

IMPACT OF OIL PRICE ON REAL EXCHANGE RATE IN KENYA

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DECLARATION

This is my original work and to the best of my knowledge has not been presented for the award of a degree in any other university or institution.

ELIZABETH W. IRUNGU _____ **Date:** _____

This research paper has been presented for examination with my approval as the university supervisor.

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DEDICATION

I dedicate this work to my family members for their firm support and encouragement. I particularly want to thank my husband Nicholas for being a Great cheerleader. Your endurance during the long nights and days is admirable; thank you! I love you all!!

ACKNOWLEDGEMENT

My ultimate acknowledgement goes to the Almighty God for good health and wisdom He granted me when I was undertaking this research. Imela! Secondly, it's my pleasure to thank you Dr. John Gathiaka for your exemplary supervision, and constructive feedback that led to a robust research paper. You have indeed taught me to be patient and stay focused on the goal. Lastly, my appreciation goes to the University of Nairobi, School of Economics defense panelist for their professionalism and pleasant support that led to the successful completion of my research.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dickey-Fuller
BIS	Bank for International Settlements
CIA	Central Intelligence Agency
CBK	Central Bank of Kenya
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
IEA	International Energy Agency
IMF	International Monetary Fund
KNBS	Kenya National Bureau of Statistics
KIPPRA	Kenya Institute for Public Policy Research and Analysis
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
OPEC	Organization of Petroleum Exporting Countries
PPP	Purchasing Power Parity
UNWTO	United Nations World Tourism Organization
VECM	Vector Error Correction Model
WEC	World Energy Council

WTO

World Trade Organization

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ABSTRACT

This study investigated the impact of oil prices and interest rate on Kenyan's real effective exchange rate using monthly time series data between 1997 and 2016. This study employed time series econometrics techniques. Cointegration was used for long relationship test while OLS gave out the empirical results. The result from cointegration revealed that real interest rate, oil prices and real effective exchange rate had a long run relationship.

VECM estimates showed that both real oil prices and real interest rate were statistically significant in influencing the country's real exchange rate. Further, the study revealed that oil prices had a positive influence on real exchange rate implying that a rise in oil prices weakened the Kenyan shillings.

Finally, the study also found a positive relationship between real interest rate and real exchange rate confirming with theory which states that an increase in interest rates leads to an appreciation of the domestic currency. The study also pointed out appropriate policy measures that the government can adopt; in addition to recommending further research on the role of debt burden and foreign direct investment on real exchange rate.

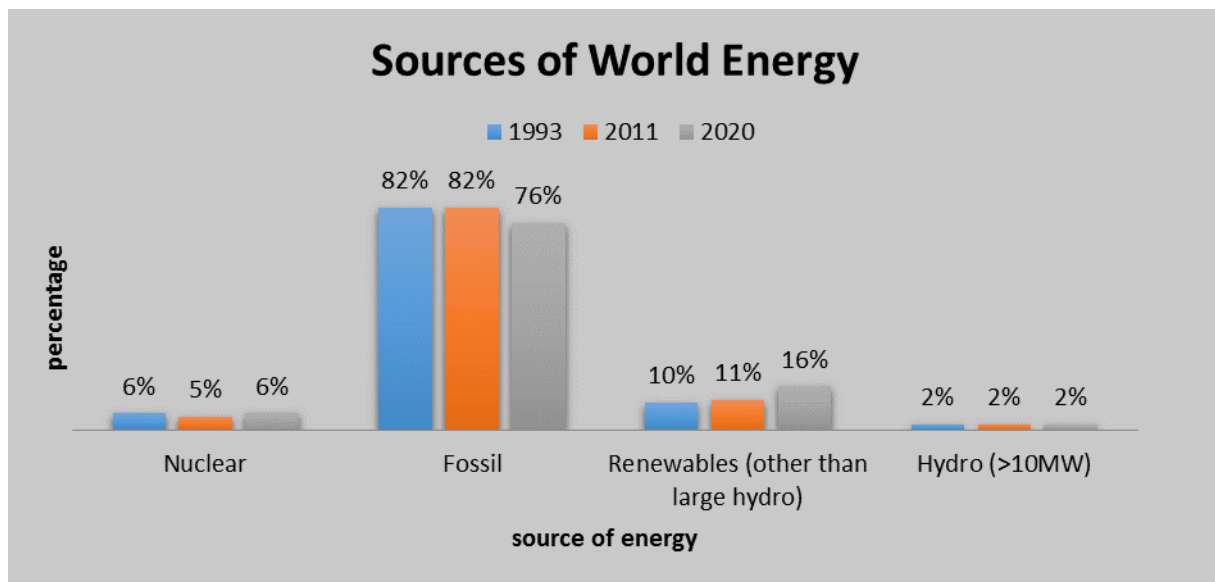
CHAPTER ONE: INTRODUCTION

1.1. Background

Oil has remained the bedrock of almost all industrial activity both in the developing and developed economies. The price of oil has a direct impact on households, governments and industrial firms.

Oil as a source of energy is versatile in applicability. As a source of energy, oil can be used for heating, thermal power, transport and road oil. According to World Energy Council (2013), fossil fuels accounted for 82% of all world energy in 2011. Fossil fuels usage is expected to decline marginally to levels of 76% in 2020 driven largely by introduction of new energy sources. Nevertheless, oil will remain a dominant source of energy.

Figure 1 Sources of World Energy



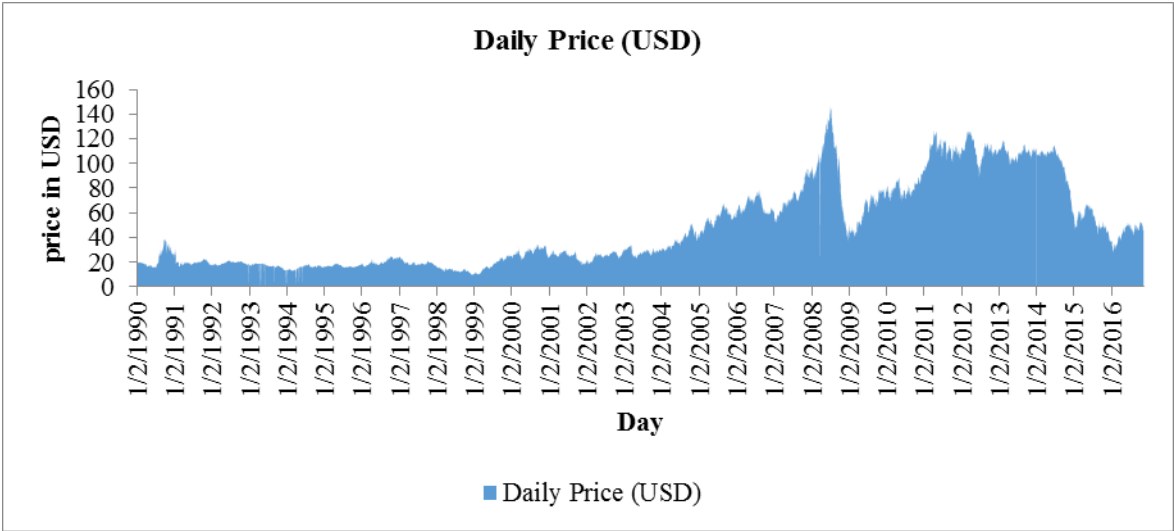
Source: World Energy Council, 2013

From Figure 1, fossil energy is still the world’s main source of energy and is expected to maintain this lead through to 2020. Nuclear and hydro energy are stagnant at 6% and 2% respectively. The alternative energy for the future is renewable energy whose growth was about 6% between 1990 and 2020 (WEC, 2013). According to World Energy Council, oil substitution is not yet imminent thus cementing the important role of oil globally.

