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**THE EFFECT OF OIL PRICES ON THE USDKES EXCHANGE RATE IN
KENYA, 2000-2017**

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MBA 73186

Dissertation submitted to Strathmore Business School in Partial Fulfilment of the
Requirements for the degree in Masters in Business Administration

Strathmore Business School

Strathmore University

Nairobi, Kenya

May, 2018

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May 2018

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ABSTRACT

This study sought to investigate the effect of oil prices on the USDKES exchange rate in Kenya over the study period 2000-2017. The study uses Brent crude oil as the benchmark for oil price and the USDKES currency as the exchange rate. Secondary data was obtained from the Central Bank of Kenya and United States Energy Information Administration. The study employed Unit Root Tests, Engle-Granger and Johansen tests for cointegration, Granger Causality test and Vector Autoregressive Models (VAR) models were used to assess for linear dependencies between the variables. The study objectives were to examine the short-run and long-run co-movement of oil price and the exchange rate. Using cointegration tests, the study found that there was no cointegration between oil price and the USDKES exchange rate implying that there is no long -run cointegrating relationship between oil price and the exchange rate. Granger causality tests found no causality between oil price and the exchange rate. VAR tests indicated that oil price accounts for a marginal proportion of exchange rate movements. The study thus finds that whereas theoretical and empirical literature have provided evidence for a long-run relationship between oil price and the exchange rate, the same is not the case for Kenya. These findings have important implications to policy makers, business entities and financial market players who may typically infer that oil price has an effect on exchange rate. For policy makers such as the Central Bank, price stability actions will be less reactive oil price movements; Business entities and Financial market players would adjust their forecasting models in line with the findings.

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LIST OF ABBREVIATIONS

GDP – Gross Domestic Product

KES – Kenya Shilling

OPEC - Organization of the Petroleum Exporting Countries

USD – United States Dollar

VAR – Vector Autoregressive Model

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My sincere gratitude goes to my friends and family who have always believed in my abilities and for their unwavering affirmation.

DEDICATION

I dedicate this work to my father, the late Isaac Waithaka Njuguna and my mother, Grace Wanjiru Njuguna for being the greatest supporters of my academic pursuits and for always encouraging me to work hard and strive for excellence in my endeavors.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The far-reaching use of oil in various sectors has propelled oil to become a significant input in the aggregate output of any given economy (Suleiman, 2013).

Changes in oil prices and its effects on macro-economic variables has been a topic of study by various researchers in the last few decades especially following on the first oil shock in 1973. Wide fluctuations in oil prices have played an important role in driving economies into recession and even regimes collapsing, which is why movements in oil prices are closely watched by economists, investors, and policymakers globally (Bacon, 1991).

Oil prices can affect exchange rates through multiple channels. Oil price fluctuations affect domestic economic activity such as GDP, inflation, and interest rates for both oil-exporting and oil-importing countries (Dernburg & McDougall, 1980).

1.1.1 Fluctuation in oil prices

With extraordinary price fluctuations in the oil market, it becomes essential to study the impact of oil price changes on world economies. These dramatic oil price variations have significant consequences for both oil-importer and oil-exporter countries' policy makers, and, international investors and consumers. From the viewpoint of Kenya as an importer of oil, it is necessary to examine the existing relationship between oil importation and exchange rates so as to shed light on the possible gains to be achieved should scaled exportation of petroleum - anticipated in the near future - be achieved (Patey, 2013).

Figure 1.1 shows the history of Brent crude oil price in United States Dollars (USD) per Barrel for the period 2000 to 2017. According to Iyenge (2011) the world price of Brent crude oil, which was stable between \$2.50 and \$3 since 1948, quadrupled from \$3 per barrel in 1972 to \$12 per barrel by the end of 1974, and from \$14 per barrel in 1978 to \$35 per barrel in 1981. The price of oil, however plummeted below \$10 per barrel in 1986, but surged again to between US\$18 and \$23 in 1990s. It crossed the US\$40 mark in 2004; and rose to about US\$60 from 2005. During the summer of 2007, the price of one barrel of crude oil jumped above US\$70 and

even crossed the US\$145 mark in July 2008. The price staggered to US\$80.50 in October 2009 and remained at an average of US\$75 till August 2011

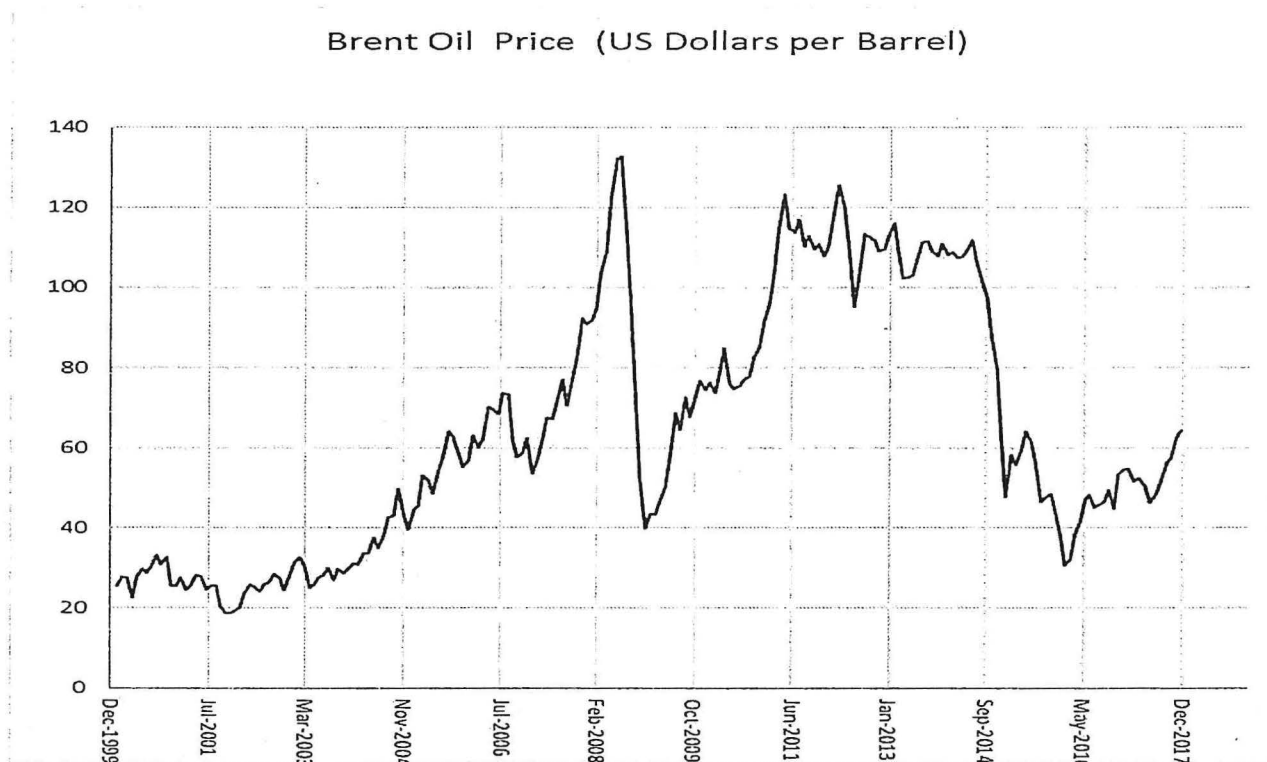


Figure 1.1: Brent Oil Price history

Source: U.S. Energy Information Administration, (2017)

1.1.2 Effect of fluctuation in oil prices on exchange rates

Theoretically, it is well established that an oil-exporting country may experience exchange rate appreciation (an increase in the value of its currency) when oil prices rise and depreciation when they fall. Research by Golub (1983) and Corden (1984) found that in general terms, an oil price increase – *ceteris paribus* – should be considered good news in oil exporting countries and bad news in oil importing countries, while the reverse should be expected when the oil price decreases. This is because an oil price increase would induce a wealth transfer from an oil importing country to the oil exporting country and it would reduce the value of national currency of the oil importing country. Another explanation of this impact utilizes the terms of trade and

net foreign exchange where an increase in oil price could deteriorate the terms of trade thereby leading to a decrease in the value of national currency of oil-importing countries (Golub, 1983).

Dawson (2004) in a study on the Dominican Republic explains that variability in oil prices has a huge impact on the relative values of the currency in the case of a small open economy and especially in open economies with a floating exchange rate. A small open economy is one that participates in international trade but is assumed to be too small to influence the level of world output or world interest rates. Conditions in the rest of the world are taken as given (Carlin & Soskice, 2006). Thus, the countries with small open economies are price takers. This is unlike a large open economy, the actions of which do affect world prices and income.

1.1.3 Oil price benchmarks

It is important to note the reference point for international oil prices. According to the Oil Trading Manual (1995) there are three global benchmarks for crude oil. North Sea Brent, Dubai National Oil Company's Murban, and Nymex West Texas Intermediate (WTI). North Sea crude oil has been the preferred benchmark for the majority of international traded crudes. Whereas Kenya imports Abu Dhabi National Oil Company (ADNOC) Murban crude, the price on ADNOC Murban is not an accurate parameter for international crude oil prices. ADNOC sets an official selling price retroactively. This price setting mechanism takes away from the internal market price setting mechanism of North Sea Brent. Further, the Brent benchmark is one of the most accurate indicators of world oil prices because it is one of the most traded oils in the current global oil market, and due to this liquidity, it follows perfectly the evolution of the global oil prices. In comparison to Brent prices, Murban may not be inferred to exhibit the price-setter qualities evident of Brent, an acclaimed global benchmark (Wlazlowski et al., 2011).

1.1.4 Significance of Oil price to Kenyan Economy

The effect of changes of international oil prices and exchange rates on economic growth for an oil importing country like Kenya is of significance. Kenya is energy dependent on oil and oil products and the import of oil represents a huge part of the trade balance. According to the European Economy (2013), energy import dependence is the extent to which a country depends on imports to meet its energy needs. All things being equal, the higher the share of imported energy, the more vulnerable a country is to price increases, supply disruptions or to foreign

political decisions. According to the Kenya Economic Survey (2015) the value of Kenya's imports of petroleum products which accounts for the largest share of the total import bill rose from KES194,602 million in 2010 to KES292,643 million in 2014, which over the period constituted 21% of total imports. This significant amount of oil imports warrants a study on the impact that oil price has on the economy of Kenya.

Oil contracts are denominated in United States Dollars (USD). Kenyan importers must therefore sell the local currency, Kenya Shillings (KES) in the foreign exchange market to obtain USD to make purchases of oil and oil products. It follows that an increase in the world price of oil would increase demand for USD putting depreciating pressure on the Kenya Shilling, whereas a decrease in the world price of oil would reduce demand for USD allowing for an appreciation of the Kenya Shilling currency. The international price of oil is therefore of great relevance to the Kenyan economy.

As volatility in the international oil price continues to dominate global energy markets and as governments and countries grapple with achieving some stability in real exchange rates, continued research and discussion on this topic remains key and of importance to gain further insight on the impact of oil prices on economic variables.

Large and persistent current account deficits are among the most serious problems of many developing countries since they result in economic crises like currency crises, burgeoning external debts and reduction in international reserves (Adams & Park, 2009). Oil price on the international market has been seen to be a major component of Kenya's current account deficit (Nyongesa & Onyango, 2012)

Oil price is also seen to contribute to the level of inflation (Brown, Oppedahl and Yucel ,1995). Kenya has an inflation targeting monetary policy which is designed to support the Government's desired economic activity and growth as well as employment creation through achieving and maintaining a low and stable inflation (CBK 2010). In light of this, studies on the dynamics of these oil price and exchange rate variables need to be continually highlighted.

