model, this study sought to carry out an econometric analysis of the relationship between changes in global oil prices and local inflation.

## Chapter 3: Methodology

### 3.1 Introduction

To estimate the relationship between oil price change and inflation, this paper incorporated the VAR framework. A Vector Autoregressive (VAR) model is an econometric model used to capture the linear interdependencies among multiple time series. It describes the evolution of a set of 'k' variables (endogenous variables) over the sample period as a linear function of only their past values. The structure is that each variable is a linear function of past lags of itself and past lags of the other variables (The Pennsylvania State).

This paper breaks down the regression analysis into three models as shown in Table 1.

**Table 1: Models to be estimated (Pre and Post ERC variables)**

<b>Model</b>	<b>Period</b>	<b>Variables</b>
M1	Jan 2005 – Dec 2010	Brent price and inflation rate
M2	Jan 2011 – May 2015	Brent price, Diesel price and inflation rate
M3	Jan 2011 – May 2015	Brent price and inflation rate

For the purpose of comparing the relationship between global oil price and inflation subject to price controls, the analysis was split into two sample periods: Pre-ERC running from January 2005 to December 2010, and Post-ERC running from January 2011 to May 2015. The regression of each model was done so as to establish a possible link among the specified variables, whereas the comparison between the regression results obtained in models 1 and 3 aided in drawing conclusions on the effectiveness of the ERC in setting local oil prices.

### 3.2 Research Design

The research design adopted was a causal-comparative design, as the study aimed at determining the causal effect of global oil prices on inflation. Additionally, it compared this relationship between two sample periods: Pre-ERC (Jan'05 to Dec'10) and Post-ERC (Jan'11 to May '15).

### **3.3 Population and Sampling Design**

#### **3.3.1 Population**

The population under study was Kenya, as it has been seen to be a net importer of oil in the past. In addition to this, as highlighted in Chapter 2, shocks to the global oil market have been seen to have an effect on macroeconomic variables in Kenya such as inflation. In Kiptui (2009), the population under observation was also Kenya.

#### **3.3.2 Sampling Design and Sample Size**

The convenience sampling design was taken up for this study based on data availability. The sample size is the data on petroleum from 2005 to 2015, and this is done so as to match the sample size pre and post ERC in order to see the effects of price controls on inflation.

### **3.4 Data collection methods**

The study involved the access of online data banks so as to obtain relevant material on the research topic, such as journal articles and economic reports, from the World Bank and Thomson Reuters and other organizations. Furthermore, one on one meetings were also held so as to gather useful information from experts in the oil industry. These data sourcing methods proved to be efficient and reliable, as information obtained was not only relevant for the study, but it was also up to date.

### **3.5 Research procedure**

The study took on the following procedure in carrying out the research. First, past studies on the global oil prices effect on inflation in Kenya were obtained. This information was also complemented by related research done on the topic, but in different countries such as US (as highlighted in Chapter 2). The next step involved gathering both primary and secondary data, from reliable and valid sources. This was done through monthly meetings with persons knowledgeable in the field of oil, reviewing reports by World Bank and ERC as well as reviewing journal articles related to the research topic. With the relevant data at hand, the next step was to carry out a regression analysis using the prescribed VAR framework, as used in other related studies (Kilian, 2008c) .

### 3.6 Data analysis methods

A quantitative approach was taken up in carrying out the data analysis; quantitative in terms of the use of inferential statistics such as regression of the variables. The Eviews software was also used as a data analysis tool, as it is equipped with the relevant programs for running VAR models. While testing for unit roots, the study tabulated the findings of each model by illustrating the different test statistics of each stationarity test, compared against their respective critical values (see Tables 2, 4 and 7). A sample VAR model is illustrated below:

#### Vector Autoregressive Model

Consider,

$$y_{it} = \alpha_i + \phi_{1i}y_{it-p} + \varepsilon_{it}$$

Where  $i = 1,2,3 \dots$ ,  $y_{it}$  is an endogenous variable at time 't',  $y_{it-p}$  is the  $p^{\text{th}}$  lag of  $y_{it}$ ,  $\alpha_i$  is a  $k \times 1$  vector of constants (intercepts) for the 'i<sup>th</sup>' variable,  $\phi_{1i}$  is a time-invariant  $k \times k$  matrix and  $\varepsilon_{it}$  is a  $k \times 1$  vector of error terms.