1.1.1. History of oil crises and shocks

An oil crisis is a situation where oil prices rise significantly arising from production cuts thus making the commodity temporarily scarce and hence demand outstripping the supply. This may be due to a unilateral decision by the producers as was made by OPEC countries to withhold supplies in 1973, political crisis in oil producing countries, or a sudden increase in world oil demand. When demand for oil outstrips supply, price of oil soars and this may negatively impact world economies especially the oil importing countries. Oil prices have been volatile since 1999 as shown in figure 2

Figure 2 World price of oil per barrel in US dollars



Source: Bloomberg, 2016

Oil crises dates back to 1973 when Organization of Petroleum Exporting Countries (OPEC) placed an oil production embargo against the United States and other industrialized nations that

supported Israel in the Yom Kippur War. Consequently, oil prices rose from \$3 per barrel to nearly \$12 per barrel. OPEC is an inter-governmental organization which was created by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela in 1960 seeking to unify the largest oil producers with aim of influencing international oil supplies. The Iranian Revolution of 1978 – 79 and the subsequent war in Iraq caused the second oil shock when oil prices rose threefold (World Energy Council).

The third oil shock was witnessed in 1990. It was triggered by Iraqi's invasion of Kuwait. The 2000's experienced rapid increase in oil price over a relatively long period (>5yrs) culminating to oil price peak of USD 147 per barrel in mid-2008. Subsequent price correction brought the price down to USD 46 per barrel in the same year. After the global financial crisis of 2008 -2009 oil prices steadily rose to above USD 100 per barrel marking a strong recovery. The sustained high oil prices however lasted till mid-2014 when price corrections exerted a downward pressure. As at the end of 2015 oil prices had declined to levels below USD 40 per barrel, a price last seen during the global financial crisis (World Energy Council).

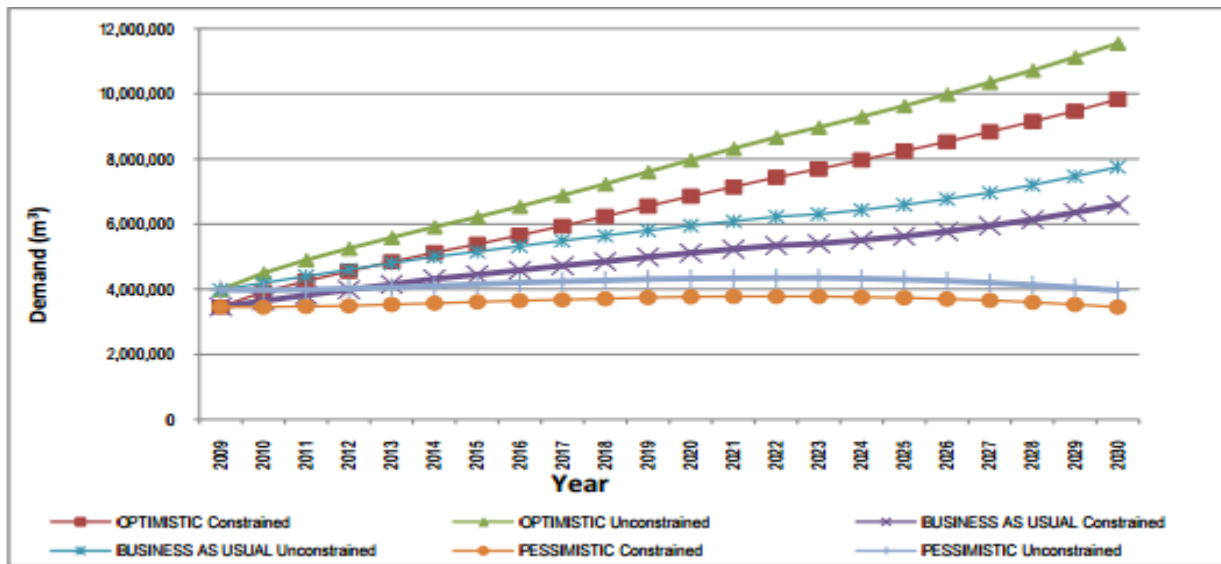
The decline has been attributed to the slowdown in China's economic growth but more importantly, world GDP growth rate has been slowing down. The sustained low oil prices have destabilized many oil exporting economies even though favoring oil importing countries.

1.1.2. Consumption of petroleum in Kenya

Kenya's consumption of petroleum has been steadily increasing as shown in Figure 3 and is expected to rise even higher in the next ten years. Petroleum products demand is expected to rise annually by 3.1% till 2030 (KIPPRA, 2010). Motor gasoline and diesel are the largest components of oil consumption in Kenya, followed closely by aviation fuel (International

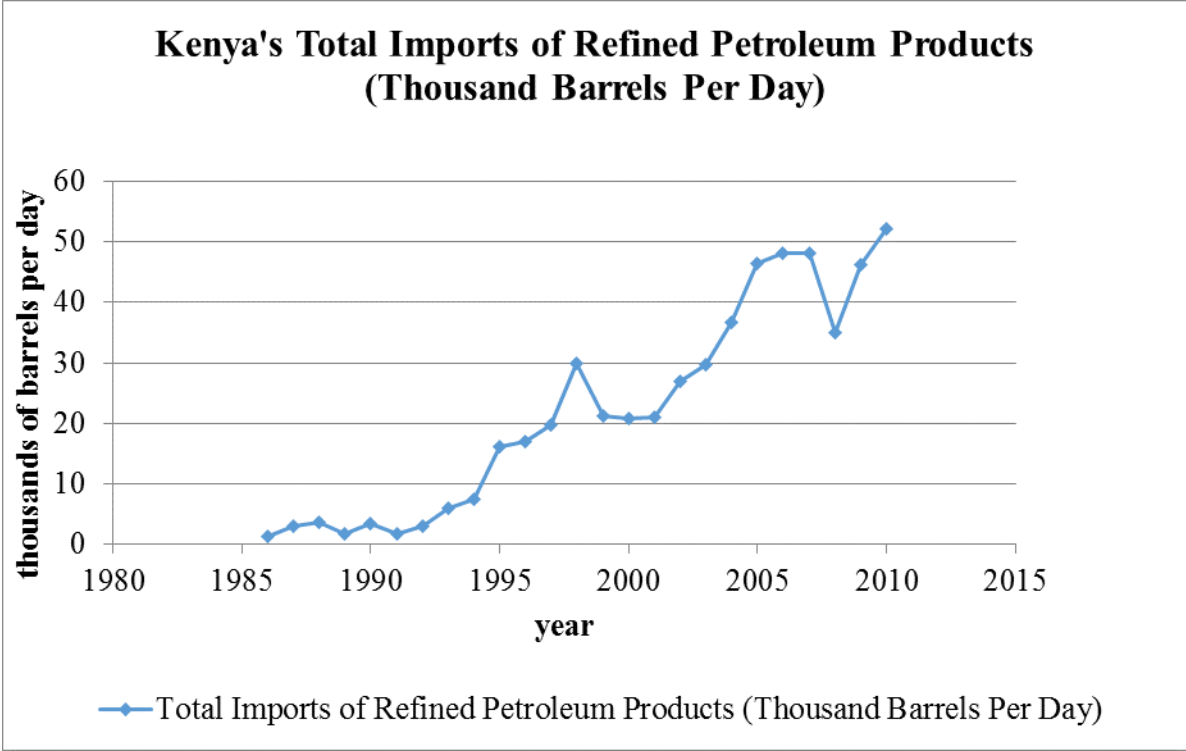
Energy Agency 2014). As a percent of total consumption diesel and gasoline accounted for 40% of total oil consumption (IEA, 2014) This scenario therefore portends oil as a primary input in the transport sector and directly feeds into the overall CPI in the economy. Further, Kenya has identified Energy sector as one of the growth sectors in achieving the Vision 2030. According to the Energy Act (2007), the country has identified challenges bedeviling the sector among them lack of strategic oil reserves; increasing dependence on imported oil as well as price volatility & unreliability. This research seeks to explore deeper the impact of international oil prices on Kenya's currency which may further deepen the country's woes. Through this research we will seek to offer empirical evidence of the impact and propose policy measures to address the challenge.