With the discovery of oil reserves (Patey, 2013), Kenya is set to become an oil producing and possibly oil-exporting country. Whilst still in exploration phase and the country's hydrocarbon potential still being determined, it is essential for the country to evaluate expected outcomes of

being an oil-exporting country. Notably, the likely impact that this will have on the exchange rate and other economic variables.

1.2 Problem Statement

Kenya's current account balance has generally been in deficit since 2004 with oil imports contributing approximately 20% of total imports. The huge import bill in the current account increases demand for foreign currency, while slowdown in exports of goods reduces the inflow of foreign currency. The combined effect exerts pressure on the USDKES exchange rate to depreciate (weaken) (World Bank, 2014). Although the country has recently discovered unspecified quantities of oil whose commercial value is yet to be ascertained, Kenya continues to rely entirely on imported petroleum products. This situation makes the country vulnerable to international oil prices.

Considering the relative volatility in oil prices and Kenya's reliance on oil for energy, this study seeks to analyse the effects of oil price fluctuations while tracing the possible channels of transmission of such shocks to the Kenyan economy via the USDKES exchange rate.

Although several studies have confirmed the important role of oil prices on exchange rates, the literature has mainly focussed on the US and other developed economies (Zhou, 1995; Amano and Norden, 1998b; Chaudhuri and Daniel, 1998; Dibooglu and Koray, 2001). The relationship between the price of oil and the exchange rate has been established by the literature for oil-producing countries (Dawson, 2004; Carlin & Soskice, 2006) but less has been done for oil-importing small open countries. Further, a number of studies in different African economies present varied findings of the relationship between oil prices and the exchange rate. Thus, the need for further evidence on how oil price volatility impacts the exchange rate still remains relevant.

Available studies in Kenya on oil price and exchange rate have looked at different time periods, applied different parameters of exchange rate and oil prices and used different empirical tests offering mixed conclusions (Chelimo, 2015; Irungu 2017). Along these lines and owing to the importance of both the oil price and exchange rates, it is instructive for research to continue to investigate how variability in oil price impacts the exchange rate. More specifically, this paper

seeks to contribute to the empirical literature in this field by using different methodology than used in previous studies.

1.3 Objectives of the Study

The main objective of this study is to examine the effect of oil price on the USDKES exchange rate in Kenya over the period 2000 to 2017.

1.3.1 Specific Objectives

The specific objectives of the study are therefore:

- i. To examine the individual statistical properties of oil price and exchange rates
- ii. To check for short-run effects between oil price and the USDKES exchange rates
- iii. To check for a long-run cointegrating relationship between oil price and the USDKES exchange rate

1.4 Research Questions

The forthcoming research questions are therefore:

- i. What are the individual statistical properties of oil price and exchange rates?
- ii. What are the short-run effects between oil price and the USDKES exchange rates?
- iii. Is there a long-run cointegrating relationship between oil price and the USDKES exchange rate?

1.5 Scope of the Study

The scope of the study is limited to the effect of oil price on the USDKES exchange rate. Oil is priced in USD so Kenyan importers are required to buy USD in the foreign exchange market and make USD available for oil purchases in the international market. The study does not cover the impact of oil prices on other currency pairs as USDKES is the traded currency pair. Other cross currencies typically quoted against the KES such as EUR/KES are derived from the USDKES exchange rate.

The study covers the period January 2000 to December 2017 which is a sufficient number of data points for time-series analysis.

1.6 Justification of the study

The significance of the impact of exchange rate fluctuations especially in countries with floating exchange rates cannot be over emphasized. Kenya and other developing countries with significant current account deficits are especially vulnerable to exchange rate volatility. This study is therefore of imperative importance to such countries as it highlights how the variability in oil price, which is a significant contributor to current account deficit, impacts on the exchange rate. The research will be useful to a number of stakeholders.

Academics & Researchers

This study adds to the body of literature on the effect of oil price movements and effects on the exchange rate. The findings can benefit future researchers and academicians as they can draw further insights for their studies

Policy Makers

Central Bankers who are tasked with maintaining price stability can get to know the extent to which oil price fluctuations impacts the exchange rates and lead them to undertake appropriate exchange rate policy decisions aiming at promoting economic growth.

Government Agencies

Ministry of Planning & The Treasury will find the study essential in that it serves as a model for forecasting the likely movement of the exchange rate and impact on current account balance in the event Kenya becomes an oil-exporting country.

Business Entities

The study will be useful to firms that are heavily impacted by movements in oil prices and exchange rates, such as Airlines and Horticulture exporters. The study can equip them to make more informed forecasting decisions and implement appropriate policies to mitigate negative impacts of oil price and exchange rate movements

Commercial Banks

Treasury Managers in commercial banks will have useful information to better forecast the likely movement of the exchange rate as a result of oil price movements.

General Public

The study is useful in that it sheds light on what the future holds with regard to financial outlook for the country.

CHAPTER TWO: LITERATURE REVIEW

This chapter first provides a discussion on the theoretical literature which gives an insight into the possible paths through which oil prices can affect the exchange rate. In addition, a discussion is undertaken on the empirical literature which shows studies conducted by other researchers. The knowledge gap and the conceptual framework are covered in this section.

2.1 Theoretical Review

This section introduces and describes the theories which explain the relationship between oil price and exchange rates. It also reviews the transmission channels through which oil price impacts exchange rates.

2.1.1 Oil price and Exchange rate theories

Diverse theoretical relationship between oil price and exchange rates have been established in literature (Beckmann & Czudaj, 2012) with many papers having suggested that oil price might have a significant influence on exchange rate. An evaluation of various theoretical work sheds light on how oil price changes are transmitted to exchange rates.

Under a floating exchange rate regime, as is the case of Kenya, the exchange rate is determined by market demand and supply. Changes in the demand or supply of a currency will affect its exchange rate. Nikbakht (2009) posited that oil prices affect exchange rates mainly through a two-way transition mechanism which includes both supply and demand channels. On the supply side, oil price increases affect production negatively since oil is a basic factor of production. Any increase in the price of a factor of production leads to an increase of the cost of production of non-tradable goods. The ultimate result is an appreciation of the exchange rate resulting from increase in prices of non-tradable goods. From the demand side, the exchange rate is indirectly affected through its relationship with disposable income. Thus, a rise in oil prices reduces the consumers spending power. This will reduce the demand for non-tradable goods leading to a fall in their prices and ultimately depreciating the exchange rate.

The elasticity approach to exchange rate determination can be applied to the impact of oil prices on the exchange rate. Price elasticity of demand is a measure of the responsiveness of quantity demanded to a change in price (Jehle & Reny, 2011). If quantity demanded is highly responsive

to a change in price, then demand is said to be relatively elastic. If quantity demanded is not significantly responsive to a change in price, then demand is said to be relatively inelastic.

It is therefore imperative to consider the responsiveness of imports to a change in the price of oil. For example, if import demand of oil is highly inelastic, a rise in oil prices will cause depreciation in the currency of the importing country. An increase in the oil price will mean that the importing country will require more of its currency to buy the same amount of oil it used to buy before. Hence there would be depreciation in the currency of the importing country. A decrease in the oil prices causes an appreciation in the currency of the importing country since it now requires less of its currency to buy the same amount of oil it used to buy before.

Krugman (1983) proposes a theoretical framework to explain the effect of oil prices on exchange rate through the balance of payments. For an oil-importing country, a rise in the price of oil worsens the balance of payments and eventually lead to currency depreciation, while it generates current account surplus for oil exporters. By the same token, Golub (1983) argues that oil price increase raises the current account surplus of oil exporters and the current account deficit of oil importing countries (wealth redistribution), eventually reducing expenditure on oil and leading to the depreciation of currencies of oil-importing countries. When oil prices rise, wealth is transferred to oil exporting countries (in US dollar terms) and is reflected as an improvement in exports and the current account balance in domestic currency terms. For this reason, we expect currencies of oil-exporting countries to appreciate and currencies of oil-importers to depreciate in effective terms after a rise in oil prices (Beckmann and Czudaj, 2013b). There is also the possibility that the US dollar appreciates in the short-run because of the wealth effect—if oil-exporting countries reinvest their revenues in US dollar assets.

The terms of trade theory introduced by Amano and van Norden (1998a, b), links the price of oil to the price level which affects the real exchange rate (Bénassy-Quéré et al., 2007). If the non-tradable sector of a country A is more energy intensive than the tradable one, the output price of this sector will increase relative to the output price of country B. Effects on the nominal exchange rate arise if the price of tradable goods is no longer assumed to be fixed.

The link between oil price and exchange rate can be explained using the law of one price or the absolute version of the Purchasing Power Parity (PPP) which stipulates that converted in the same currency, a good must sell for the same price in all locations. The PPP theory of exchange

rate determination expresses the change in the exchange rate as a function of the difference between the (appropriately weighted) change in world prices and the change in domestic prices (Sachs & Larrain, 1993). In the long run, identical products and services in different countries should cost the same. This is based on the principle that exchange rates will adjust to eliminate the arbitrage opportunity of buying cheaper goods or services in one country and selling it at increased prices in another (Boykorayev, 2008). Therefore, if one is to assume that the long-run real exchange rate equals a constant, an increase in the oil price should give a correction of the real and nominal exchange rate back toward its equilibrium level through the purchasing power parity (PPP) theory (quote). If the price of oil increases, we expect currencies of countries with large oil dependence in the tradable sector to depreciate due to higher inflation.

Other theoretical studies that investigate the impact of real oil price on real exchange rate have focussed on oil exporting countries and specifically to investigate the concept of the Dutch Disease Theory, one of the resource curse concepts which has primarily been observed in Oil-exporting countries. According to Corden (1984) and Corden and Nearly (1984), Dutch Disease is the appreciation of a country's real exchange rate caused by an exogenous increase in resource price or sharp rise in resource export and the tendency of a booming resource sector to draw capital and labour away from a country's manufacturing and agricultural sectors, which can lead to a decline in exports of these sectors and inflate the cost of non-tradable goods. It therefore follows that for an oil exporting county, a commodity boom (reflected in an increase in oil price) would lead to an appreciation of the country's currency which would have a long term negative impact on the economy, requiring policy makers to take necessary policy actions to stem its effects.

2.2 Empirical Review

A large body of empirical research has established that oil prices have an effect on exchange rates. Chen and Chen (2007) tested cointegration between oil prices and the exchange rates of the G7 countries (Canada, France, Germany, Italy, Japan, the UK, and the USA). Using panel cointegration tests with monthly data over the period 1972–2005, their study showed that real oil prices may have been the dominant source of real exchange rate movements in the G7 and that there is a link between real oil prices and real exchange rates.

A further study by Lizardo and Mollick (2010) using cointegration tests showed that an increase in the real price of oil led to a significant depreciation of the U.S. dollar relative to the currency of oil-exporting countries, however, the currency of oil-importing countries depreciated relative to the U.S. dollar in 24 Emerging Markets. They also found that currencies of countries that are neither oil exporters nor importers appreciate relative to the U.S. dollar when oil prices rise.

In a study on 14 oil-exporting countries, Jahan and Hassan (2008) using a autoregressive distributed lag (ARDL) model found a long-run stable relationship between oil prices and real exchange rate. Application of the ARDL testing methodology to monthly data from fourteen oil exporting countries revealed the existence of stable long-run relations between real oil prices and real exchange rates in all countries. However, real exchange rates appeared to adjust to equilibrium errors at moderate to slow rates.

Using Blanchard- Quah identification strategy Clarida and Gali (1994) estimated the share of exchange rate fluctuations that were due to the different shocks in oil. Using quarterly data from 1974 to 1992 comparing the United States of America to four different countries (Germany, United Kingdom, Japan and Canada) they found that more than 50% of the variance of real exchange rate changes over all the horizons was caused by real oil shocks.

Buetzer, Habib and Stracca (2012) investigated whether oil shocks matter for global exchange rate configurations. The paper was based on data on real and nominal exchange rates as well as on an exchange market pressure index for 44 advanced and emerging countries. Using Vector Autoregression model, they found no systematic evidence of a clear link between the oil or the commodity trade balance and real exchange rate movements following oil price shocks.

