Determinants of Volatility of Pump Prices of Petroleum Products in Kenya

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DECLARATION

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

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DEDICATION

This thesis is dedicated to my beloved wife Minnie Wanjiru and my lovely children Richard Munyua and Cynthia Njeri for their understanding, prayers and support while I was undertaking this study. I also dedicate this thesis to my parents Richard Munyua and Virginia Wairimu for having given their all to ensure I went through the best schools they could afford and for having inculcated good values in me and for encouraging me to aim high in my studies.

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ACRONYMS AND ABBREVIATIONS

ACF	Auto Correlation Function
ANOVA	Analysis of Variance
ARDL	Autoregressive Distributed Lag
BP	British Petroleum
CBD	Central Business District
CBK	Central Bank of Kenya
PPI	Petroleum Price Index
DBA	Degree in Business Administration
DF	Degrees of Freedom
ECB	European Central Bank
ER	Exchange Rate
ERB	Energy Regulatory Board
ERC	Energy Regulatory Commission
EXR	Exchange Rate
FAVAR	Factor-Augmented Vector Auto-Regression
GMM	Generalized Method of Moments

GoK	Government of Kenya
IEA	Institute of Economic affairs
JKUAT	Jomo Kenyatta University of agriculture & Technology
KMO	Kaiser-Meyer-Olkin
KPC	Kenya Pipeline Company
KPRL	Kenya Petroleum Refineries Limited
K-R	Kunder-Richardson
KRA	Kenya Revenue Authority
MMBPD	Million Barrels per Day
MOEP	Ministry of Energy and Petroleum
NOCK	National Oil Company of Kenya
OECD	Organisation for Economic Co-operation and Development
OMC	Oil Marketing Company
OPEC	Organization of Petroleum Exporting Countries
OTS	Open Tender System
PCM	Principal Components Method
PCR	Price Cap Regulation

PIEA	Petroleum Institute of East Africa
POL	Political Shocks
PP	Pump Prices
PPP	Purchasing Power Parity
REG	Regulatory Costs
SCH	Supply Chain Costs
SPSS	Statistical Package for Social Science
UK	United Kingdom
UNCTAD	United Nation Centre of Trade and Development
US	United States
USA	United States of America
VAR	Vector Auto-Regression
VECM	Vector Error Correction Model
WOP	World Oil Prices
WTI	West Texas Intermediate

DEFINITION OF TERMS

Exchange Rate Fluctuation: This refers to changes in the value of one currency relative to another. An exchange rate between two currencies is the rate at which one currency was exchanged for another. It is also regarded as the value of one country's currency in terms of another currency (O'Sullivan & Steven, 2003).

Price Regulation: Price regulation is a form of regulation that sets upper limits on prices of utilities. The regulation takes into account such factors as the Petroleum Price Index, overall rate of inflation, and industry averages for operating efficiencies (Business Dictionary, 2011).

Supply Chain Disruption: A supply chain is channel of distribution beginning with the supplier of materials or components, extending through a manufacturing process to the distributor and retailer, and ultimately to the consumer Collins English Dictionary, (1991).

Price Volatility: Price volatility of oil is the standard deviation of oil prices in a given period. The economic uncertainty generated by the extreme volatility of oil prices has important consequences for the global economy that differ markedly from the impacts of oil price shocks

World Prices of Oil : The world price of oil generally refers to the spot price of a barrel of benchmark crude oil. World crude oil prices are established in relation to three market traded benchmarks (West Texas Intermediate (WTI, Brent or Dubai), and are quoted at premiums or discounts to these prices (International Energy Agency, 2006). The world prices of oil influence international trade. Barring any trade barriers, a country imports oil products with higher local prices than the world price (Farlex Financial Dictionary, 2012).