Figure 3 National Demand Forecast for petroleum products



Source: KIPPRA, 2010

Figure 4 Kenya’s petroleum imports, 1980-2015



Source: World Bank Data, 2013

Kenya’s total import bill is estimated to have increased by compounded annual growth rate (CAGR) of 11% between 1992 and 2013 (KNBS, Economic Survey, various). This growth rate is faster than the average GDP growth rate during the same period of less than 5%. According to the national accounts data of the World Bank and OECD, Kenya’s total imports as a percent of GDP stood at 29% in 2015 comparing favorably with the East African counterparts and 6% less than the Sub-Saharan Africa average. (World Bank Statistics, 2015)

Kenya is a small open economy thus making it highly susceptible to currency fluctuation. The country has consistently operated a trade deficit due to the small under-developed export market weighed by large imports to support increasing consumption by both households and firms. For more than two decades Kenya has consistently run on a current account deficit (IMF Statistics, 2014), which has been burgeoning reaching a historical high of USD 6.3 billion in 2015. These statistics point to the very importance of furtherance of research in key causes of exchange rate volatility

The evolution of oil prices in the international market is an important aspect for the economy considering the significance of oil in the economy and specifically in the balance of trade equation. Kenya does not produce oil and hence relies solely on imports to support her economic activities that require oil as an input. Among the major uses of the oil is transport (road, rail & air), electricity generation whereby Kenya supplements hydro and geo-thermal power with thermal power from diesel plant to ensure steady supply of electricity to the economy. Because of global warming, causing drought, hydro power has been unreliable causing government to install more capacity for emergency thermal power. Many bulk power users have also installed diesel generators as supplement source of power because of unsteady power from the national distributor. These factors contribute significantly to the production curve and therefore trickling to the consumer prices. This is the reason why this paper seeks to unravel the impact of international crude oil prices on Kenya's exchange rate.

From 2014, oil prices have been coming off largely on account of China's economy ceasing to grow at double digit levels single digits. Another exacerbating factor is the increase production of Shale oil especially by USA thus reducing global oil demand from US. These developments are new and may have long lasting effects to the International Oil markets

Figure 5 Historical Brent Crude Oil Prices (USD)



Source: World Bank Data, 2013

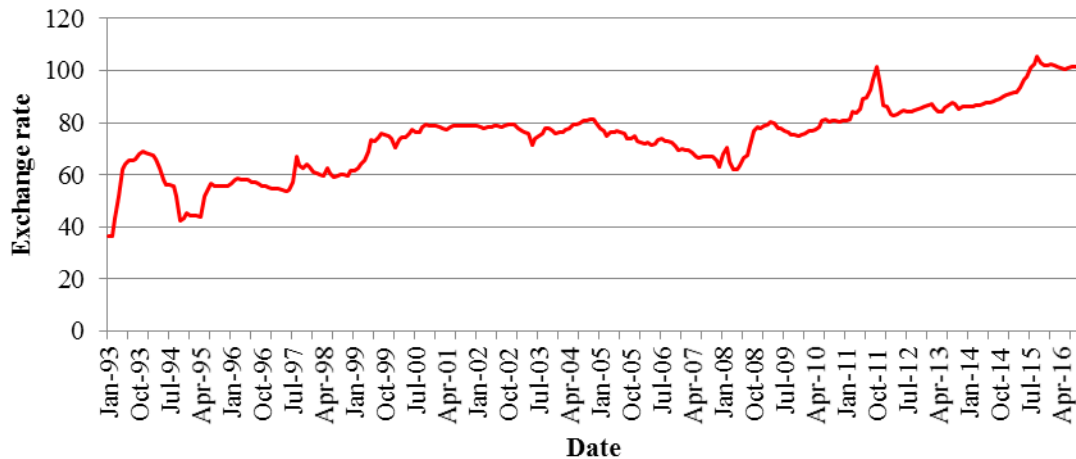
1.1.3. Oil price shocks versus real exchange rates

Kenya has gone through several transformations in the exchange rate regimes having adopted a fixed exchange rate regime between 1960 and 1970's; exchange rate controls in the 1980's and finally market determined exchange rates from 1990s. The shift in exchange rate regimes was primarily driven by economic events such as balance of payment crises as well as shifts in the structural characteristics of the economy (Ndungu, 2000). This research used data from 1997 to 2016 primarily on the strength that the exchange rate was market driven and hence transparent.

Oils shocks have a pronounced impact on the average domestic prices of oil importing countries and more so on oil dependent country on the production process. Holding other factors constant, a shortage of oil causes the supply curve to shift leftwards thus automatically leading to a general rise in its prices. As a consequence, price levels of domestically produced goods and services will effectively increase as cost of production increases. The transmission mechanism to the production curve is primarily through the exchange rate. Volatile exchange rates cause production uncertainties and buildup of costs of production.

Currency depreciation, leads to rising cost of imports which if not countered by increased export amounts will ultimately lead to larger trade deficit for the country. This phenomenon would strain a country's balance of trade and stability filtering further to the country's consumer price index (CPI). In this paper we want to determine how oil price volatility impacts Kenya's exchange rate due to the importance of oil as a component of total imports and a raw material in basically all the industrial production process. Without proper policy framework Kenya will continue to reel under the world's cyclical and volatile prices of world major energy source of which no close substitutes are foreseeable (WEC, 2016).