In the specific case of oil-exporting countries, empirical research on the role of the oil price as a determinant of the real exchange rate has yielded varying results. While strong relationships between the two variables have been found for some countries, weak or even negative relationships have been found for others. Korhonen and Juurikkala's (2007) study of a panel of nine OPEC countries in the period 1997 to 2005 using mean group estimator showed that increasing crude oil prices caused a real exchange rate appreciation in oil exporting countries.

In the case of Norway, Akram and Holter (1996) and Bjørvik, Mork and Uppstad (1998) concluded that there was weak relationship between oil price and Norwegian Krone exchange

rate. These findings were however challenged by Feng (2012) citing pitfalls in the empirical data in the use of Norwegian Kroner/ European currency unit (ECU) exchange rate as a variable rather than United States Dollar/Norwegian Kroner exchange rate. Feng (2012) employed Engel Granger test and Error correction model using monthly data from 2001 to 2011 to reach the conclusion that there is a cointegrated relationship between the oil price and nominal exchange rate USD/NOK.

In the case of Canada, there has been substantial reluctance in labelling the Canadian dollar as a petrocurrency, with researchers again reporting insignificant (Gauthier and Tessier, 2002) or even negative relationships between oil price and exchange rates (Amano and van Norden, 1995).

Zaldueño (2006) in a study on Venezuela used a vector error correction model using annual time series data from the period 1950 to 2004. He finds evidence that Venezuela has a time-varying equilibrium real exchange rate and increases in oil prices are associated with the emergence of appreciation pressures and vice versa for price declines.

Various studies have been done in Asian economies with mixed findings. Tsen (2011) examines real exchange rate determination in Japan, Korea, and Hong Kong using the Engle and Granger and Johansen cointegration tests. The author finds that the world real oil price, terms of trade, productivity differential, and reserve differential are important determinants of the real exchange rate. Huang and Guo (2007) in a test on the effect of oil price shocks on China's real exchange rate using found that real oil price shocks lead to a minor real appreciation of the renminbi exchange rate in the long-run.

Wang and Dunne (2000) showed mixed results in investigating the sources of movements in real exchange rates of East Asian countries. They find evidence of a long-run relationship between the real exchange rate and its fundamentals, including the world real oil price. In particular, their results show that an increase in the real oil price leads to appreciation in the currencies of Indonesia, Malaysia, Singapore, and Thailand, but depreciation in the currencies of Japan, Korea, and the Philippines

Empirical findings specific to single country studies of oil-importing economies are however limited. The existing studies indicate a significant relationship between oil prices and exchange

rate. Hidayathulla and Mahammad (2014) examined the effects of oil price on exchange rate of Indian rupee against US dollar using time series data from 1972 to 2013. Their study employed multiple linear regression models to analyse the data. The model results suggested that the import of crude oil continued to rise when the crude oil future price increased. The oil imports thus became a substantial source of demand for dollar in India's foreign exchange market. This strong demand contributed to strengthen the dollar against Indian rupee.

Koranchelian (2005) uses a vector error correction model in a study on Algeria. Using annual data from 1970 to 2003 to analyse whether real exchange rate deviates from its equilibrium level due to a oil price shock, the findings were that the long-run real exchange rate of Algeria is time-varying, and dependent on movements in relative productivity and real oil prices.

A study on Nigeria by Ogundipe et al (2014) examined the effects of oil price, external reserves and interest rate on exchange rate volatility in Nigeria using annual data covering the period 1970 to 2011. It was observed that a proportionate change in oil price leads to a more than proportionate change in exchange rate volatility in Nigeria, which implied that exchange rate is susceptible to changes in oil price.

Kin and Courage (2014) analyse the impact of oil prices on the nominal exchange rate of the South African Rand using monthly time series data covering the period between 1994 and 2012. The results suggested that oil prices have a significant impact on nominal exchange rates. In addition, the findings revealed that an increase in oil prices leads to a depreciation of the rand exchange rate.

Only a handful of studies have been conducted on the oil price-exchange rate nexus in Kenya. Iyenge (2011) compared the effects of oil price shock and exchange rate volatility on the economic growth of Nigeria and Kenya. He specifically examined how GDP Growth of Nigeria and Kenya are affected by changes in oil prices and the exchange rate in the long-run and further employed a vector error correction model (VECM) to analyze the short-run dynamics of the real GDP Growth for the two countries. The main findings indicate that the oil price shock have effect on GDP Growth of both Nigeria and Kenya. The exchange rate of both countries also has effect on the GDP output of the countries.

Chelimo (2015) studied the effects of murban adnoc oil import prices on the exchange rate dynamics in Kenya using unrestricted VAR analysis covering the period 2005 to 2014 and found that oil import prices did not have a significant impact on exchange rates

2.3 Overview of Literature

A summary of empirical findings is presented in Table 2.1

Table 2.1 Summary of empirical literature

Country/Region	Methodology	Findings	Study
G7 countries	Panel cointegration tests	Real oil prices are a dominant source of exchange rate movements	Chen and Chen (2007)
24 emerging markets	Cointegration tests	Cointegration between oil price and exchange rate	Lizardo and Molick (2010)
14 oil-exporting countries	Autoregressive distributed lag	Existence of a stable long-run relationship between oil prices and real exchange rate	Jahana and Hassan (2008)
Asian economies	Engle – Granger & Johansen tests	Oil price & other variables important determinant of the exch rate	Tsen(2011), Huang and Guo (2007)
OPEC countries	Mean group estimator	Increase in oil prices caused real exchange rate appreciation	Korhonen and Juurikkala (2007)
Venezuela	vector error correction model	Increases in oil prices associated with	Zalduendo (2006)

		appreciation in exchange rate	
India	Multiple linear regression	Oil substantial source of USD demand , driving appreciation of the USD	Hidhayathulla & Mahammad (2014)
Algeria	Vector error correction model	Long run real exch rate is dependent on movement in real oil prices and other variables	Koranchelian (2015)
South Africa	Time series analysis	Oils prices have a significant impact on nominal exchange rate	Kin & Courage (2014)
Nigeria & Kenya	Vector error correction model	Oil price shocks impact GDP	Iyenge (2011)
Norway	Engle – Granger & Error correction model	Weak relationship between oil price and Norwegian Kroner/ European currency unit	Akram and Holter (1996) and Bjørvik, Mork and Uppstad (1998)
44 Advanced & emerging economies	Vector Autoregression model	No systematic clear link between oil & real exch rate	Buetzer, Habib, Stracca (2012)
Kenya	VAR analysis	oil import prices did not have significant impact on exchange rate	Chelimo (2015)

The significance of the price of oil for exchange rate movements has been noted by both the theoretical and real country empirical findings. Strong evidence showed that real exchange rate

and real oil price are cointegrated and that oil prices may have been the dominant source exchange rate movements.

Literature has generally found a negative relationship between oil price and exchange rate in oil-exporting countries. In other words, an increase in oil prices leads to an appreciation of the domestic currency. Studies of oil price-exchange rate relationship in oil importing countries clustered mainly among developed economies with consensus that real oil prices may have been the dominant source of real exchange rate movements and there is a positive link between oil prices and real exchange rate. Studies on developing countries have reported varying reports where this variance is mostly influenced by the direction of the impacts; whether net oil importing or exporting (Akram, 2011)

Although there exists a general consensus from the studies that oil price shocks impact on macroeconomic variables, there are inconsistencies in the findings of the reviewed studies. Akram and Holter (1996) found a weak relationship between oil price and exchange rate in Norway. Chelimo (2015) found that oil prices did not have significant impact on exchange rates in Kenya.

2.3 Gap in Existing Research

Contributions to the literature on developing economies highlight how they are severely affected by external influences. Given that they are usually oil importing economies, oil prices fluctuations become striking factors to take into account. First, real oil prices might be a proxy for exogenous changes of the terms of trade, and arguably the most important exchange rate long run determinant (Amano and van Norden, 1998). Second, movements in oil prices may be linked to wealth transfers among oil-importing and oil-exporting countries, i.e. to the balance of payments and international portfolio choices (Golub, 1983, Ozturk et al., 2008). Therefore, the effects of movements in oil prices may be assessed through different transmission channels.

Based on the review of the literature on the oil price effect on exchange rates, the researcher has identified areas for further study that this research seeks to investigate. Existing literature has largely been focussed on developed oil exporting countries. Whilst some similarities can be drawn, the underlying economic environment and variables are significantly different to a developing country setting. As is evidenced by the literature review, few empirical studies on

this topic have been done for developing economies. With African countries and specifically Kenya falling into this category, it is of significant policy interest to investigate the behaviour of exchange rates and oil prices and the role they can play as a tool for policymaking in improving their economic standing. This paper seeks to contribute to the empirical literature in this field.

Results from previous studies imply that the relationship between oil prices and exchange rates can vary in different time periods. This specific study on Kenya covers a significantly longer period of 18 years dissimilar to any previous study done. This longer time frame will allow for examination of the relationship between oil and exchange rates incorporating periods of extraordinary oil price fluctuations, exchange rate volatility and varied performance of both the local and global economy. This study employs econometrics and uses cointegration and VAR modelling to assess the relationship between oil price and exchange rates. The combination of analysis approaches allows for more validity in findings, hence, robustness in inferences.

2.4 Conceptual Framework

This section provides an exposition of variables for the study. The section also details justification of the variables arrived at and provides a diagrammatic depiction of the conceptual framework to be applied for the study. A table showing the operationalisation of variables is also presented (Table 2.2).

The conceptual framework, presenting the various literature-variables and their pertinence to this study, is diagrammatically represented below.

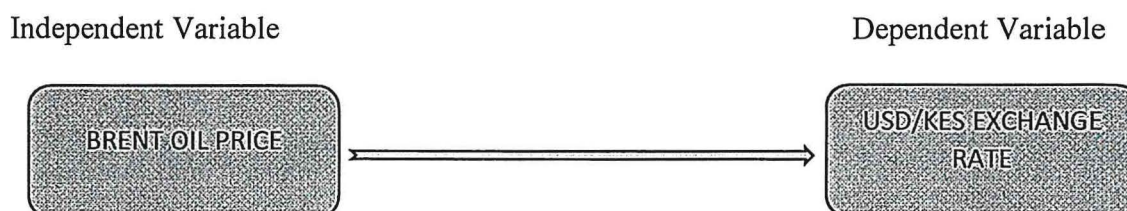


Figure 2.1 Conceptual Framework for the relationship between oil price and the exchange rate

2.4.1 A determination of variables

A modern open economy that is reliant on global trade is, in many ways, dependent on the exchange rate of its currency against other currencies (Frankel,1994). From the real value a company receives from selling a commodity abroad to the price of petrol which is an imported product, it all depends, at least to some degree, on the exchange rate. This means that the general state of the economy evolves and varies with the exchange rate against its trading partners currencies. As Kenya is a relatively small and open economy, the USDKES exchange rate has importance to the development of the Kenyan economy. Further, given that oil makes up 20% of imports into Kenya, it is reasonable to think that the USDKES exchange rate depends on, and varies with the often sharp fluctuations of the oil price.

When oil prices rise, wealth is transferred to oil exporting countries (in US dollar terms) and is reflected as an improvement in exports and the current account balance in domestic currency terms. For this reason, we expect currencies of oil-exporting countries to appreciate and currencies of oil-importers to depreciate in effective terms after a rise in oil prices (Beckmann and Czudaj, 2013).

The independent variable of particular relevance to this study is Brent Oil price and its effects on the dependent variable, the USDKES exchange rate. Brent Oil price is the primary benchmark for international oil prices serving as the price reference for roughly two-thirds of the world's traded-oil volume (EIA,2017) Kenya imports refined petroleum products through the Open tender system (OTS) which is run through monthly tenders, it entails sourcing of petroleum predominantly from the spot market whereby petroleum is sourced from the open market without any prior contracts (Ministry of Energy). This means that the country is exposed to changes in the international oil price.