Taking  $y_{1t}$  to denote the Brent price,  $y_{2t}$  to denote the ERC oil price and  $y_{3t}$  to denote the CPI rate, while assuming a Vector Autoregressive model of order one - VAR (1), the matrix form will be written as:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{pmatrix} + \begin{pmatrix} \phi_{11} & \phi_{12} & \phi_{13} \\ \phi_{21} & \phi_{22} & \phi_{23} \\ \phi_{31} & \phi_{32} & \phi_{33} \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \\ y_{3t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{pmatrix}$$

Or, equivalently, as the following system of three equations:

$$y_{1t} = \alpha_1 + \phi_{11}y_{1t-1} + \phi_{12}y_{2t-1} + \phi_{13}y_{3t-1} + \varepsilon_{1t} \dots \dots \dots (1)$$

$$y_{2t} = \alpha_2 + \phi_{21}y_{1t-1} + \phi_{22}y_{2t-1} + \phi_{23}y_{3t-1} + \varepsilon_{2t} \dots \dots \dots (2)$$

$$y_{3t} = \alpha_3 + \phi_{31}y_{1t-1} + \phi_{32}y_{2t-1} + \phi_{33}y_{3t-1} + \varepsilon_{3t} \dots \dots \dots (3)$$

### 3.7 Chapter summary

In summary, having identified the key variables to be studied as the Brent price, inflation rate and Diesel price, the study took on a regression approach using the VAR model. Regression results obtained would then be interpreted objectively so as to determine if a relationship does exist between the Brent oil price and Inflation in Kenya, and to what extent the global price affected the macroeconomic variable.

## Chapter 4: Data and Results

### 4.1 Introduction

Chapter four presents the data set used in this study and the empirical results based on the empirical model developed in Chapter three. Data conversion was done and time series properties of the data determined using Augmented Dickey Fuller (ADF) tests before estimation.

### 4.2 Data

This paper investigated monthly data from 2005: M12 to 2015: M5. Data for the monthly Brent oil price (in Kenyan shillings) was obtained from the World Bank. Monthly CPI rates were obtained from Kenya National Bureau of Statistics (KNBS) while the local diesel prices as set by ERC were obtained from Energy Regulatory Commission.

### 4.3 Empirical Results

The main objective was to investigate the impact of global oil price on inflation within Kenya. This was done by use of a Vector Autoregressive Model.

#### 4.3.1 Model 1

When time series data is non stationary and used for analysis it may give spurious results because estimates obtained from such data will possess non constant mean and variance. Because this study used time series data, it was important to establish the stationarity of the data or what order they are integrated to make sure that the results obtained are not spurious. In this regard, Augmented Dickey-Fuller (ADF) <sup>7</sup> test was used to test for unit roots.

##### 4.3.1.1 Unit Root Test Results

The variables within Model 1, on testing for stationarity, had no unit roots implying that there was no stationarity<sup>8</sup>. Results drawn from this procedure are shown in Table 2.

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<sup>7</sup>Augmented Dickey-Fuller (ADF) test, the Phillips-Peron (PP) test and the Dickey-Fuller-Generalized Least Squares (DF-GLS) test were proposed by Elliott, Rothenberg and Stock (1996) to investigate the time series properties of the variables adopted in their study.

<sup>8</sup> However, in the event that non-stationarity should arise, econometric tools such as differencing and detrending should be used so as to correct for non-stationarity.

**Table 2: Model 1 stationarity test at level results (Brent and Inflation are stationary)**

Variable	ADF	Critical Values at	Probability
Brent price	-6.347707	1%	-2.598416
		5%	-1.945525
		10%	-1.613760
Inflation	-5.852588	1%	-2.598416
		5%	-1.945525
		10%	-1.613760

*Note: In the ADF test, the null hypothesis is that the series has a unit root (non-stationary).*

The above test statistics in their absolute form, viewed against their respective critical values at each significance level, rejected the null hypothesis implying that the variables were stationary at level. Therefore, if all are stationary i.e. no unit root, no cointegration can exist.

#### 4.3.1.2 VAR Estimation Output Results

Having tested for stationarity, the next step involved running the VAR estimation on Model 1, and the regression output was as shown in Appendix 1. The optimal lag length as determined by the AIC<sup>9</sup> was 1 as shown in Table 3.