Figure 6. Monthly Exchange Rate Movement (1993 -2016)



Source: Central Bank of Kenya

1.2. Statement of Research Problem

Research has shown that oil price affects countries differently because of its multi-faceted nature and transmission mechanisms. According to Hamilton (2008) all US economic recessions have been preceded by oil price shocks but the same does not explain inflation for US. Doğan et al (2012) researched on the interactions of real oil prices and real exchange rates for Turkey in the period 2001 – 2011 concluded that oil price shocks had negatively impacted Turkey’s real exchange rate. A price decline positively impacts on an oil-importing country through reduced import bills, lower costs of production and increased real income to households through lower cost of goods as measured by Consumer Price Index (CPI). On the other hand, for the oil exporting country, a similar price movement would decrease the revenues of the country translating to current account deficit thus hindering economic growth due to high fiscal deficit.

In 2013, Kenya was globally ranked at position 74 in crude oil imports and position 58 in refined petroleum products imports according to The World Fact book produced by Central Intelligence

Agency (CIA). Her positioning indicates the increasing energy use in the country and its importance to the country. The World Fact book (2015) also shows that Kenya has nil national strategic oil reserves, thus making it susceptible to future oil price increases.

Kenya has however, recently discovered commercially viable oil in Turkana County and she is currently going through the pre-mining phase involving infrastructure development and policy development. The oil find is a welcome development for Kenya as it will mitigate the heavy crude oil imports that have continued to strain the balance of trade. According to Tullow Oil Plc (www.tulloil.com) current estimate of oil deposits is up to 750 million barrels with further exploration potential estimated at 1 billion barrels. This discovery and subsequent commercialization of the oil will greatly reduce the over-reliance on imported oil. Assuming that imports will not rise in tandem with increased exports from oil, we foresee the current account balance shifting in favor of the country. This new development will help support the economy especially via the exchange rate whereby trade has been skewed to our import partners.

A review of Kenya's current account shows that Kenya has predominantly operated a trade deficit for more than two decades (IMF Data, 2014). The deficit has increased more than 48 times between 2004 and 2014 (IMF Data, 2014). The country has been over reliant on imported products and oil is one of the major imports. A disaggregation of the sector imports shows that oil imports peaked to 25% of all imports in 2011 but has declined to 18% levels in 2014 (KNBS, Economic Surveys, 2008 - 2016) primarily due to low global oil prices. On the other hand, consumption of oil has been on the rise, recording a 35% rise over the past eleven years (KNBS, Various).

Kenya unpegged her currency in the 1990's adopting a floating exchange rate that is determined by market forces. Since independence the Kenya shilling has continued to lose against the US dollar. This is on account of large imports that have exponentially grown well ahead of the exports. World Bank data shows that in 1990 the average exchange rate was KES/USD 22.90 compared to KES/USD 103 in 2017 marking a depreciation of almost 450% in 27 years. The volatility experienced in this review period can be explained by many factors but one outstanding factor is the growth in current account deficit and to which, we believe, has largely been fueled by rising oil imports which at one point accounted for a quarter of all imports.

Due to the prime position taken by oil in the balance of trade, we sought to find out if oil price volatilities have a connection to the exchange rate volatility observed in the forex market. International oil prices have experienced volatilities since the first oil crisis in 1973. This research investigates if oil price volatility drives the real exchange rate in Kenya.

1.3. Study questions

- i. What is the effect of world oil price fluctuations on Kenya's real exchange rate?
- ii. What is the elasticity of real exchange rate to changes in oil prices in Kenya?
- iii. What policy recommendations can be derived from this study?

1.4. Study Objectives

The primary objective of this study was to unravel the impact of oil price movements on Kenya's real exchange rate.

The specific objectives.

The specific objectives of the research include:

- i. To estimate the effect of world oil price fluctuations on Kenya's real exchange rate.
- ii. To estimate the elasticity of KES/USD to changes in global oil prices in Kenya.
- iii. To draw policy commendations that would provide early warning signals on Kenya's exchange rates when oil prices start to fluctuate

1.5. Significance of the study

This research paper goes a long way in empirically, providing evidence of how oil price volatility impacts our country's currency and will further provide policy recommendations to mitigate for the same. The research will be useful to firms, governments and other small oil importing open-economies like Kenya.

The findings will also be useful to firms through which they can reliably plan for their businesses e.g. the airline industry tends to hurt the most when both oil and currency shocks hit the country. With this research they can reliably project macroeconomic outlook and put measures in place to cushion the businesses. The research findings are also useful to the government, noting that the Energy Act (2007) foresees establishment of oil strategic reserves for the country. This analysis may be used by economic agents in planning for their businesses as they can use futures prices of oil to reliably predict the direction of exchange rates in the country. This will be a departure from what businesses use as future indicators of currency evolution.

1.6 Organization of the Study

The research report is organized into four sections: Chapter 2 delves into literature review, mainly looking at past studies that have been carried out both as theoretical literature and empirical studies. Chapter 3 describes the methodology used to carry out the analysis and test for the study objectives. Chapter 4, covers the data analysis and discussion of test results obtained after modelling. Chapter 5 shows the summary of the findings and conclusions drawn from the same.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section provides a n assessment of literary work: theoretical and empirical intended to give informative and descriptive origin, trends and patterns and other factors propagating oil price shocks and its effects on real exchange rate.

2.2 Theoretical Literature

This section explores possible linkages of oil prices movements and exchange rates of oil importing countries. Interestingly most of the research has focused on developed countries and very little on small less developed and developing countries.

The first recorded international oil price shock was in 1973. Since then a lot of research has been conducted examining the oil price – macro economy relationship. A lot of this research has however been largely focused on the developed nations. Among the researchers include James Hamilton (2008), Bernanke who has intensively covered the American economy and G7 countries in his research and modest literature can be found on least developed countries and developing countries.

Rafiq et al (2008) in their research on Thailand concludes that oil price volatility has substantial bearing on macroeconomic variables, such as unemployment and investment but proposes that a floating exchange rate may transmit the impact through the budget deficit, an area that he did not delve into. Guyen (2015) concludes in his research investigating impact of oil prices on currencies of major world oil exporters, Canada, Mexico and Norway that indeed there exists

long and short run relationship between oil prices and exchange rate of selected oil exporting countries with the notable exception of Mexico. Zhou et al (1998) indicates that oil price shocks affect fiscal policy, productivity and exchange rates.

Shiu-Sheng (2008) concludes that oil prices may be the most important source of real exchange rate movements after researching on the oil prices exchange rates for G7 countries. Abbas and Leili (2009) investigating the impact of real oil prices and real exchange rates on seven OPEC countries concluded that there was significant impact on these countries exchange rates. Kenya being a net oil importer we can postulate that the impact of oil price volatilities has significant influence on the exchange rate transmitted as a reverse for the export countries. This research paper seeks to empirically prove this hypothesis.

According to Bank for International Settlements (BIS), Real effective exchange rate can be defined as weighted average of bilateral real exchange rates with trading partners of a country (BIS, 2012). When real effective exchange rate index decreases, this is referred to as appreciation while a rise in real exchange rate is called depreciation of the domestic currency.