Given that the international oil priced is denominated in USD, purchases of oil for the Kenyan market must be sourced from the foreign exchange market. An increase in oil price would require additional USD to be sourced from the market for the same quantity of Oil supplied, consequently a decrease in the oil price would lead to decreased demand for USD. This changes in the oil price would therefore be reflected in an appreciation or depreciation of the local currency. In addition, the USDKES currency pair is chosen as dependent variables as is this the quoted currency pair that is traded directly by foreign exchange dealers and market players in the

Kenyan market. The focus of the study is on the dependence structure of oil and exchange rate. The co-movements in the oil and currency markets are held as a base for the examination

2.5 Operationalisation of the variables

Table 2.2 provides a list of variables used, sourcing of data and type of data collected.

Table 2.2 Operationalisation of Variables

Variables		Source of Data	Data Type	Source
Independent Variable	Brent Oil Prices	United States Energy Information Administration website	Interval	EIA,2017
Dependent Variable	USD KES exchange rate	Central Bank of Kenya	Ratio	CBK

2.6 Research Hypothesis

Considering the literature and the numerous studies investigating the relationship between the oil price movements and exchange rates suggesting a significant link between them, it is expected that this study will show similar results. Whereas various studies have concluded that there is a link between oil price and exchange rates, a number of studies have produced inconclusive results and notably with respect to Kenya (Irungu,2017; Chelimo ,2015; Buetzer, Habib, Stracca ,2012). We therefore cannot infer the existence of a relationship and the study seeks to investigation of the effects of the oil price movements on exchange rates. The first hypothesis is set on a fundamental level.

This study provides a formal test of the statistical hypothesis by testing for the existence of a cointegrating relationship between oil prices and the exchange rate.

The following is the study hypothesis guiding this research

H0: Oil price does not have a significant effect on the exchange rate

H1: Oil price has a significant effect on the exchange rate

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter highlights the methodology used in conducting the study in order to evaluate the impact of oil price on USDKES exchange rate. The chapter begins present information on the research design that will be applied, the population of the study and the sample size. This is then followed with sections describing the sampling technique used, data collection methods and data analysis methods.

3.2 Research Design

This exploratory study seeks to find the effect that international oil price movements have on the exchange rate. An exploratory study is a valuable means of finding out what is happening, seeking new insights, asking questions and assessing phenomena in a new light (Baxter & Jack, 2008). The choice of research strategy was guided by the research objectives and research questions.

3.3 Population

The data for this study constitutes the monthly observations for Brent Oil price and USDKES Exchange rate for the period under study. Brent oil as highlighted in the literature is the mostly actively traded benchmark for international oil prices (Iyenge, 2011). USDKES exchange as highlighted in the literature this is the traded currency pair in Kenya's foreign exchange market (CBK, 2010).

3.4 Sample Size

This study analyses the impact of Brent Oil price on the USDKES exchange rate. The sample data comprises monthly observations of the Brent Oil price for the period 2000 to 2017 and the monthly USDKES exchange rate in the same period. The period selected includes the last moments of upswing in the global economy before the financial crisis of 2007-2008 and the resulting period of recovery from that crisis which saw significant movement in oil price over the period.

3.5 Data Collection

Secondary data was used in the study. Monthly data on Brent oil price is sourced from United States Energy Information Administration website, and monthly data on exchange rates is collected from Central Bank of Kenya economic reports.

3.6 Data Analysis

The data analysis was conducted using econometrics and time series with modelling to investigate the long-term relationship between the variables.

3.6.1 Empirical Model

Since the influential work of Engle and Granger (1987), cointegration has emerged as a powerful technique for investigating common trends in multivariate time series, providing a sound methodology for modelling both long run and short run dynamics in a system. Reviews of past studies provided us with insight, guidance and reasoning as to what cointegration methods should be used in our study.

The first stage of the estimation and modelling procedure was to identify the order of integration of the data series by undertaking unit root tests. The Augmented Dickey-Fuller (ADF) test and the alternative Phillips and Perron, (PP) tests were undertaken. The next stage involved short run and long run assessment of oil price on USDKES exchange with tests for cointegration. This included Engle and Granger cointegration method (1987), Johansen cointegration method (1991), Granger causality-type tests, impulse response functions and the error variance decompositions of the VAR model (Stock and Watson, 2001).

3.6.2 Unit Root Tests

Unit root tests are conducted on the variables to obtain stationarity status of the two time series. Many series in finance and economics in their log-levels forms are non-stationary and exhibit stochastic trends. They have a tendency to not revert to a mean level, but they “wander” for prolonged periods in one direction or the other (Brooks, 2008). It is therefore not possible to perform any hypothesis tests in models which inappropriately use non-stationary data (Brooks, 2008). Unit root tests are conducted on the variables to obtain stationarity status of the time series. The study used the conventional root tests, Augmented Dickey-Fuller test (Dickey & Fuller, 1979) and Phillips-Perron test (Phillips & Perron, 1988). If a series is by itself stationary at

levels, without having to be differenced, then it is said to be $I(0)$. If a variable is differentiated once in order for it to be stationary it is said to be integrated to order 1 that is $I(1)$.

For the **Augmented Dickey-Fuller (ADF)** test, the following regression equation which includes a constant and trend term will be applied.

$$\Delta Y_t = \alpha + \lambda_t + \gamma Y_{t-1} + \sum_{i=1}^p \alpha_i \Delta Y_{t-1} + \mu_t$$

Where, ΔY_t is the first difference of the variable of interest, α is an intercept constant, λ is the coefficient on a time trend, γ is the coefficient presenting process root, p is the lag order of the first difference autoregressive process and μ_t is the error term.

The null hypothesis in the ADF tests is that Y_t is non-stationary or has a unit root.

The **Phillips-Perron test** has a more comprehensive theory of unit root non-stationarity. The test is similar to ADF test but incorporates an automatic correction to the DF procedure to allow for autocorrelated residuals. (Brooks, 2008)

3.6.3 Tests for Cointegration

Testing for cointegration implies testing for the existence of a long-run relationship between economic variables. Thus, to investigate the long-run relationship between the variables, the Engle-Granger test (1987) and Johansen method of Cointegration was carried out (Johansen, 1988, 1991; Johansen and Juselius, 1990). The study sought to find out whether there existed a common stochastic trend in the oil price variable and the USDKES exchange rate variable. The set of variables is defined as cointegrated if a linear combination of them is stationary. Many time series are non-stationary but move together over time. This means that there exist some influences on the series which imply that the two series are bound by some relationship in the long run. (Brooks, 2008). On the basis of the theory that integrated variables are of order one, $I(1)$, may have a cointegration relationship, it is crucial to test for the existence of such a relationship. If the group of variables are individually integrated of the same order and there is at least one linear combination of these variables that is stationary, then the variables will be said to be cointegrated. The two most widely used tests for cointegration are the Engle-Granger (1987) two-step estimator and the Johansen (1988) and Johansen and Juselius (1990) maximum likelihood estimator.

3.6.3.1 Engle-Granger Test

If each of the variables, oil price and USDKES exchange rate is subjected to unit root analysis and is found to be integrated of order one, $I(1)$, then they contain a unit root. In order to find out whether the variables cointegrate, the least squares regression equation is estimated and the residuals (the error term) of the regression equation are subjected to unit root analysis. If the residuals are stationary, that is $I(0)$, it means that the variables cointegrate and have a long-term or equilibrium relationship. (Brooks, 2008)

The two-step process for determining whether two integrated variables cointegrate of the same order are the following:

1) Pre-testing each variable to determine its order of integration by estimating the co-integrating regression),

$$y_t = \beta_1 + \beta_2 y_{t,2} + \dots + \beta_k y_{k,2} + u_t$$

2) Estimation of the error-correction model by using step 1 residuals as one variable in the error correction model testing for a unit root in the residual process of the cointegrating regression above. For this purpose, a ADF test is set up,

$$\Delta \hat{u}_t = \alpha + \pi \hat{u}_{t-1} + \sum_{i=1}^k \gamma_i \Delta \hat{u}_{t-1} + v_t$$

3.6.3.2. Johansen Test

This method was considered because compared to Engle-Granger and other test methods the Johansen test provides more robust estimations. (Brooks, 2008). The Johansen process is a maximum likelihood method that determines the number of cointegrating vectors in a non-stationary time series Vector Autoregression (VAR) with restrictions imposed, known as a vector error correction model (VEC). Johansen's estimation model is as follows:

$$\Delta y_t = \mu + \sum_{i=1}^p \Gamma_i \Delta y_{t-1} + \alpha \beta' y_{t-1} + \mu_t$$

Where

$y_t = (n \times 1)$ vector of all the non-stationary indices in our study

$\Gamma = (n \times n)$ matrix of coefficients

$\alpha = (n \times r)$ matrix of error correction coefficients where r is the number of cointegrating relationships in the variables, so that $0 < r < n$. This measures the speed at which the variables adjust to their equilibrium. (Also known as the adjustment parameter)

$\beta = (n \times r)$ matrix of r cointegrating vectors, so that $0 < r < n$. This is what represents the long-run cointegrating relationship between the variables.

3.6.4 VAR Model

The VAR model to be estimated within this framework will be given as:

$$Y_{1t} = \alpha_{10} + \alpha_{11}Y_{1t-1} + \dots + \alpha_{1k}Y_{1t-k} + \beta_{11}Y_{2t-1} + \dots + \beta_{1k}Y_{2t-k} + U_{1t}$$

$$Y_{2t} = \alpha_{20} + \alpha_{21}Y_{2t-1} + \dots + \alpha_{2k}Y_{2t-k} + \beta_{21}Y_{1t-1} + \dots + \beta_{2k}Y_{1t-k} + U_{2t}$$

Where U_{1t} and U_{2t} are identically independently distributed error terms and k is the lag length. The basis for using a VAR model to evaluate the relationship between oil prices and exchange rates is that VAR, in addition to treating all variables as exogenous, captures more features of the data and therefore provides fairly good results that can be used to make inferences about the data.

3.6.4.1 Lag selection

To effectively assess the short-run relationship between the exchange rate and the price per barrel of oil, it was essential to determine the appropriate lag to be applied in the VAR model. To achieve this end, the information criteria - Akaike's information criteria (AIC), Schwarz information criteria (SIC) and Hannan Quinn information criteria (HQIC) – Sequential Modified Likelihood Ratio (LR) test, and Final Prediction Error (FPE) test, were applied.

3.6.4.2 Granger Causality

Granger causality is applied for determining whether one time series is useful for forecasting another. The causal relationship of two separate time series can be identified by using the Granger Causality test. The test is based on the VAR model. Each estimated VAR model is tested to find out whether a causal relationship exists between the two variables. (Granger 1969) According to the Granger causality theorem, a variable y_t is Granger causing another variable x_t if it's possible to predict better the variable y_t using all available information about the variable x_t and not just the lagged values of y_t . (Granger 1969.)

3.6.4.3 Impulse response

Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted

3.6.4.4 Variance decomposition

Variance decompositions offer a slightly different method for examining VAR system dynamics. They give the proportion of the movements in the dependent variables that are due to their 'own' shocks, versus shocks to the other variables. A shock to the i th variable will directly affect that variable of course, but it will also be transmitted to all of the other variables in the system through the dynamic structure of the VAR (Zhang, Fan, Tsai & Wei 2008.)

3.7 Research Quality

Data for the study are collected from ratified institutions and therefore a pre-assumption of verifiability and accuracy of data is made. This therefore indicates that the results to be obtained from this study will be derived from quality data and therefore inferences to be made are valid and robust.