ABSTRACT

The purpose of this research was to examine the determinants of volatility in pump prices of petroleum products in Kenya. Petroleum products drive the economies of all countries in the world but the prices have been volatile, often affecting economic growth and planning. The study adopted a causal research design which ensured to investigate the problem using a time series model. This research design helped the researcher to understand why the dependent variable worked the way it did by proving causal links between variables and eliminating other possibilities. The population of this study comprised of the 65 licensed oil marketing companies and 600 oil dealers, one petroleum lobby group (PIEA), one regulator (ERC), Kenya Pipeline Company (KPC), Kenya Petroleum Refineries Limited (KPRL), National Oil Company of Kenya (NOCK) and Ministry of Energy and Petroleum & Petroleum (MOEP) all of whom play different roles in the Petroleum industry of the Energy sector in Kenya. The sampling technique followed in this study was stratified random sampling. The study selected all respondents where population was less than 30 and 30% of the target population. A self-administered questionnaire and face-to-face standardized interview schedules were the two principal tools of primary data collection. Target questions (structured and unstructured) were used in the questionnaire and addressed the investigative questions of the study. Closed ended questions were designed with alternative answers expressed in a Likert scale-style. Secondary data sources were the MOEP, ERC, PIEA, KPC and KPRL. The Data Collection Instrument, which is the questionnaire, was pilot tested on 5% of the sample size to ensure that it was manageable, relevant and effective. The data from the questionnaires and interviews schedules were coded and the response on each item put into specific main themes. Secondary data analysis used the E views statistical software to perform granger causality, GMM equation estimation, and analyse data for

correlation, heteroskedasticity and multicollinearity. Descriptive statistics were utilized to analyze data from observation schedules. Qualitative analysis involved content analysis and identification of common themes emerging from the responses to the interview schedule.The study findings indicate thatthe world had witnessed a high volatility of oil prices over the study period (December 2010 to June 2015). The greatest single factor influencing petroleum product prices is the world oil prices. Political shocks and supply chain costs also impacted pump prices in a statistically significant manner. Exchange rates and regulatory costs did not have a statistically significant impact. However, sudden shocks in regulatory components (tax changes) had a direct impact on pump prices. It was observed that they comprise a huge percentage of the pump price of up to 50%. Currency exchange rate fluctuations were found to indirectly affect volatility of oil prices. The study concludes that the pump pricing of petroleum products in Kenya is volatile and complex, and is regulated by more than one government body causing many sources of influences on pump prices. The study recommends that the Central Bank of Kenya (CBK) should be empowered to be always in a position to intervene and stabilize currency exchange rate fluctuations. The indirect impact of the requirement that petroleum taxes be paid at the point of product entry, and its financing implications further complicates the impact of taxes on prices of petroleum products. The study recommends that this should form part of a future study. The study recommends that in order to lessen the burden of dealing with petroleum prices, the government should consider reduction of regulatory costs (especially taxes) and also look into the issue of oil losses.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Price Volatility of Oil is defined as the standard deviation of oil prices in a given period. The economic uncertainty generated by the extreme volatility of oil prices has important consequences for the global economy that differ markedly from the impacts of oil price shocks (Ebrahim Z, Inderwildi O &King D., 2013).This study focuses on oil price volatility as opposed to shocks. Ebrahim et al (2013) explained that acute deviations in oil prices, such as those seen in early 2008 are termed shocks, while relatively minor price deviations are referred to as price volatility. This study seeks to examine the determinants of volatility of pump prices of petroleum products in Kenya and begins by reviewing the challenges faced when attempting to control volatility of oil prices from a global, regional and Kenya perspective.