There are different arguments why oil prices can affect macro-economic variables. As one of the primary raw materials used in the production of many goods, a change in prices will cause cost of production to rise (shift in production curve) which will then cause prices of goods to rise. A sustained increase in general prices will lead to inflation. It can also be argued that volatility in the prices of oil cause firms to postpone irreversible investments (Ferderer, 1996) which then affects the country's total output. To further cement the investment argument, is that higher oil prices will lead to reduced aggregate supply, inherently causing labor demand to decline and ultimately leading to reduced expected output. As for the households, high oil prices deplete their

disposable incomes for instance for a country like Kenya whose large populations use public means as a way of transport, oil prices have a direct impact on their consumption basket. As oil prices rise, the cost of transport will be adjusted upwards thus reducing the disposable income of the peasant Kenyan.

Several exchange rate theories have been advanced to explain the determination of currency exchange rates. Among the theories is balance of payments theory which has evolved over time as analyzed by Krueger (1983) in her book, *Exchange Rate Determination*. According to balance of payment theory there exists an exchange rate at which an economy experiences both internal and external equilibrium. According to this theory, the exchange rate will adjust according to the balance of these two factors. For a small open oil-importing economy like Kenya, if there was an oil price shock, and no equivalent export shift, this would distort the external equilibrium, accordingly, the local currency would be expected to depreciate to the foreign currency in order to achieve new equilibrium.

Lizardo and Mollick (2010) added oil prices to the monetary model of exchange rate determination and found that oil prices are a key determinant of movements in the value of the U.S. dollar (USD) against major currencies from the 1970s to 2008. In particular, currencies of oil importers were observed to depreciate against the USD when oil prices rose.

One channel that oil prices are transmitted to the macro economy include: Wealth Transfer from oil importers to Oil exporters. According to Wealth Transfer proponent (Aziz, 2009), when oil prices rise, there is an immediate re-allocation of wealth from the oil importers to the oil exporters through the balance of trade equation as well as portfolio flows. Aziz sought to estimate the long run effects of real oil prices and real interest rate differential on real exchange

rate for eight countries. The study concluded that there is a positive correlation between real oil prices on real exchange rates of oil importers but for exporters the results were not supportive. In the case of Kenya, a net oil importer, we postulate that this channel is significant for the economy drawing from the large composition of oil imports in the trade account. Furthermore, Kenya's current account deficit has increased 30-fold since 1975, significantly outstripping the exports earnings (IMF Data, 2016).

Following the above argument, is the proposition that the elasticity of imports will also influence the impact of oil prices on the domestic exchange rate? Price elasticity of demand measures the relationship between changes in quantity demanded given a certain percent change in the price of a commodity. The price elasticity can be defined as uni-elastic, elastic or inelastic. For a country with inelastic oil-import demand, the rise in prices would have little impact on the amounts consumed thus causing the currency to depreciate. The mechanism would be such that for the same amount of oil demanded, at the new higher prices, the amount of domestic currency required to buy the quantity is more thus causing her currency to depreciate.

Amano and Norden (1998) studied the relationship between oil prices and exchange rates for Germany, Japan and United States, using a model that assumed oil as one of the determinants of the terms of trade. Using a simple model assuming two commodities, one tradable and the other non-tradable, they assume two factors of production in both sectors, a tradable input in this case oil and a non-trade input assumed to be labour. In both sectors Constant returns to scale are assumed and there is input mobility across the sectors. The tradable sector's price is set in the international market. Thus the real exchange rate would equal to the output price in the non-tradable sector. This analysis seeks to identify a real factor (oil price) that would explain real exchange rate fluctuation. What this model portends is that an increase in the price of inputs

would result into price rises in both industries as costs rise. The costs will however, rise more in the industry that has higher intensity of the input whose price has risen more than the other. What would tilt the cost imbalance between the sectors is the relative price of the non-tradable and tradable good and this is achieved through a change in real exchange rate (Amano and Norden, 1998).

2.3 Empirical Literature

Hamilton is one of the pioneer researchers in the area of oil prices and the impact the same may have on macro-economic activities. In his earliest research, (Hamilton, 1983) he examined the behavior of oil prices and the US GDP and concluded that post World War II, all US recessions were heralded by a dramatic surge in the price of crude oil. His research triggered more research work in this field and whereas a lot of researchers have investigated various dynamics of the oil-macro-economic relationship for the developed markets, scanty research has been covered especially on the African context.

Rafiq et al (2008) researched on the effect of oil prices on major macro-economic variables of Thailand using VAR system and Granger Causality tests and found significant impact on variables such as unemployment and investment for the period 1993 – 2006. Their research however did not consider the influence of oil price on the local currency exchange rate. However, their investigation for the period after Asian Financial Crisis (1997-1998) did show that oil price volatility had an effect on the budget deficit. They argue that this may have been caused by the change of exchange rate regime to floating exchange rate. This argument therefore infers that for the Kenyan scenario if indeed the transmission does go via budget deficit, then our hypothesis of a positive causality of oil prices to Kenya shilling may be validated.

Kin and Courage (2014) used the GARCH model to review the role of oil prices on the nominal exchange rate in South Africa. South Africa is a net oil importer and an oil price taker in the international market and has a floating exchange rate system. Their model specification was modified from Aziz (2009), defining the nominal exchange rate as a function of oil prices and interest rates. The findings showed that oil prices have a dominant influence on the Rand/USD exchange rate. This research will borrow heavily from this study but instead of using nominal exchange rates our research will use real effective exchange rates as the dependent variable. We believe real effective exchange rate is a better index to use as it encompasses the purchasing power parity (PPP) theory. The PPP theory assumes the 'law of one price' across markets. According to the law of one price similar goods should have similar price and any price differentials are adjusted via exchange rate. The PPP theory is attributed to the seminal work of Frenkel (1978).

Chen and Chen (2007) argue that oil prices may be responsible for the real exchange rate movements for a panel study of G7 countries where they found positive link between the two variables. Aziz (2009) using a simple model developed by Meese and Rogoff (1988) to investigate links between the price of oil and real exchange rate for five oil importing and three oil exporting countries found strong positive linkages for the oil importers but relatively weak for the exporting countries. They utilized three tests in their analysis; Mean Group (MG), Dynamic Fixed Effect (DFE) and Pooled Mean Group (PMG) tests. The results from the three tests were diverse and therefore they centered on the PMG results. The PMG results provided confirmation in support of positive effects of real oil price on real exchange rate. The countries investigated included: Japan, Pakistan, South Africa, Cote d'Ivoire, Switzerland, Canada, Denmark and Malaysia.

Turhan et al (2012) researched on the dynamic link between oil prices and exchange rates of 13 emerging economies all constituent members of Emerging Markets Bond Index (EMBI+). His hypothesis was based income theory using petro-dollar flows between oil exporters and the rest of the world. He postulated that high oil prices would benefit emerging markets more as flows of petro-dollars to these economies were expected to be higher. Using VAR and Generalized impulse response, his research concluded that a spike in oil price leads to strengthening of currencies in developing economies against the US Dollar. He noted that this significance was even more, post the 2008 financial crisis.