3.8 Ethical Considerations

Given the reliance on secondary data from public sources, it is noteworthy that few ethical considerations are to be taken into account in the sourcing of pertinent data. Accuracy and rigor in collection will however be established by multiple checks on collected data.

CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION

4.1 Introduction

This chapter provides an analysis of series data collected over the period 2000 to 2017. The section is divided into five main categories – descriptive statistics, unit root tests, cointegration analysis, VAR model and summary of findings. The first section provides a graphical representation of the data; the second establishes the suitability of the data for assessment of cointegration. The third and fourth section describe analysis based on cointegration approaches – Engle-Granger Test, and Johansen Test and VAR model respectively. The final section summarizes findings from the preceding sections.

4.2 Descriptive Statistics of Oil price and USDKES exchange rate

4.2.1 Oil Price

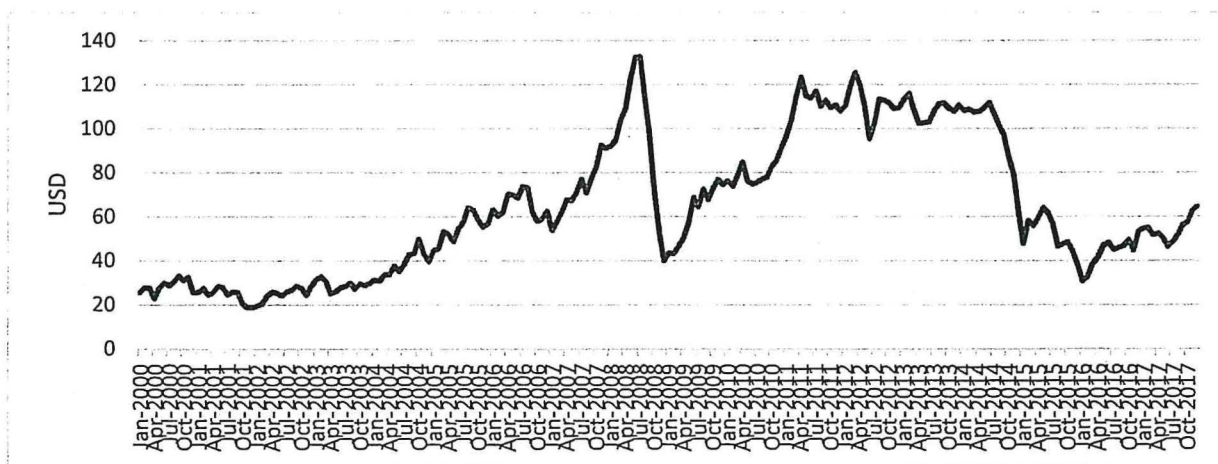


Figure 4.1 Monthly observations of Oil Price

Figure 4.1 depicts the graph showing the USD buying price per barrel of oil which indicates that a general upward trend was observed pre-2008. Rapidly increasing demand in emerging economies such as China and India and production cuts by the Organization of Petroleum Exporting Countries (OPEC) in the Middle East drove the price of oil to its record highs. Shortly after following a deep global recession that cut global demand, a steep dip was

experienced with prices plummeting to a low of USD 40 by the end of 2008. The economic recovery that began the following year sent the price of oil back over USD 100; it hovered between USD 100 and USD 125 until 2014, when it experienced another steep drop following a slowdown in large emerging economies notably China. After a rebound in the first two quarters of 2015, oil prices dropped again following a slowdown in aggregate demand and an increase in oil supply by OPEC

4.2.2. USDKES Exchange rate

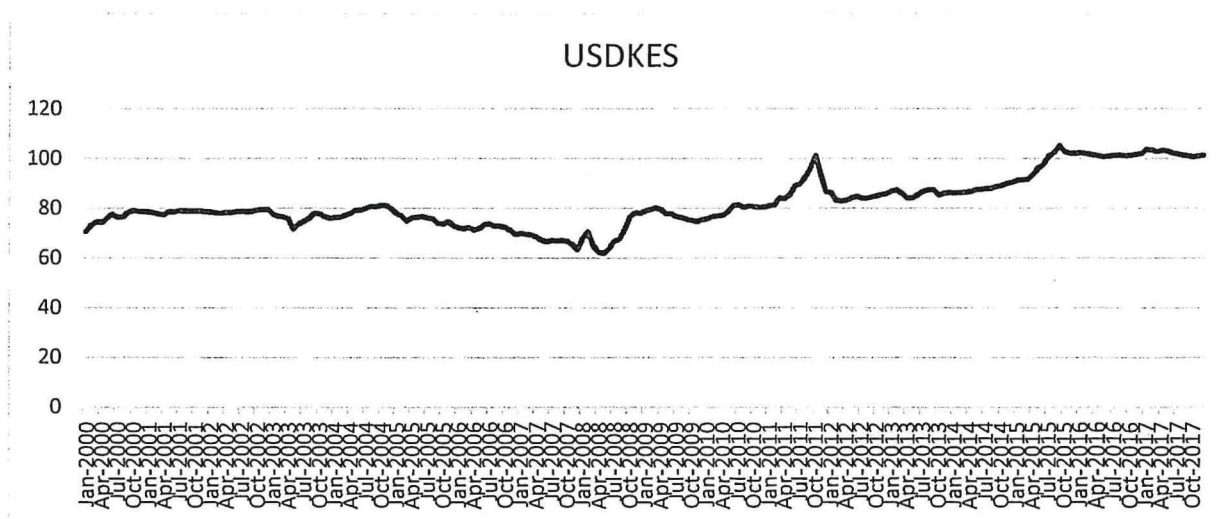


Figure 4.2 Monthly observation of USD/ KES exchange rate

The USD to KES exchange rate showed stagnation at the 80 mark from 2000 to 2003 with a period of KES appreciation to a trough of 63 in November 2007. An upward trend indicating a period of KES depreciation was then observed at the start of 2008 following the political crisis after the general election and resulting election violence. Following this a general weakness of the KES was observed which reached a low against the US Dollar of 101 in October 2011. The elements behind this were rising international food prices, and higher global fuel prices, which were triggered by the crisis in the Arab world, effects of the Euro crisis, widening fiscal and current account deficits This was followed by a decline to 83 in April 2012 after which a steady increase was observed reaching 106 in September 2015, attributed to reduction of export inflows from tourism over security concerns and weakness in the agricultural sector. A downward trend

was observed following the recovery of the KES, and steady trend around the 100 mark has been observed since.

4.2.3 USDUSD Exchange Rate

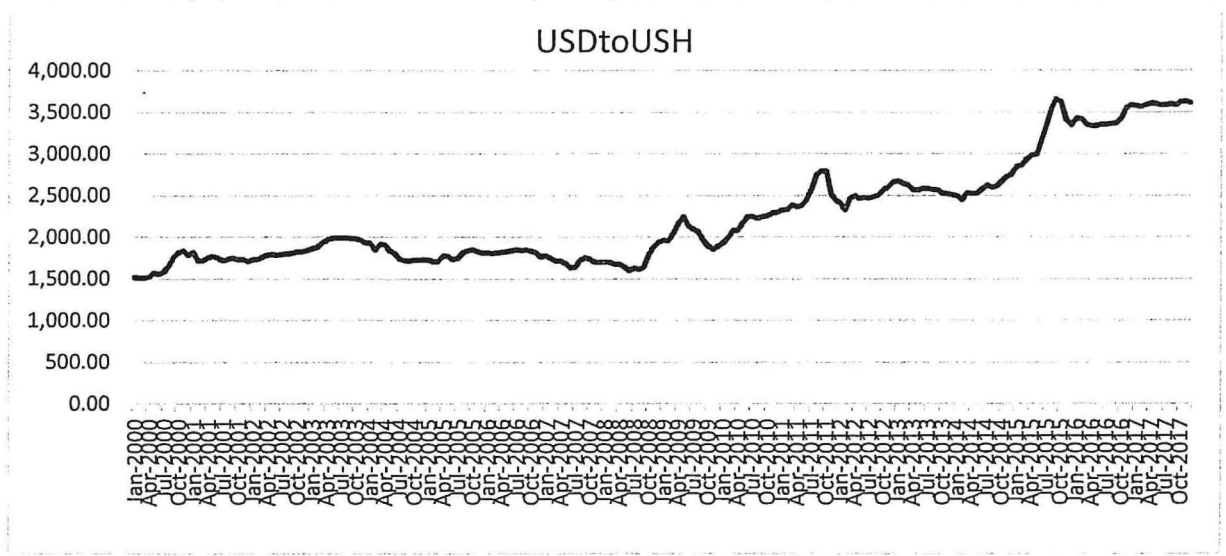


Figure 4.3 USD to USH exchange rate

The USD to USH exchange rate showed stagnation at the 2000 mark from 2000 to 2004 with a period of slow decline to a trough of 1600 in May, 2008. An upward trend was then observed leading to a peak of 3600 in October 2011. This was followed by a decline to 3300 in April 2012 after which a steady increase was observed reaching 3600 in May of 2017. The general movement for the pair was similar to that observed for the USD to KES exchange rate thereby indicating a similarity in market trends within the region.

4.3 Unit Root Tests Results

To assess the suitability of the time series data for cointegration analysis, the order of integration of the datasets was established using two unit-root tests - Augmented Dickey-Fuller (ADF) and in addition Phillips-Perron test was done to confirm for triangulation. Both tests were run for each of the two datasets at the log level and at first difference.

4.3.1 Augmented Dickey – Fuller (ADF) Unit Root Test Results

Table 4.1 Augmented Dickey-fuller unit root test results

Augmented Dickey- Fuller (ADF) unit root test results							
Variable	Level		First Difference		Test critical values		
	t-statistic	p value	t-statistic	p value	1%	5%	10%
Oil price	-1.876902	0.6630	-11.76654	0.0000	-4.001516	-3.430963	-3.139114
USDKES rate	-2.222840	0.4741	-10.21964	0.0000	-4.001722	-3.431062	-3.139173

In assessing the variable Oil price with the test for unit root at level, the data presented an Augmented Dickey-Fuller test statistic of -1.876902 with a p-value of 0.6630. Given that the generated t-statistic was lower than the test critical values at 1%, 5% and 10% levels, and that the p-value was higher than α 0.05, the null hypothesis indicating that the series had a unit root could not be rejected. In assessing the variable Oil price with the test for unit root at first difference, the data presented an Augmented Dickey-fuller test statistic of -11.76654 with a p-value of less than 0.01. Given that the generated t-statistic was higher than the test critical values at 1%, 5% and 10% levels, and that the p-value was lower than α 0.05, the null hypothesis indicating that the series had a unit root was rejected; the series was therefore of I (1)

In assessing the variable USDKES exchange rate with the unit test at level, the data presented an Augmented Dickey-fuller test statistic of -2.222840 with a p-value of 0.4741. Given that the generated t-statistic was lower than the test critical values at 1%, 5% and 10% levels, and that the p-value was higher than α 0.05, the null hypothesis indicating that the series had a unit root could not be rejected. In assessing the variable USDKES exchange rate with the test for unit root at first difference, the data presented an Augmented Dickey-fuller test statistic of -10.76654 with a p-value of less than 0.01. Given that the generated t-statistic was higher than the test critical values at 1%, 5% and 10% levels, and that the p-value was lower than α 0.05, the null hypothesis indicating that the series had a unit root was rejected; the series was therefore of I (1).