**Table 3: Model 1 Lag Selection Criteria (optimal lag length is 1 using the AIC)**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1.577387	NA	0.065149	<b>0.106788</b>	0.172599	0.13283
1	2.438892	7.672890*	0.059542*	<b>0.016749*</b>	0.115467*	0.055812*
2	2.546691	0.202727	0.061154	<b>0.043382</b>	0.175006	0.095466
3	3.159763	1.13464	0.061873	<b>0.054932</b>	0.219462	0.120037
4	4.14244	1.789353	0.061918	<b>0.05545</b>	0.252885	0.133575

<sup>9</sup>The decision rule is to choose the model with the lowest value of the information criteria. This ensures that the error term is not misspecified. The AIC results point to the use of 1 lag as the most appropriate lag length that would minimize the value of the selection criteria.

The results from the regression of model 1 can be summarized in the VAR equation below:

$$\text{Inflation}_t = 0.007 + 0.333\text{Inflation}_{t-1} + 0.058\text{Brent}_t$$

(0.116)                      (0.313)                      (0.028)

Where: () are the standard errors

Having tested for the significance of the coefficient of Inflation<sup>10</sup>, results from the equation yielded the conclusion that a 1 unit change in the current inflation rate lagged one period would lead to a positive change in the current inflation rate of 0.333. However, testing the critical value of the Brent variable for significance, at 5%, led to the rejection of null hypothesis that the Brent coefficient was significant. This therefore meant that any change in the Brent price would not have any substantial impact on the inflation rate.

### Impulse Response Functions

The impulse response to one standard deviation of the variable under study was captured on the graph indicated below.

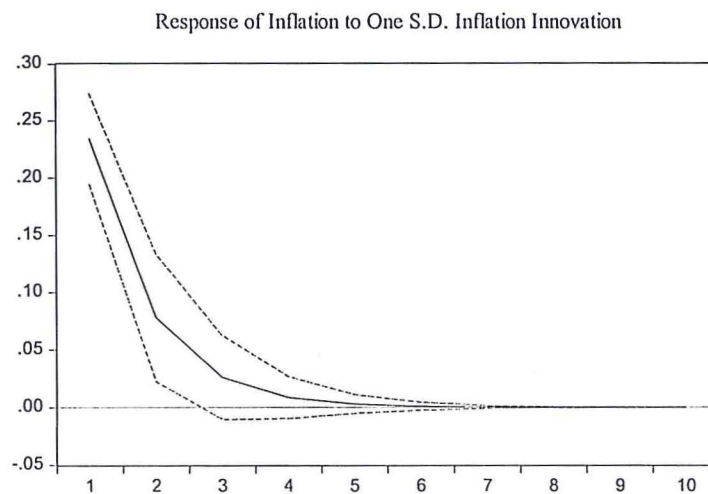


Figure 1: The impact of inflation to inflation

There is an immediate positive change to inflation due to a one standard deviation on inflation in Kenya. The impact starts dwindling from the first year to the sixth year, after which the shock of inflation to itself becomes zero.

<sup>10</sup>Tested against the 5% significance level, the inflation rate test statistic was greater than the critical value. Thus this implied that the variable's coefficient was indeed significant.

#### 4.3.2 Model 2

Variables within this model were the Brent oil price, Inflation rates as well as the local Diesel price.

##### 4.3.2.1 Unit Root Tests Results

Adopting the ADF test as used in model 1, the stationarity tests for model 2 are shown in Table 4.

**Table 4: Model 2 stationarity test at level results (Brent, Inflation and Diesel are stationary)**

Variable	ADF	Critical Values at	Probability
Brent price	-5.889299	1%	-2.611094
		5%	-1.947381
		10%	-1.612725
Inflation	-3.620749	1%	-2.611094
		5%	-1.947381
		10%	-1.612725
Diesel price	-4.537715	1%	-2.612033
		5%	-1.947520
		10%	-1.612650

The unit root tests results showed that the Brent price, Inflation rate and Diesel price were stationary at level.