Abed et al (2016) investigated exchange rate movements of oil price fluctuations on MENA region, a region with both oil importers and exporters. Their investigation employed the GJR-GARCH model to draw inferences using daily prices for the period 2001 – 2015. The results show that there is a significant relationship between oil price shocks and exchange rates. In the same study, exchange rates of oil exporter were observed to strengthen when oil prices rose while for oil importers the exchange rates appreciated when oil prices declined. This led them to conclude that oil price is an important variable to consider when modelling for exchange rate movement and volatilities.

Akram (2002) used several models in trying to probe the oil price-exchange rate relationship for the Norwegian economy. His model with non-linear oil price effects showed the strongest explanatory abilities during sharp currency devaluations compared to a random walk model and a linear model. He used data for the period 1998 – 2000

Huang and Sissoko (2014), analysed US imported crude oil prices and exchange rates to determine the causality relationship between the two variables. The study established that

exchange rates Granger-caused crude oil price in the short run while crude oil prices Granger-caused exchange rates in the long run. They used monthly data for the period January 1996 to December 2009. They employed panel co-integration and variance decomposition models to arrive at their conclusion.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter expounds on the methodology of the study. This includes the research design and conceptual framework, detailing the relationship between the dependent variable and the independent variables. The chapter further presents the study model, how it will be estimated and how it can be used to project the impact of oil price on the real exchange rate in Kenya.

3.2 Research Design

The study used a time series research design. The aim was to investigate the impact of oil price volatility on real exchange rate of Kenya between 1997 and 2016. The study used monthly data to determine direction and strength of the relationship.

3.3 Model Description

This section presents both the theoretical and empirical models. The theoretical model is a collection of concepts and their hypothetical interrelationships. The theoretical model based on theories presented in literature review. The empirical model on the other hand is the econometric model that emerges from the theory.

3.4 Theoretical Model

In a model of tradable- non tradable goods and services, Dornbusch (1973) separated tradable goods and services into importable and exportable goods and services. In so doing, the model

gave an equilibrium condition for the domestic market's exchange rate under a static expectation. This model starts by assuming free capital flows and thus gave the nominal domestic absorption (NDA) is:

$$NDA = f(P+G) \dots\dots\dots 1$$

Where:

P is private expenditure

G is Government expenditure

Public expenditure is a fixed ratio of the gross domestic product (Y) expressed as

$$G = G/Y \dots\dots\dots 2$$

On non-tradable goods side public expenditure is a fixed ratio of government expenditure

$$Govt_{exp \dots NT} = G^N/G \dots\dots\dots 3$$

Further, the the ratio of non-tradable private expenditure to tradable private expenditure is a function of the export prices, import prices as well as non-tradable prices and thus is endogenously determined.

Assume that the price of importable is given as P_m and that of exportable is P_x and that T_x and T_m the net export and net import tax respectively, then the nominal exchange rate (E) according to Dornbusch (1973)'s model is given by

$$P_d = E (1 - T_x) P_x \dots\dots\dots 4$$

Where P_d is the domestic price

$$E = P_d / P_x (1 - T_x) \dots\dots\dots 5$$

Thus the real exchange rate e is given as:

$$e = P_N / E \cdot P_x^\alpha \cdot P_x^{(1-\alpha)} \dots\dots\dots 6$$

Where P_N is the price of non-tradable and that $0 < \alpha < 1$

In summary, Dornbusch (1973) model concludes that real exchange rate is a function of

$$\text{Real exchange rate (e)} = \left(\frac{A}{Y}, \frac{Xp^*}{Mp^*}, Tm, Tx, \frac{\text{Govt exp on Tradable}}{\text{Total Govt exp}}, \frac{\text{Govt Exp}}{Y} \right) \dots\dots\dots 7$$

A is the absorption rate

Y is national income

3.3.2 Empirical model

The study estimated the relationship between Kenya's real exchange rate, oil prices and real interest rate using Error correction models. Vector Error Correction models are known for a number of advantages. To begin with, they are convenient for computing the adjustment from disequilibrium of the prior period to the present. Secondly, in cases of cointegration, trend is eliminated from the variable since VECM models are expressed in terms of first difference, this solves the problem of producing spurious results. Finally, VECM originates from disequilibrium error term is a stationary variable, which implies that, for cointegrated variables, there is some automatic adjustment which prevents the errors in the long-run relationship becoming larger and larger.

The specified error correction equations to be estimated are stated as follows:

$$\Delta RER_t = \sum_{k=1}^r \gamma_k \mu_{k,t-1} + \sum_n^p \alpha_{1,n} \Delta ROIL_{t-1} + \sum_n^p \alpha_{2,n} \Delta RIR_{t-1} + \varepsilon_{1,t} \dots \dots \dots 9$$

$$\Delta ROIL_t = \sum_{k=1}^r \gamma_k \mu_{k,t-1} + \sum_n^p \alpha_{1,n} \Delta RER_{t-1} + \sum_n^p \alpha_{2,n} \Delta RIR_{t-1} + \varepsilon_{1,t} \dots \dots \dots 10$$

$$\Delta RIR_t = \sum_{k=1}^r \gamma_k \mu_{k,t-1} + \sum_n^p \alpha_{1,n} \Delta ROIL_{t-1} + \sum_n^p \alpha_{2,n} \Delta RER_{t-1} + \varepsilon_{1,t} \dots \dots \dots 11$$

Where, $\mu_{k,t-1}$ represents residuals from the cointegration equations and γ_k are the adjustment coefficients while r and p are the respective optimal lag lengths and $\varepsilon_{1,t}$ represents the errors assumed to be white noise. Δ is the change (difference) operator.

3.4 Estimation technique

The study estimated the effect of exogenous variables on endogenous variable using the ordinary least squares (OLS) method. The OLS was considered robust in this study as it uses observable sample whose regression equation can be estimated (Hayakwawa et al., 2008)

3.5 Statistical tests

3.5.2 Unit root test

The data to used is time series in nature. Since many macroeconomic variables suffers from non-stationarity (Nelson and Plosser, 1982) it is vital to test for unit root. This is because running a regression on non-stationary time-series data may lead to spurious results. We applied Augmented Dickey-Fuller test to test for unit root.

3.5.3 Cointegration test

In economics when two or more variables have a long run relationship or equilibrium, we conclude that those variables are cointegrated. If we determine that economic variables in this study have a unit root, then the study will proceed to test for cointegration. To test for cointegration, the study applied Engel-Granger (1987) test. According to Engel-Granger (1987), if the residuals are stationary($I(0)$), then it means that the variables are co-integrated or have long-run equilibrium.

3.5.4 Diagnostic tests

This study utilized Shapiro-Wilk test to test for normality of the error term. This involved computation of the, W, V, Z and P-value. We used the p-value to make an inference of normality. If our calculated p-value exceeded the level of significance, then the variable would be statistically significant or normal in our case otherwise the variable is not normal. The credibility of the OLS parameters will be confirmed by testing for the degree of multicollinearity and heteroscedasticity.