The results suggest that all variables are nonstationary in levels and stationary in first difference, i.e. they are I (1) variables. This therefore suggested a possibility of the presence of cointegrating relationship between oil price and USDKES exchange rate. The findings are supported by the literature, many series in finance exhibit non-stationary at log level and have to be differenced at least once to obtain stationarity (Brooks, 2008). Niyimbanira (2013) in a study in South Africa also found that the variables real exchange rate and fuel price become stationary after the first difference. Similar results were in studies on exchange rate oil and fuel prices in Kenya. (Chelimo, 2015; Irungu, 2017)

4.3.2 Phillips – Perron Unit Root Test Results

Table 4.2 Phillips - Perron unit root test results

Phillips - Perron unit root test results							
Variable	Level		First Difference		Test critical values		
	t-statistic	p value	t-statistic	p value	1%	5%	10%
Oil price	-1.748230	0.7263	-11.75642	0.0000	-4.001516	-3.430963	-3.139114
USDKES rate	-1.913174	0.6442	-10.77352	0.0000	-4.001516	-3.430963	-3.139114

In assessing the variable Oil Price with the test for unit root at level, the data presented a Phillips-Perron test statistic of -1.748230 with a p-value of 0.7263. Given that the generated t-statistic was lower than the test critical values at 1%, 5% and 10% levels, and that the p-value was higher than α 0.05, the null hypothesis indicating that the series had a unit root was not rejected. In assessing the variable Oil price with the test for unit root at first difference, the data presented a Phillips-Perron test statistic of -11.75642 with a p-value of less than 0.01. Given that the generated t-statistic was higher than the test critical value at 1%, 5% and 10% levels, and that the p-value was lower than α 0.05, the null hypothesis indicating that the series had a unit root was rejected; the series was therefore of order I (1).

In assessing the variable USD to KES with the test for unit root at level, the data presented a Phillips-Perron test statistic of -1.913174 with a p-value of 0.6442. Given that the generated t-

statistic was lower than the test critical values at 1%, 5% and 10% levels, and that the p-value was higher than α 0.05, the null hypothesis indicating that the series had a unit root could not be rejected.

In assessing the variable USD to KES with the test for unit root at first difference, the data presented a Phillips-Perron test statistic of -10.77352 with a p-value of less than 0.01. Given that the generated t-statistic was higher than the test critical value at 1%, 5% and 10% levels, and that the p-value was lower than α 0.05, the null hypothesis indicating that the series had a unit root was rejected; the series was therefore of order I (1). These results reinforced the ADF unit root test suggesting a possibility of the presence of cointegrating relationship between oil price and USDKES exchange rate.

4.4 Tests of Cointegration between Oil price and USDKES exchange rate

Of the variables assessed, all presented evidence of being of order I(1) as inferred from at least one level of the Augmented Dickey-Fuller test. Based on results from the Augmented Dickey-Fuller tests and Phillips- Perron test it was observed that the series could be assessed for cointegration as they prevented evidence of being of order I (1) at least at one critical value level. The objective of the study – to examine the effect of oil prices on the exchange rate – was therefore addressed through cointegration analysis using two tests – the Engle-Granger Test and the Johansen Test. The results of the tests addressing the objectives are presented below.

4.4.1 Engle-Granger Test Results

The first stage of the test involved depicting the USD/KES exchange rate as the dependent variable with the oil price as the independent variable. The error correction terms (residuals) from the equation were then generated and assessed for presence of a unit root. The results are depicted in table 4.3

Table 4.3 Engle – Granger Stationary test on residuals

Engle-Granger Stationary test on residuals	
	Test critical values

t- statistic	p value	1%	5%	10%
-1.162904	0.6905	-3.460884	-2.874868	-2.573951

The test indicated a t-statistic of -1.162904 and a p-value of 0.6905. The assessed t-statistic was lower than the critical values at levels 1%, 5% and 10%. The p-value was higher than $\alpha = 0.05$. The null hypothesis, indicating that the series has a unit root was therefore not rejected, an indication that oil price and USDKES exchange rate are not cointegrated

4.4.2 Johansen Cointegration Test Results

In assessing cointegration using the Johansen cointegration test, it was observed that under the trace and maximum eigenvalue cointegration test criteria, no cointegration equations emerged. This therefore indicated that there was not a cointegrated relationship between the two series. The results of this test are shown in table 4.4.

Table 4.4 Johansen Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob**
None	0.019620	4.718766	15.49471	0.8379
At most 1	0.002546	0.537869	3.841466	0.4633
Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob**
None	0.019620	4.180896	14.26460	0.8398
At most 1	0.002546	0.537869	3.841466	0.4633
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

The findings of no cointegration go against the theoretical research on exchange rate theories specifically the balance of payments theory posited by Krugman (1983), that expects the currencies of oil importers such as Kenya to depreciate after an oil price rise. That said, it may be that the import demand of oil is relatively elastic, suggesting that increase in oil price leads to a decrease in quantity demanded therefore having no effect on the exchange rate.

The findings are however in line with similar studies (Habib & Kalamova, 2007; Buetzer, Habib, Stracca, 2012; Chelimo, 2015) that have found no long-run relationship between oil price and exchange rate

4.5 VAR Model Results

Upon establishment of a lack of cointegration between the variables, short-run relationships between the two series were assessed through the vector autoregression technique. The process involved establishment of the appropriate lag length through criteria lag selection approaches - Akaike's information criteria (AIC), Schwarz information criteria (SIC), Hannan Quinn information criteria (HQIC) – Sequential Modified Likelihood Ratio (LR) test, and Final Prediction Error (FPE) test. The ordinal least squared estimation was then used to generate p-values used to evaluate the significance of the various coefficients depicted in the autoregression model

4.5.1 Lag selection

To effectively assess the short-run relationship between the exchange rate and the price per barrel of oil, it was essential to determine the appropriate lag to be applied in the VAR model. To achieve this end, the information criteria - Akaike's information criteria (AIC), Schwarz information criteria (SIC) and Hannan Quinn information criteria (HQIC) – Sequential Modified Likelihood Ratio (LR) test, and Final Prediction Error (FPE) test, were applied. Results, as per each of the criteria, is indicated in table 4.5

Table 4.5 Endogenous variables

Lag	LogL	LR	FPE	AIC	SC	HQ
0	327.6155	NA	0.000150	-3.130918	-3.098826	-3.117942

1	1086.203	1495.294	1.06e-07	-10.38657	-10.29030	-10.34764
2	1104.331	35.38292	9.23e-08	-10.52241	-10.36195*	-10.45753*
3	1109.334	9.670741*	9.14e-08*	-10.53206*	-10.30742	-10.44123
4	1112.446	5.954800	9.22e-08	-10.52352	-10.23470	-10.40674
5	1113.076	1.192759	9.53e-08	-10.49112	-10.13811	-10.34838
6	1114.309	2.311790	9.78e-08	-10.46451	-10.04732	-10.29582
7	1118.028	6.901730	9.81e-08	-10.46181	-9.980433	-10.26717
8	1118.398	0.680002	1.02e-07	-10.42691	-9.881349	-10.20631
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Three of the tests, (LR, FPE and AIC) indicated an optimal lag length of three, whereas the SC and HQ tests indicated two as the optimal lag length; lag length three was therefore chosen as the preferential lag for subsequent assessment of the variables.

4.5.2 Granger causality results

Pairwise tests of Granger causality were conducted to demonstrate the short run impact of oil price on exchange rate. A summary of the results from the tests are reported in Table 4.6

Table 4.6 Granger Causality Test results

Null Hypothesis:	Observations	F-Statistic	Prob.
USDKES does not Granger Cause OIL PRICE	214	3.81275	0.0236
OIL PRICE does not Granger Cause USDKES		0.80807	0.4471

It emerged the variable cannot be inferred to be a valid explanative variable as it presented a p-value of 0.4471 (higher than $\alpha=0.05$) hence the null hypothesis indicating that oil price does not granger cause changes in the exchange rate could not be rejected. Oil price movements cannot forecast exchange rate movements. This finding also does not follow some of the empirical literature (Kin & Courage, 2014) that found causality between oil price and exchange rates. However, this result is akin to the findings of Gachara (2015) that world crude oil price shocks do not directly Granger-cause exchange rate. In addition, Reboredo (2012) also found that oil price-exchange rate dependence is generally weak during turbulent time such as financial crisis, which cover the period under this study. Interestingly, the hypothesis that USDKES does not granger cause oil price is rejected. This could suggest that the oil price responds to changes in the value of the US Dollar specifically, because the oil price is denominated in USD. According to Yousefi and Wirjanto (2003), most OPEC countries will adjust their prices on the value of the dollar to maintain market share and secure the purchasing power of oil revenue in the foreign exchange markets but not the other way around.

4.5.3 Unrestricted VAR models

Following the results of the cointegration tests – no cointegration relationship between the variables – and having established that the series were stationary, the presence of a short-term relationship was assessed through construction of an unrestricted vector autoregression model (VAR). The lag length of three, as deemed suitable was used. Three coefficients per variable were generated with one, the seventh, being the error term used to estimate the OLS regression.

The ordinal least squared estimation was then used to generate p-values used to evaluate the significance of the various coefficients depicted in the autoregression model. The results are shown in table 4.8 below.

Table 4.8 Ordinal Least Squares estimates

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.340355	0.068885	19.45800	0.0000

C(2)	-0.524807	0.110162	-4.763935	0.0000
C(3)	0.175331	0.069451	2.524543	0.0123
C(4)	-0.013791	0.013991	-0.985703	0.3254
C(5)	0.017965	0.021193	0.847709	0.3976
C(6)	-0.001603	0.013769	-0.116424	0.9074
C(7)	0.013475	0.019782	0.681170	0.4965
R-squared	0.979624	Mean dependent var		1.911955
Adjusted R-squared	0.979031	S.D. dependent var		0.053518
S.E. of regression	0.007750	Akaike info criterion		-6.850000
Sum squared resid	0.012372	Schwarz criterion		-6.739535
Log likelihood	736.5249	Hannan-Quinn criter.		-6.805357
F-statistic	1650.676	Durbin-Watson stat		1.957862
Prob(F-statistic)	0.000000			

From the output, it emerged that the coefficients C(1), C(2) and C(3) - representing the three lagged periods of the USD to KES rate – were statistically significant. All other coefficients were not statistically significant at $\alpha = 0.05$. The equation of interest, derived from the OLS estimation is depicted below with the tabulated results presented in table 4.9.

$$\text{USD TOKSH_LOG_} = C(1)*\text{USD TOKSH_LOG_}(-1) + C(2)*\text{USD TOKSH_LOG_}(-2) + C(3)*\text{USD TOKSH_LOG_}(-3) + C(4)*\text{DOLLARS_PER_BARREL_LOG_}(-1) + C(5)*\text{DOLLARS_PER_BARREL_LOG_}(-2) + C(6)*\text{DOLLARS_PER_BARREL_LOG_}(-3) + C(7)$$

Table 4.9 OLS regression results

R-squared	0.979624	Mean dependent var	1.911955
Adjusted R-squared	0.979031	S.D. dependent var	0.053518
S.E. of regression	0.007750	Sum squared resid	0.012372

Durbin-Watson stat	1.957862		
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The regression model, as indicated by the 0.98 R-squared value accounted for 98% of the variance in the dependent variable - exchange rate. The lagged values of the exchange rate were the only statistically inferable significant explanatory variables with their coefficients presenting p-values of less than 0.01, less than 0.01 and 0.0123 for the three lagged periods, respectively. Oil price was therefore not viewed as an inferable determinant of the exchange rate in the Kenyan context.

4.5.4 Variance Decomposition

Variance decomposition was further employed to estimate the variance that each variable accounted for in light of other predictors in the model.

Table 4.10 Variance decomposition

Variance Decomposition of USDTOKSH_LOG_:			
Period	S.E.	USDTOKSH_LOG_	DOLLARS_PER_BARRE L_LOG_
1	0.007750	100.0000	0.000000
2	0.013019	99.83567	0.164330
3	0.016432	99.75093	0.249065
4	0.018910	99.75669	0.243313
5	0.020979	99.78950	0.210499
6	0.022811	99.82104	0.178964
7	0.024455	99.84323	0.156772
8	0.025942	99.85325	0.146749
9	0.027299	99.84973	0.150274
10	0.028547	99.83211	0.167886

From the results depicted in table 4.10, it emerged that exchange rate accounted for 99.83% of the variance whereas the oil price accounted for 0.168%. The standard error associated with the

estimates was 0.028, hence being lower than 0.05, it emerged that the estimates were statistically significant. The predictive value of oil price on the exchange rate was therefore deemed marginal. This finding is line with Chelimo (2015) study that concluded that oil prices have little predictive power on exchange rates Kenya

4.5.4 Impulse response

The essence of the impulse response test is to assess the effect of a shock in the model on a variable of interest. The shock may be introduced in the form of a single standard deviation change on the variables of the model with the effect of the unit shock observed in light of the variable of interest. An impulse response test was therefore conducted with the effect observed on the exchange rate. The results are depicted in figure 4.3.