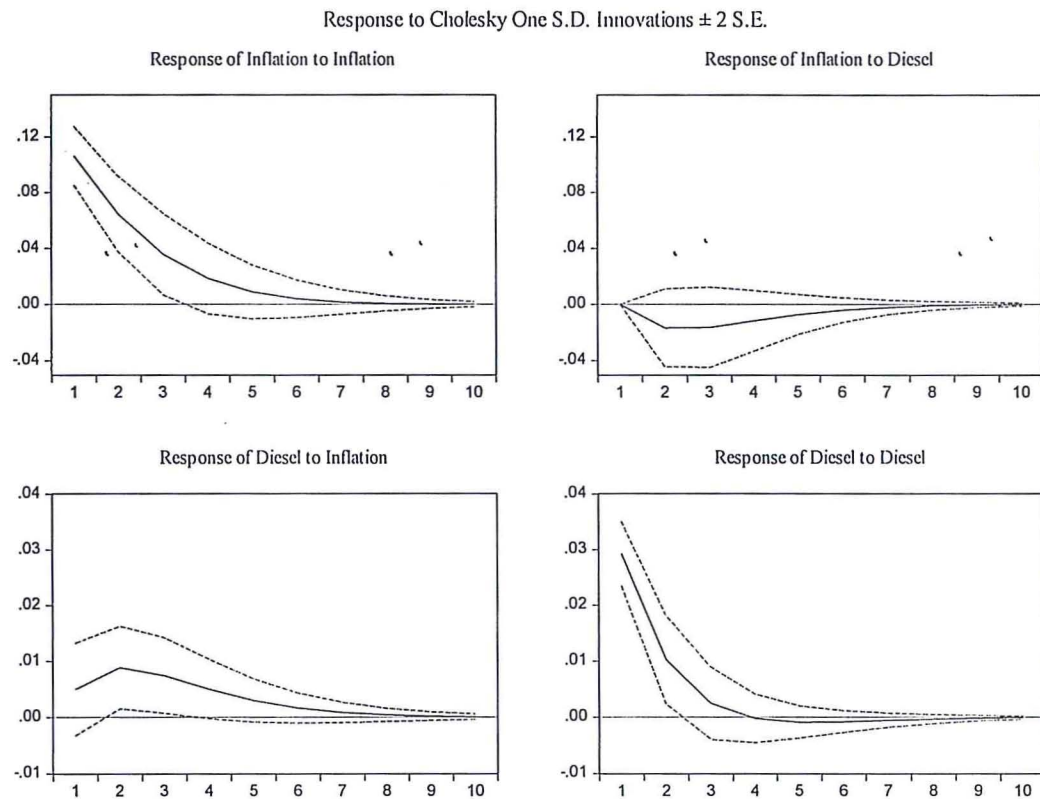
##### 4.3.2.2 VAR Estimation Output Results

Having tested for stationarity, the next step involved running the VAR estimation on Model 1, and the regression output was as shown in Appendix 1. The optimal lag length as determined by the AIC was 1 as shown in Table 5.



However, due to the insignificance of the Brent coefficient, any change in the Brent price would have no significant effect on the current diesel price.

### Impulse Response Functions.



**Figure 2: The impact of inflation and diesel on diesel and inflation respectively**

From the figure above, the study drew the following conclusions: 1) immediate positive shocks to inflation, shown by in the upper left graph, would lead to negative shocks to diesel which tend towards zero in the long run, as seen in the upper right graph; and 2) immediate positive shocks to the diesel price, as shown in the lower right graph, would result in positive shocks to inflation which dwindle from the first period to the fourth, after which they become negative and tend towards zero in the long run, as shown in the lower left graph.

### Variance Decomposition

While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

**Table 6: Variance Decomposition of both Inflation and Diesel**

Variance Decomposition of Inflation			
Period	S.E.	Inflation	Diesel
1	0.106441	100	0
2	0.1256	98.22754	1.772463
3	0.13163	96.82938	3.170616
4	0.133435	96.13317	3.866829
5	0.133926	95.86221	4.137792
6	0.134046	95.77434	4.225659
7	0.134072	95.74994	4.250064
8	0.134077	95.74409	4.255909
9	0.134078	95.7429	4.257097
10	0.134078	95.74271	4.257292

Variance Decomposition of Diesel			
Period	S.E.	Inflation	Diesel
1	0.029728	2.835258	97.16474
2	0.032672	9.762459	90.23754
3	0.033598	14.1363	85.8637
4	0.033969	15.99658	84.00342
5	0.034111	16.62817	83.37183
6	0.03416	16.80953	83.19047
7	0.034174	16.85417	83.14583
8	0.034178	16.86345	83.13655
9	0.034179	16.86498	83.13502
10	0.034179	16.86514	83.13486

Cholesky Ordering: Inflation Diesel

The above results show how both inflation and diesel are affected by their lagged variables as well as those of the other variable across each time period. Where shocks of both variables to themselves are experienced from the first period, any shock to inflation would affect diesel a period later. It can then be concluded that when there is a price “jump” the effects on inflation will be felt immediately, though only quantified for reporting periods later (usually 3 months).

### 4.3.3 Model 3

Variables within model 3 were Brent price and Inflation rate, which were obtained from the sample period of January 2010 to May 2015.