CHAPTER FOUR: PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the empirical analysis and interpretations of results. The chapter begins by presenting the standard explanatory statistics of all the variables in the model estimated in this study. This is followed by pretest for time series properties of the variables and finally the regression results and post estimation test results are presented.

4.2 Descriptive statistics

The descriptive statistics show the statistical characteristics of the data used in this paper. These include mean, Standard deviation, minimum and maximum values of variables used in this study as indicated in table 1.

Table 1 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
reer	240	95.28271	28.94979	54.81	155.86
oilp	240	57.66033	34.52437	9.8	133.87
rir	239	9.918478	5.786557	.8296	27.14725

The real exchange rate (reer) had a mean of 95.28 and a standard deviation of 28.95%. The standard deviation is a measure of how the values of reer differ from the mean. The price of oil had a mean of 57.66 and a standard deviation of 34.52%. The mean Treasury Bill rate was 9.92% with a standard deviation of 5.78%.

4.3 Normality Test

Shapiro-Wilk test was employed in this study to determine the distribution of the data relative to normal distribution. According to this test, a variable is said to be normal if the mean, median and mode are equal. This test gives four options which are W, V, Z and P-value. In making decision the p-value is used to make inference as far as normality is concerned. If calculated p-value exceeds the level of significance then the indication is that the variable is normal otherwise the variable will be non-normal.

Table 2 Normality Test-Shapiro-Wilk

Shapiro-Wilk W test for normal data					
Variable	Obs	W	V	z	Prob>z
reer	240	0.89589	18.216	6.739	0.00000
oilp	240	0.91692	14.536	6.215	0.00000
rir	239	0.86833	22.955	7.274	0.00000

From the table 2 above, all the variables had p-value less than the levels of significance of 5%v and 10%. Therefore, from this, it can be concluded that reer, oilp and rir did not follow normal distribution both 5% and 10% level of significance.

4.4 Multicollinearity test

Variance inflation Factor (VIF) and its tolerance defined as $1/VIF$ were used in this study to test for multicollinearity. In the interpretation requirement in this test is that the VIF values less than 10 indicate the absence of multicollinearity while values greater than 10 indicate the presence of multicollinearity

Table 3. Multicollinearity Test-VIF

Variable	VIF	1/VIF
oilp	1.13	0.885241
Rir	1.13	0.885241
Mean VIF	1.13	

The results of the test in table 3 indicated that all the VIF values for all the independent variables were all 1.13 The VIF are less than 10 and from this it was concluded that there was no multicollinearity.

4.5 Unit root results

Before carrying out the unit root test, the Akaike Information Criterion (AIC) and Schwarz Bayesian information criterion were used to determine the optimal lag length for all the variables using. Upon carrying out the test, the following results were obtained:

Table 4 Lag Selection Criteria

Selection-order criteria								
Sample: 1960m6 - 1980m1, but with a gap						Number of obs	=	231
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-407.619				.007024	3.55514	3.57317	3.59985
1	825.814	2466.9	9	0.000	1.7e-07	-7.046	-6.97388	-6.86718
2	863.698	75.768	9	0.000	1.4e-07*	-7.29608*	-7.16986*	-6.98314*
3	868.128	8.86	9	0.450	1.4e-07	-7.25652	-7.0762	-6.80945
4	881.453	26.65*	9	0.002	1.4e-07	-7.29396	-7.05955	-6.71278

Endogenous: ln_reer ln_oilp ln_rir
Exogenous: _cons

From the results in table 4, the selected lag for the model was 2. Engle-Granger two step procedure was used to test the nulle hypothesis of no co-integration against the alternative hypothesis that there is co-integration.

Ordinarily, time series data suffers from non-stationarity (Nelson & Plosser, 1982). This study tested for unit root using Augmented Dickey-Fuller test. The test is important in determining the required order of differencing to achieve stationarity.

Table 5 Unit Root test

Variables	Levels		Order of differencing	Differences		lags
	Trend	No Trend		Trend	No Trend	
REER	-3.553**	-0.139	1	-8.466***	-11.293***	2
RIR	-2.706	-2.163	1	-6.776***	-10.345***	2
OiLP	-1.830	-1.289	1	-7.909***	-12.489***	2

Asterisk (*) = Significance at 1%; () = Significance at 5%; (***) = Significance at 10%**

From table 5, the results indicated that all the variables were non-stationary at level, and at varied levels of significance.1%, 5% and 10% and thus failure to reject null hypothesis of non-stationarity. Therefore, this led to the differencing of all the variables and Augmented Dickey-Fuller test carried out on first differenced series. The results thus led to the rejection of the null hypothesis of non-stationarity. Therefore, it can be inferred from these results that both dependent and independent variables are stationary at first difference and not at level.

4.6 Cointegration test

To test for cointegration, all the variables are required to be non-stationary at level and upon carrying out first differences they become stationary. Stationarity test confirmed that all the variables were non stationary at level, and became stationary at first difference.

Cointegration means there exists long-run relationship between the dependent variable and independent or predictor variables. This is justified by the fact that it solves the problem of losing information through detrending and differencing (Odedokun, 1993).

Table 6 Cointegration test

Dickey-Fuller test for unit root		Number of obs = 231		
Test Statistic	Interpolated Dickey-Fuller			
	1% Critical Value	5% Critical Value	10% Critical Value	
Z(t)	-11.922	-3.466	-2.881	-2.571
MacKinnon approximate p-value for Z(t) = 0.0000				

Table 6 shows t statistic and critical values at 1%, 5% and 10% levels of significance. The absolute t value of residuals was found to be greater than the absolute critical values of t at different levels of Significance. Consequently, the null hypothesis of there is no cointegration among variables was rejected. Consequently, the variables in the model have a long run relationship towards equilibrium and are co-integrated. The implication was that, the non-stationary time series in their levels give results which are sensible and do not suffer from spurious errors.

4.7 ECM Regression Results

Table 7 ECM Regression Results

MODEL	
D_ln_reer	
L_cel	-0.00851* (0.00362)

LD.D.L2.ln_REER	0.266*** (0.0624)
LD.D.L2.ln_oilp	-0.0176 (0.0190)
LD.D.L2.ln_RIR	0.0138 (0.0113)
Constant	0.00308 (0.00177)
<hr/>	
D_ln_oilp	
L_cel	0.0390** (0.0121)
LD.D.L2.ln_REER	0.217 (0.209)
LD.D.L2.ln_oilp	0.207** (0.0635)
LD.D.L2.ln_RIR	0.0587 (0.0377)
Constant	0.00115 (0.00594)
<hr/>	
D_ln_rir	
L_cel	0.0281 (0.0198)
LD.D.L2.ln_REER	-0.691* (0.340)
LD.D.L2.ln_oilp	-0.0898 (0.103)
LD.D.L2.ln_RIR	0.405*** (0.0614)
Constant	-0.000658 (0.00967)
<hr/>	
Observations	238
Adjusted R^2	

Table 8 Johansen Normalization Restriction

Johansen normalization restriction imposed						
beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
_cel						
ln_reer	1	.	.	.	.	.
ln_oilp	-.7880147	.1826194	-4.32	0.000	-1.145942	-.4300872
ln_rir	-.7558453	.1921475	-3.93	0.000	-1.132447	-.3792431
_cons	.1607847	.	.	.	.	.