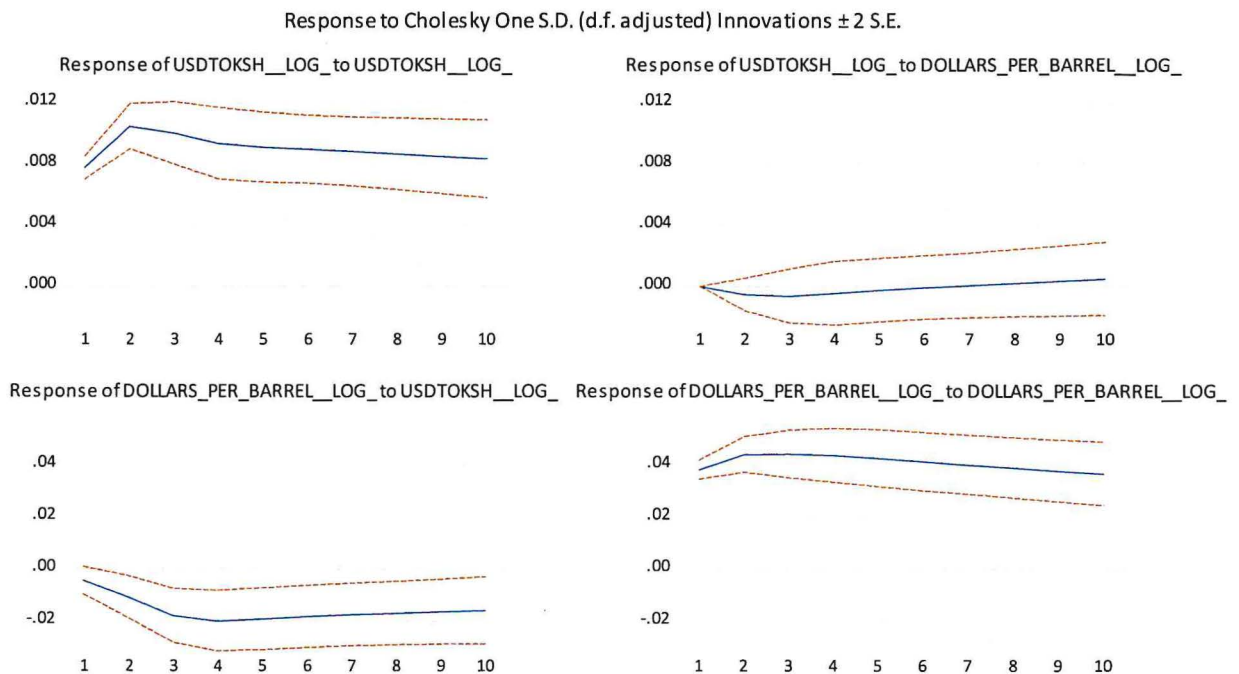


Figure 4.3 Response to Cholesky One S.D. innovations

The results of the analysis therefore indicate, as prior deduced from the variance decomposition assessment, that a unit shock on oil price results in a shock in exchange rate, albeit a marginal one.

Evidence from VAR estimation, impulse response functions and variance decomposition suggests that increased oil price volatility is expected to have significant negative effects on the exchange rates of oil importing countries. However, if exogenous factors affect the data the effects of many other exogenous conditions and variables such as policy interventions as is commonly seen by the Central Bank of Kenya and global economic crises would not explicitly show the impact of the change in oil prices on exchange rate (Beckman & Czudaj, 2013)

4.6 Summary of findings

In time series analysis, it is instructive to plot the observed values of the data series over time in order to have an idea whether the given data is stationary or not. This is confirmed by Gujarati and Porter (2009) who posit that it is advisable to plot the time series under investigation graphically. Such plots provide an initial clue about the likely nature of the time series. As depicted in the descriptive graphical summaries, the two series presented a general upward trend in the period of study, suggesting a correlation in the direction of oil price movements and USDKES exchange rate which would lead us to infer that increases in oil price lead to a depreciation in the local currency.

The study employed an empirical analysis to examine the effects of oil price on the USDKES exchange rate in Kenya. The first step in the empirical analysis involved testing the time series properties for stationarity using Augmented Dickey-Fuller (ADF) and Phillips-Perron test. The study results found that the variables oil price and exchange rate were characterized by a unit root at level but the hypothesis of non-stationarity was rejected at first difference. Both oil price and USDKES exchange rate were found to be of the same order of integration. This is consistent with the literature on characteristics of time series data exhibiting nonstationarity at level (Brooks, 2008) The similarity in order of integration, as established through both tests, therefore indicated that the two variables could be analysed for cointegration – the third objective of the study.

Two tests were run to check for cointegration of oil price and USD to KES exchange rates – the Engle-Granger Test and the Johansen Cointegration Test – with both indicating that the series were not cointegrated. This finding was contrary to those posited by most of the literature reviewed. Multiple authors indicate that oil prices have a direct effect on exchange rates (Beckmann & Czudaj, 2012; Nikbakht, 2009; Nkomo, 2006). Although most findings indicated that there was a relationship between the two timeseries, other others were of the opposing, and therefore supporting view to this study. Buetzer, Habib and Stracca (2012) in a study investigating whether oil shocks matter for global exchange rate configurations reveal found no systematic evidence of a clear link between the oil or the commodity trade balance and real exchange rate movements following oil price shocks. The relatively larger dataset considered in this study therefore serves to indicate that although seemingly unconventional, the findings from this study are valid. Further, in a recent study Chelimo (2015) using monthly observations between 2005 and 2014 analysed the relationship between Murban ADNOC oil price and the exchange rate in Kenya and found that import prices do not have a significant impact on exchange rates. Similarly, in a study on thirteen African countries including Kenya, Coleman, Cuestas and Morales (2010), found that the hypothesis of linearity between real oil price and real exchange was rejected in some countries but was not rejected in others. The Granger causality test was used to determine causality relationship by VAR model in which the optimal lag 2 had determined according to the Schwartz information criterion. The results indicate that oil price does not granger cause USDKES exchange rate, a finding in line with a similar study by Gachara (2015) on Kenya. Results from the unrestricted VAR analysis indicated that Oil price was not an inferable determinant of the exchange rate. The variance decomposition and impulse response functions found that unit shock on oil price results in a shock in exchange rate, albeit a marginal one. This could suggest that other exogenous variables have a larger impact on USDKES exchange rate.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS.

5.1 Introduction

This chapter provides the summary of the findings of the study conducted as per the research objectives. Also, the chapter provides conclusions and recommendations of the study in relation to the study findings

5.2 Chapter Summary

As volatility in oil prices continue to dominate global energy markets, and as governments and countries grapple with achieving some stability in exchange rates, the need for evidence on how this volatility impacts on countries becomes crucial. Aiming to contribute to studies determining the sources of shocks to real exchange rates, the main objective of this study was to examine the effect of oil price on the USDKES exchange rate over the period 2000 to 2017. Whether or not exchange rates depend in the long run on oil prices has important implications for exchange rate modelling.

The main objective of the study was to examine the effect of oil price on the USDKES exchange rate in Kenya over the period 2000 to 2017. The study was guided by the null hypothesis that oil price does not have a significant effect on the exchange rate. Time series data was sourced from the United States Energy Information Administration website and the Central Bank of Kenya economic reports. The study employed unit root tests, cointegration and VAR modelling to investigate the relationship between the two variables.

The first objective of the study was to understand the characteristics of the variables oil price and exchange rate. Results show that both oil price and USDKES exchange rate exhibit an upward trend, inferring a directional correlation where, as oil prices, an upward move in the USD (KES depreciation) is observed.

The second and third objective of the study was to check the short run and long run relationship between oil price and exchange rates. Following cointegration and VAR tests, the study finds

that there is no long-run cointegrating relationship between oil price and exchange rates. However, the study finds that oil prices account for a smaller proportion of exchange rate movements.

5.3 Conclusion

The main purpose of this study was to establish the relationship between oil prices and the USD to KES exchange price. A relationship between the variables would serve to inform on possible impact to the USD to KES exchange rate following fluctuations in oil price. Most studies unveiled in the literature review indicated a relationship between the two variables with oil prices generally posited as having an impact on the exchange rate. There was however a considerable collection of studies arguing the opposite position thereby indicating a lack of consensus in the association of the timeseries. Findings from this study served to give weight to the position indicating a lack of relationship between oil price and exchange rate in the Kenyan context. A fair conclusion is that oil price movements are not a silver bullet for understanding or forecasting the USDKES exchange rate.

5.4 Recommendations and Areas for further Research

It is worth noting that the intensity or lack thereof of the link between oil prices and exchange rates is of potential relevance for monetary policy makers. Policy makers such as the Central Bank of Kenya which has the objective of price stability will react less to less to inflationary effects stemming from oil prices. Business entities and Commercial would also be expected to update their forecasting models to incorporate the finding that oil price has a marginal impact on the nominal exchange rate.

It is well appreciated that the variables included in this model are not, by any means, the only ones or the most pivotal. Given that exchange rates are influenced by a wide array of factors, it would be necessary for other researchers to conduct future investigations into the long-run relationship of exchange rates with other variables. Another important avenue for future research is an extension of the study to the East African Community given the linkages these economies have with each other.

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IMF working Paper

APPENDICES

Table A1: Dollars per barrel - Augmented Dickey-Fuller Test: Level

Null Hypothesis: DOLLARS_PER_BARREL has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 1 (Automatic - based on SIC, maxlag=14)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.876902	0.6630
Test critical values:		
1% level	-4.001516	
5% level	-3.430963	
10% level	-3.139114	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(DOLLARS_PER_BARREL)
 Method: Least Squares
 Date: 04/09/18 Time: 18:27
 Sample (adjusted): 2000M03 2017M12
 Included observations: 214 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOLLARS_PER_BARREL(-1)	-0.027585	0.014697	-1.876902	0.0619
D(DOLLARS_PER_BARREL(-1))	0.223699	0.067314	3.323190	0.0010
C	0.045568	0.022779	2.000421	0.0467
@TREND("2000M01")	3.74E-05	5.46E-05	0.684757	0.4943
R-squared	0.061946	Mean dependent var		0.001705
Adjusted R-squared	0.048545	S.D. dependent var		0.040026
S.E. of regression	0.039043	Akaike info criterion		-3.629800
Sum squared resid	0.320112	Schwarz criterion		-3.566885
Log likelihood	392.3886	Hannan-Quinn criter.		-3.604376
F-statistic	4.622568	Durbin-Watson stat		2.005286
Prob(F-statistic)	0.003739			

Table A.2 Dollars per barrel - Augmented Dickey-Fuller Test: First Difference

Null Hypothesis: D(DOLLARS_PER_BARREL) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=14)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-11.76654	0.0000
Test critical values:		
1% level	-4.001516	
5% level	-3.430963	
10% level	-3.139114	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(DOLLARS_PER_BARREL,2)
 Method: Least Squares
 Date: 04/09/18 Time: 18:29
 Sample (adjusted): 2000M03 2017M12
 Included observations: 214 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DOLLARS_PER_BARREL(-1))	-0.791211	0.067242	-11.76654	0.0000
C	0.004037	0.005442	0.741816	0.4590
@TREND("2000M01")	-2.50E-05	4.35E-05	-0.574152	0.5665
R-squared	0.396228	Mean dependent var		-0.000120
Adjusted R-squared	0.390505	S.D. dependent var		0.050308
S.E. of regression	0.039276	Akaike info criterion		-3.622510
Sum squared resid	0.325482	Schwarz criterion		-3.575323
Log likelihood	390.6086	Hannan-Quinn criter.		-3.603442
F-statistic	69.23486	Durbin-Watson stat		1.996927
Prob(F-statistic)	0.000000			

Table A.3 Dollars per barrel - Phillips-Perron Test: Level

Null Hypothesis: DOLLARS_PER_BARREL has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.748230	0.7263
Test critical values:		
1% level	-4.001311	
5% level	-3.430864	
10% level	-3.139056	

*Mackinnon (1996) one-sided p-values.