#### 4.3.3.1 Unit Root Tests Results

Adopting the ADF test as used in the previous models, the stationarity tests for model 3 are shown in Table 7.

**Table 7: Model 3 stationarity test at level results (Brent and Inflation are stationary)**

Variable	ADF	Critical Values at Probability		
Brent price	-5.889299	1%	-2.611094	0.0000
		5%	-1.947381	
		10%	-1.612725	
Inflation	-3.620749	1%	-2.611094	0.0000
		5%	-1.947381	
		10%	-1.612725	

#### 4.3.3.2 VAR Estimation Output Results

Having tested for stationarity, the next step involved running the VAR estimation on Model 3, and the regression output was as shown in Appendix 3. The optimal lag length as determined by the AIC was 1 as shown in Table 8.

**Table 8: Model 3 Lag Selection Criteria (optimal lag length is 1 using AIC)**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	34.35407	NA	0.015208	<b>-1.348086</b>	-1.27012	-1.318623
1	42.5252	15.32085*	0.011281*	<b>1.646883*</b>	1.529933*	1.602688*
2	42.81382	0.529151	0.011623	<b>-1.617243</b>	-1.461309	-1.558315
3	42.81543	0.002876	0.012122	<b>-1.575643</b>	-1.380726	-1.501984
4	42.94453	0.225924	0.012577	<b>-1.539355</b>	-1.305455	-1.450964

The VAR equation for Model 3 was:

$$\begin{aligned} Inflation_t = & 0.003 + 0.578Inflation_{t-1} + 0.376Brent_t \\ & (0.015) \quad (0.108) \qquad \qquad (0.191) \end{aligned}$$

Having initially tested for the statistical significance of the variable coefficient terms at the 5% significance level, the study concluded that both the inflation and Brent variables were significant (see Appendix 3). Thus the interpretation of the equation above yielded the following implications: (1) a 1 unit change in the inflation rate lagged one period would lead to a positive change in the current inflation rate of 0.578, and (2) a 1 unit change in the Brent price would lead to a positive change in inflation of 0.376.

#### 4.4 Summary

There are various drivers of inflation in Kenya, but of key interest was the global oil price. As highlighted in chapter two, a possible relationship may have existed between the oil price and the inflation within an economy, which could be estimated using a Vector Autoregressive model. Having established the key variables and a viable model, this study worked towards carrying out a regression analysis using the Eviews platform.

Evidence from the regression of Model 1 results showed that the change in Brent price had no impact on inflation in Kenya. The regression results of Model 2 also suggested that the change in the Brent price would have no significant impact on the inflation in Kenya, as well as the local diesel price. However, estimation output results of Model 3 showed that a change in the Brent price would have a positive effect on inflation in Kenya. This meant that as Brent prices increased, inflation in Kenya would also increase.

## **Chapter 5: Discussion, Conclusions and Recommendations**

### **5.1 Introduction**

This chapter provides an overview of the empirical work carried out in this study as documented within the summary. A detailed discussion is also included within the chapter, from which relevant conclusions are drawn and recommendations are made.

### **5.2 Summary**

The main objective of this study was to investigate the relationship between global oil prices, in particular the Brent price, and inflation in Kenya as Kenya is a net importer of oil. To achieve this objective, time series data for the period 2005 to 2015 was collected for the Brent, Inflation and Diesel variables. The sample period was split into two: Pre-ERC running from 2005 to 2010, and Post-ERC running from 2011 to 2015. This was done so as to build a comparison of the relationship between the Brent and inflation in both periods, and to see whether the ERC might have been effective in setting prices<sup>11</sup>. Unit root tests were conducted to test for stationarity of the data which was found to be stationary at level.

With stationary data, the study estimated a Vector Autoregression on the models introduced in Chapter 3 and concluded that any changes to the Brent price had no impact on Inflation within the first sample period. Similar to this, during the second sample period, with the inclusion of the diesel price, the Brent price also had no effect on inflation. However, within the same period, excluding the diesel variable, changes in the Brent price were found to have an effect on the inflation in Kenya.

### **5.3 Discussion**

Findings from the study show that during the period when ERC was not in existence, the changes in the Brent price had no impact on the inflation within Kenya. However, within the period following the establishment of the regulatory body, fluctuations in the global price were seen to impact inflation positively. A possible explanation to the contrasting results would be that, before ERC was established, companies that traded in the local oil market were free to set their own prices.

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<sup>11</sup>The ERC sets prices and aims at limiting the pass-through effect of shocks in the global oil market to the Kenyan economy.