4.8 Discussion of the results

The study estimated the relationship between Real exchange rate, Oil prices and Real interest rate using Error correction models as indicated in chapter three. The results were produced in three tables in which REER was the dependent in first model, OILP as the second and RIR as the third. The residuals from the cointegration equations were used generate the error correction term which is the lagged residuals inserted in the short run model. The results in table 7 with L_ce1, L_ce2 and L_ce3 were lagged residuals when D_ln_reer, D_ln_oilp and D_ln_rir were dependent variables.

The coefficients of lagged residuals shows the speed of adjustment of the model towards the equilibrium. The models above show that L_ce1 of -0.00851* reveals that 0.851% of the prevailing long run disequilibrium will be adjusted significantly per month at 1% significance level when the REER increases above its long run relationship with other variables. The others, OILP and RIR with 0.0390 and 0.0281 respectively indicated their 3.9% and 2.81% rate of adjustment towards the long run equilibrium.

Since this study sought to find out the effect of oil price prices on the real exchange rate then it majored on the model when reer is the dependent variable in the Johansen Normalization restriction. The test statistics indicated that a unit increase in the oil price will lead to a corresponding significant decrease in the reer by 0.7880% while unit increase in the real interest rate will significantly reduce reer by 0.7558%.

4.9 Post-estimation tests

4.9.1 Heteroscedasticity

Heteroscedasticity refers to the circumstance in which the variability of a variable (usually the dependent variable) is unequal across a range of values of the second variable that predict it, usually the independent variable(s) (Greene, 1993). It is a common problem in time series data and thus this study used Breusch-Pagan to test for the existence of heteroscedasticity. The null hypothesis says there is no heteroscedasticity. Calculated P-values less than the threshold p-value, lead null hypothesis not to be rejected while calculated P-value larger than the threshold p-value, we reject the null hypothesis and conclude that there exists heteroscedasticity.

Table 9 Breusch-Pagan test for Heteroscedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity			
Ho: Constant variance			
Variables: fitted values of ln_reer			
chi2(1)	=	0.07	
Prob > chi2	=	0.7948	

From table 9 above, the calculated P value was found to be 0.7948 which is greater than the P-values of 0.01, 0.05 and 0.10. Thus, this lead to the rejection of null hypothesis of no heteroscedasticity and hence the conclusion that heteroscedasticity exists. Despite the findings that heteroscedasticity exist our OLS estimators remain robust and unbiased but they are not BLUE (Best Linear Unbiased Estimators).

4.1.1 Serial Correlation Tests

Table 10 Breusch – Godfrey LM test for Serial Correlation

Breusch-Godfrey LM test for autocorrelation			
lags (<i>p</i>)	chi2	df	Prob > chi2
1	225.630	1	0.0000
2	226.387	2	0.0000

H0: no serial correlation

Serial correlation is the relationship between a given variable and itself over various time intervals. Serial correlations are often found in repeating patterns, when the level of a variable affects its future level. This is also called autocorrelation and particularly refers to the relationship between the observations of the same variable over specific time period. Breusch test for Autocorrelation was employed to test for serial correlation .The study results indicated a p value of 0.00 much less than the 0.05 and this led to the rejection of the null hypothesis that there is no serial correlation.

CHAPTER FIVE: SUMMARY AND CONCLUSION

5.1 Introduction

First this chapter discusses the summary and conclusion, policy relevance of the findings, limitations of the study and ends by proposing further areas of research.

5.2 Summary and Conclusion

This study set out to determine the impact of oil price shocks on Kenya's real effective exchange rate following fluctuations of oil prices and interest rates from time to time. For analysis, time series data for the period 1997-2016 was used in this study. To test for long run relationship between the real effective exchange rate which is the dependent and Brent oil prices and real interest rate which are the independent variables, residuals were used and ADF was carried out which provided evidence that there was a long run relationship between the variables.

The first objective of this study was to estimate the effect of world oil price fluctuations on Kenyan's real exchange rate. This was achieved by running a Vector Error Correction model(VECM) which indicated that L_ce1 of -0.00851^* reveals that 0.851% of the prevailing long run disequilibrium will be adjusted significantly per month at 1% significance level when the REER increases above its long run relationship with other variables. On the other hand, OILP and RIR coefficients were estimated as 0.0390 and 0.0281 respectively and can be interpreted as 3.9% and 2.81% rate of adjustment towards the long run equilibrium for the two variables respectively.

The second objective was to estimate the elasticity of KES/USD to changes in global oil prices in Kenya and this was achieved by the coefficient of oil prices which was found to be 0.35. This was positive and significant in relation to reer.

5.3 Policy Relevance

The study results indicated that international oil prices and real interest rate play an important role on the real effective exchange rate which is the weighted average of a country's currency in relation to an index or basket of other major currencies and it is adjusted for the effects of inflation (BIS, 2017). This index indicates a country's competitiveness in terms of international trade and thus appropriate policy measures should be taken to ensure the stability of the reer since oil prices are exogenous to the model.

First, there exists a positive and significant influence of oil prices on Kenya's real exchange rate. This is an important finding. The policy implication is that governments should ensure that there is stabilized prices for the oil used in Kenya to be able to maintain real effective exchange rate. The Energy Regulatory Commission sets the maximum retail prices of oil prices in Kenya and in their calculation methodology, currency movement is an important factor. When the local currency depreciates the effects are loaded to the retail prices and consumers shoulder that burden. From this study we have found positive and significant influence of international oil prices to the currency.

If government does not put in place proper policy framework to mitigate the economy from the negative effects of rising oil prices, this may curtail long term economic performance. This study therefore, recommends that an oil price stabilization policy be developed to cushion the economy from the external shocks. Since oil prices are determined by the suppliers then this can be

achieved through prudent measures such as subsidies and establishment of national reservoirs that can cushion the economy from the effects of major shocks in international oil prices which have become more prevalent. The national oil reserves would be utilized during such periods and thus economic agents would be cushioned from drastic price and currency effects from negative changes in international oil prices.

Secondly, this study established that the existence of a positive and significant relationship between real interest rate and the real effective. This finding is in line with macroeconomic theory. Kenya's interest rate policy is set by the Monetary Policy Committee of the Central Bank and is defined as the Central Bank Rate. This rate is largely used by commercial banks in setting the lending rates but other economic agents hardly use the policy rate as a benchmark. To this end, this research report recommends that the Central Bank of Kenya to popularize the CBR as a benchmark rate by all economic agents. By so doing the debt market will be deepened and efficient and open borrowing opportunities for firms.

5.4 Limitation of the study

This study investigated effect of interest rate and oil prices (Brent) on real effective exchange rate and this was limited to only those two factors. Therefore, this study did not exhaust all the options on the factors that affect real effective exchange rate. Moreover, Brent oil prices was used and this in reality this is not the only type of oil used in Kenya and therefore other types were excluded.

5.5 Research gap

We note that there may be other factors that influence the real effective exchange rate and thus this study proposes a further study on the role of debt burden and foreign direct investment on real exchange rate.

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