Residual variance (no correction)	0.001571
HAC corrected variance (Bartlett kernel)	0.002088

Phillips-Perron Test Equation

Dependent Variable: D(DOLLARS_PER_BARREL)

Method: Least Squares

Date: 04/09/18 Time: 18:31

Sample (adjusted): 2000M02 2017M12

Included observations: 215 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOLLARS_PER_BARREL(-1)	-0.022243	0.014910	-1.491764	0.1372
C	0.039410	0.023123	1.704350	0.0898
@TREND("2000M01")	1.29E-05	5.52E-05	0.232882	0.8161
R-squared	0.013708	Mean dependent var		0.001870
Adjusted R-squared	0.004403	S.D. dependent var		0.040005
S.E. of regression	0.039917	Akaike info criterion		-3.590162
Sum squared resid	0.337798	Schwarz criterion		-3.543130
Log likelihood	388.9424	Hannan-Quinn criter.		-3.571159
F-statistic	1.473240	Durbin-Watson stat		1.560804
Prob(F-statistic)	0.231518			

Table A.4 Dollars per barrel – Phillips-Perron Test: First Difference

Null Hypothesis: D(DOLLARS_PER_BARREL) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-11.75642	0.0000
Test critical values:		
1% level	-4.001516	
5% level	-3.430963	
10% level	-3.139114	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.001521
HAC corrected variance (Bartlett kernel)	0.001509

Phillips-Perron Test Equation
 Dependent Variable: D(DOLLARS_PER_BARREL,2)
 Method: Least Squares
 Date: 04/09/18 Time: 18:33
 Sample (adjusted): 2000M03 2017M12
 Included observations: 214 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DOLLARS_PER_BARREL(-1))	-0.791211	0.067242	-11.76654	0.0000
C	0.004037	0.005442	0.741816	0.4590
@TREND("2000M01")	-2.50E-05	4.35E-05	-0.574152	0.5665
R-squared	0.396228	Mean dependent var		-0.000120
Adjusted R-squared	0.390505	S.D. dependent var		0.050308
S.E. of regression	0.039276	Akaike info criterion		-3.622510
Sum squared resid	0.325482	Schwarz criterion		-3.575323
Log likelihood	390.6086	Hannan-Quinn criter.		-3.603442
F-statistic	69.23486	Durbin-Watson stat		1.996927
Prob(F-statistic)	0.000000			

Table A.5 USD to KES - Augmented Dickey-Fuller Test: Level

Null Hypothesis: USDTOKSH has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 1 (Automatic - based on SIC, maxlag=14)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.222840	0.4741
Test critical values: 1% level	-4.001516	
5% level	-3.430963	
10% level	-3.139114	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(USDTOKSH)
 Method: Least Squares
 Date: 04/09/18 Time: 18:56
 Sample (adjusted): 2000M03 2017M12
 Included observations: 214 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
USDTOKSH(-1)	-0.032073	0.014429	-2.222840	0.0273
D(USDTOKSH(-1))	0.322003	0.064834	4.966604	0.0000
C	0.059053	0.026631	2.217453	0.0277
@TREND("2000M01")	2.46E-05	1.23E-05	1.993591	0.0475
R-squared	0.117347	Mean dependent var		0.000659
Adjusted R-squared	0.104738	S.D. dependent var		0.008196
S.E. of regression	0.007755	Akaike info criterion		-6.862459
Sum squared resid	0.012629	Schwarz criterion		-6.799543
Log likelihood	738.2831	Hannan-Quinn criter.		-6.837035
F-statistic	9.306392	Durbin-Watson stat		1.906909
Prob(F-statistic)	0.000008			

Table A.6 USD to KES - Augmented Dickey-Fuller Test: First Difference

Null Hypothesis: D(USD TOKSH) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 1 (Automatic - based on SIC, maxlag=14)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-10.21964	0.0000
Test critical values:		
1% level	-4.001722	
5% level	-3.431062	
10% level	-3.139173	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(USD TOKSH,2)
 Method: Least Squares
 Date: 04/09/18 Time: 18:56
 Sample (adjusted): 2000M04 2017M12
 Included observations: 213 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(USD TOKSH(-1))	-0.815921	0.079839	-10.21964	0.0000
D(USD TOKSH(-1),2)	0.171422	0.067571	2.536920	0.0119
C	-9.78E-05	0.001080	-0.090536	0.9279
@TREND("2000M01")	5.66E-06	8.64E-06	0.654563	0.5135
R-squared	0.369175	Mean dependent var		-2.96E-05
Adjusted R-squared	0.360120	S.D. dependent var		0.009681
S.E. of regression	0.007744	Akaike info criterion		-6.865190
Sum squared resid	0.012534	Schwarz criterion		-6.802067
Log likelihood	735.1428	Hannan-Quinn criter.		-6.839680
F-statistic	40.77070	Durbin-Watson stat		1.957904
Prob(F-statistic)	0.000000			

Table A.7 USD to KES - Phillips-Perron Test: Level

Null Hypothesis: USDTOKSH has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.913174	0.6442
Test critical values: 1% level	-4.001311	
5% level	-3.430864	
10% level	-3.139056	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	6.67E-05
HAC corrected variance (Bartlett kernel)	9.93E-05

Phillips-Perron Test Equation
 Dependent Variable: D(USDTOKSH)
 Method: Least Squares
 Date: 04/09/18 Time: 18:57
 Sample (adjusted): 2000M02 2017M12
 Included observations: 215 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
USDTOKSH(-1)	-0.023435	0.015199	-1.541839	0.1246
C	0.043494	0.028057	1.550205	0.1226
@TREND("2000M01")	1.86E-05	1.30E-05	1.434358	0.1529
R-squared	0.012104	Mean dependent var		0.000728
Adjusted R-squared	0.002784	S.D. dependent var		0.008238
S.E. of regression	0.008226	Akaike info criterion		-6.749107
Sum squared resid	0.014346	Schwarz criterion		-6.702075
Log likelihood	728.5291	Hannan-Quinn criter.		-6.730104
F-statistic	1.298694	Durbin-Watson stat		1.357261
Prob(F-statistic)	0.275050			

Table A.8 USD to KES – Phillips-Perron Test: First Difference

Null Hypothesis: D(USDTOKSH) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-10.77352	0.0000
Test critical values:		
1% level	-4.001516	
5% level	-3.430963	
10% level	-3.139114	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	6.04E-05
HAC corrected variance (Bartlett kernel)	6.34E-05

Phillips-Perron Test Equation
 Dependent Variable: D(USDTOKSH,2)
 Method: Least Squares
 Date: 04/09/18 Time: 18:57
 Sample (adjusted): 2000M03 2017M12
 Included observations: 214 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(USDTOKSH(-1))	-0.694916	0.064984	-10.69368	0.0000
C	-9.55E-05	0.001082	-0.088322	0.9297
@TREND("2000M01")	4.91E-06	8.67E-06	0.566974	0.5713
R-squared	0.351576	Mean dependent var		-6.78E-05
Adjusted R-squared	0.345430	S.D. dependent var		0.009674
S.E. of regression	0.007827	Akaike info criterion		-6.848548
Sum squared resid	0.012926	Schwarz criterion		-6.801362
Log likelihood	735.7947	Hannan-Quinn criter.		-6.829481
F-statistic	57.20224	Durbin-Watson stat		1.898641
Prob(F-statistic)	0.000000			

Table A.9 Engle-Granger Test Step 1

Dependent Variable: USDTOKSH_LOG_ Method: Least Squares Date: 05/04/18 Time: 16:32 Sample: 2000M01 2017M12 Included observations: 216				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOLLARS_PER_BARREL_LO	0.010290	0.015878	0.648077	0.5176
C	1.893247	0.028032	67.53893	0.0000
R-squared	0.001959	Mean dependent var		1.911260
Adjusted R-squared	-0.002705	S.D. dependent var		0.053478
S.E. of regression	0.053550	Akaike info criterion		-3.007181
Sum squared resid	0.613670	Schwarz criterion		-2.975929
Log likelihood	326.7756	Hannan-Quinn criter.		-2.994555
F-statistic	0.420004	Durbin-Watson stat		0.024264
Prob(F-statistic)	0.517630			

Table A.10 Engel-Granger Test Step 2

Null Hypothesis: RESID01 has a unit root Exogenous: Constant Lag Length: 1 (Automatic - based on SIC, maxlag=14)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.162904	0.6905
Test critical values:	1% level		-3.460884	
	5% level		-2.874868	
	10% level		-2.573951	
*Mackinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(RESID01) Method: Least Squares Date: 05/04/18 Time: 16:34 Sample (adjusted): 2000M03 2017M12 Included observations: 214 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.011847	0.010187	-1.162904	0.2462
D(RESID01(-1))	0.324176	0.064980	4.988882	0.0000
C	0.000410	0.000539	0.761219	0.4474
R-squared	0.107023	Mean dependent var		0.000642
Adjusted R-squared	0.098559	S.D. dependent var		0.008273
S.E. of regression	0.007855	Akaike info criterion		-6.841435
Sum squared resid	0.013019	Schwarz criterion		-6.794249
Log likelihood	735.0336	Hannan-Quinn criter.		-6.822368
F-statistic	12.64412	Durbin-Watson stat		1.898805
Prob(F-statistic)	0.000007			

Table A.11 Vector Autoregression Estimates

	USD TOKSH_LOG_	DOLLARS_PER_BARREL_LOG_
USD TOKSH_LOG_(-1)	1.340355 (0.06888) [19.4580]	-0.728462 (0.34241) [-2.12748]
USD TOKSH_LOG_(-2)	-0.524807 (0.11016) [-4.76394]	0.167277 (0.54759) [0.30548]
USD TOKSH_LOG_(-3)	0.175331 (0.06945) [2.52454]	0.551682 (0.34522) [1.59806]
DOLLARS_PER_BARREL_LOG_(-1)	-0.013791 (0.01399) [-0.98570]	1.151580 (0.06955) [16.5584]
DOLLARS_PER_BARREL_LOG_(-2)	0.017965 (0.02119) [0.84771]	-0.179391 (0.10534) [-1.70292]
DOLLARS_PER_BARREL_LOG_(-3)	-0.001603 (0.01377) [-0.11642]	0.007765 (0.06844) [0.11345]
C	0.013475 (0.01978) [0.68117]	0.055645 (0.09833) [0.56589]
R-squared	0.979624	0.972364
Adj. R-squared	0.979031	0.971559
Sum sq. resids	0.012372	0.305690
S.E. equation	0.007750	0.038522
F-statistic	1650.676	1208.000
Log likelihood	736.5249	394.9656
Akaike AIC	-6.850000	-3.642870
Schwarz SC	-6.739535	-3.532405
Mean dependent	1.911955	1.755028
S.D. dependent	0.053518	0.228420
Determinant resid covariance (dof adj.)		8.80E-08
Determinant resid covariance		8.23E-08
Log likelihood		1132.895
Akaike information criterion		-10.50606
Schwarz criterion		-10.28513
Number of coefficients		14