This meant that their prices were independent of those determined within the global oil market. Therefore, any changes in the global oil prices would thus have no sizeable impact on local oil prices. On the contrary, following the establishment of the ERC, prices were no longer set by private companies but by the public entity. Since local oil prices set by the authority are derived from the international oil prices, any fluctuations in the global oil prices would therefore have an impact on oil prices and inflation within the country. These findings concur with other related studies such as Kiptui (2009), Kotut, Menjo, & Jepkwony (2012) and Orondoh (2014) as the papers looked at the possible link between international oil prices and inflation in Kenya using different models, and drew a similar conclusion that global oil price change does have an impact on inflation in Kenya.

#### **5.4 Conclusions**

Overall, the analysis shows that that there exists a relationship between global oil prices and inflation in Kenya as the results suggest that changes in the Brent price would have an impact on inflation in Kenya.

From the study, it is evident that within the period of ERC price controls, the fluctuations in the Brent price had a positive effect on inflation in Kenya, meaning that an increase in the Brent price would lead to a rise in inflation. This is justified by the fact that prices set by the ERC are derived from the international oil prices as Kenya is a net importer of oil.

#### **5.5 Recommendations**

Given the reason that international oil prices have a positive effect on inflation in Kenya as seen during the period of ERC price controls, there is therefore need for the regulatory body to look into more effective mechanisms of setting and regulating oil prices within the country. Better policies would ensure that the knock-on effect that global oil prices have on the Kenyan economy, as measured by inflation, would thus be minimal, if not absent.

## Appendices

### Appendix 1: Model 1 VAR Estimation Output using Eviews

Vector Autoregression Estimates	
Sample (adjusted): 2005M03 to 2010M12	
Included observations: 70 after adjustments	
Standard errors in ( ) & t-statistics in [ ]	
	Inflation
Inflation (-1)	0.333702 (0.11574) [ 2.88319]
Brent	0.057795 (0.31364) [ 0.18427]
C	0.006838 (0.02841) [ 0.24070]
R-squared	0.11038
Adjusted R-squared	0.083824
Sum of squared residuals	3.678217
Standard Error equation	0.234305
F-statistic	4.156539
Log likelihood	3.786653
Akaike AIC	-0.022476
Schwarz SC	0.073888
Mean dependent	0.009861
Standard Deviation dependent	0.244789

Appendix 2: Model 2 VAR Estimation Output using Eviews

Vector Autoregression Estimates		
Sample (adjusted): 2011M03 to 2015M05		
Included observations: 51 after adjustments		
Standard errors in ( ) & t-statistics in [ ]		
	Inflation	Diesel
Inflation (-1)	0.633235 (0.11694) [ 5.41525]	0.067175 (0.03266) [ 2.05685]
Diesel (-1)	-0.57063 (0.46958) [-1.21518]	0.348956 (0.13115) [ 2.66070]
Brent	0.354305 (0.19106) [ 1.85440]	0.074337 (0.05336) [ 1.39305]
C	0.000801 (0.01511) [ 0.05299]	-0.002274 (0.00422) [-0.53897]
R-squared	0.444269	0.308124
Adjusted R-squared	0.408797	0.263962
Sum of squared residuals	0.532491	0.041537
Standard Error equation	0.106441	0.029728
F-statistic	12.52443	6.977099
Log likelihood	43.96553	109.0155
Akaike AIC	-1.567276	-4.118256
Schwarz SC	-1.41576	-3.96674
Mean dependent	0.010092	-0.002254
Standard Deviation dependent	0.138433	0.034651
Determinant residual covariance (dof adj.)		9.73E-06
Determinant residual covariance		8.26E-06
Log likelihood		153.7145
Akaike information criterion		-5.714294
Schwarz criterion		-5.411262

Appendix 3: Model 3 VAR Estimation Output using Eviews

Vector Autoregression Estimates	
Sample (adjusted): 2011M03 to 2015M05	
Included observations: 51 after adjustments	
Standard errors in ( ) & t-statistics in [ ]	
	Inflation
Inflation (-1)	0.577817 (0.10821) [ 5.33982]
Brent	0.376233 (0.19115) [ 1.96826]
C	0.002863 (0.01509) [ 0.18975]
R-squared	0.426809
Adjusted R-squared	0.402926
Sum of squared residuals	0.549221
Standard Error equation	0.106968
F-statistic	17.87084
Log likelihood	43.17669
Akaike AIC	-1.575557
Schwarz SC	-1.46192
Mean dependent	0.010092
Standard Deviation dependent	0.138433

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