1.1.1 Global Outlook of Oil Price Volatility

Ming (2009) observed that the global petroleum industry was, dominated by seven oil companies ("Seven Sisters") between mid-1940s and the 1970s which formed the "Consortium for Iran." The group comprised Standard Oil of New Jersey and Standard Oil Company of New York (now ExxonMobil); Standard Oil of California, Gulf Oil and Texaco (now Chevron); Royal Dutch Shell; and Anglo-Persian Oil Company (now BP). The world oil market today consists of the United States, Organization of Petroleum Exporting Countries (OPEC) and non- OPEC countries (Olowe, 2009). The twelve members of OPEC are Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. Countries that are non-OPEC members and are oil exporters include the United States, Norway, and Sudan among several others. OPEC is an intergovernmental cartel of twelve member countries established in 1960 (Boll, 2005). It was formed in an attempt to counter the oil Seven Sisters cartel, which had been controlling posted prices and had achieved a high level of price volatility until

1972. Boll (2005) further affirms that from the end of World War II until the oil embargo of 1973, the price of oil used to be low and stable. Hamilton (2008) states that although there was a time when a few oil companies played a big role in world oil markets, that era is long past. This supports (Boll, 2005) who observed that after the oil embargo the oil price shot up and then started to stabilize.

According to the United Nation Centre of Trade and Development (UNCTAD) (2005), between 1948 and 1970, small price movements occurred with seasonal changes in demand but the 1973 Arab oil embargo associated with the Yom Kippur War raised prices fourfold to $12.00.Subsequently, the Iranian revolution in 1979 decreased Iran's oil supply by 2.5 million barrels of oil per day (MMBPD) and the war with Iraq a year later further aggravated the situation. Oil prices increased from the $14 reached after the first shock to $35 per barrel.

Câmpean(2011) confirms this position by stating that until the foundation of OPEC in 1960, the market was dominated by Western oil companies which, though constantly in competition, resorted to secret agreements in order to control the production and the price. The crude oil price was as low as $2.17 per barrel in 1971 but spiked to $12 in 1973 and to $34 in 1981. It soared to approximately $40 per barrel toward the end of February 2003.Câmpean (2011) observes that during the oil shocks period OPEC held absolute power over oil prices; but after 1983 this power became relative power. Zittel and Schindler (2007), who notes that after 1983 prices moved above $40, OPEC talked less and less about a target price and eventually went quiet about price volatility. Kojima (2009) observed that globally, oil prices began to rise in 2004 and, after a sharp drop in late 2008, it has been rising again. According to Ming (2009) during the past years, oil prices in the global market have fluctuated a lot. Câmpean (2011) states that OPEC currently, indirectly exerts its influence on the global price of oil by controlling the total supply quantity by

member states but cannot effectively use the production quotas to manipulate or match changing market conditions hence the swings in the supply and the price of oil. Boll (2005) similarly concluded that a key reason for high oil prices is the artificial scarcity imposed on the market by the OPEC cartel, which controls 70 percent of the world's known oil reserves and restricts how much oil reaches consumers.

According to Câmpean (2011), OPEC has today become a player among many others, its power consisting now only in the control of its total supply. The study further stated that the emergence of futures contracts, has meant the end of administered price system for oil, initiated by U.S. producers in the nineteenth century, continued by Western oil companies until 1960, then settled by negotiations between them and OPEC and finally imposed by OPEC after 1973. Figure 1.1 shows the trend of world oil prices in US Dollars from 1950 to 2015 with a sharp increase in 1973, and again during the 1979 energy crisis. Sharp decreases are notable in 1998, 2009 and 2015.

Figure 1.1: Trend of World Oil Prices from 1861 to 2015

Source: http://www.macrotrends.net/1369/crude-oil-price-history-chart

The adoption of the market-related pricing system (futures market) by many oil exporters (between 1986 and 1988) opened a new chapter in the history of oil price

formation representing a shift from a system in which prices were first administered by the large multinational oil companies in the 1950s and 1960s; and then by OPEC for the period 1973 to1988 to a system in which prices are set by "markets" (Fattouh, 2011).UNCTAD (2005) concurs with this position by observing that in the latter part of the 1980s, a market related pricing system that links oil prices to the market price of certain reference crude, namely Brent, Dubai or West Texas Intermediate, was developed.

Rui (2009) noted that the international oil market is a complex system and that the fluctuation of world oil price is affected by many factors: among which the supply-demand relationship and inventory of petroleum are fundamental. Rui (2009) referred to other factors, such as emergent events or political shocks, as being deemed as non-fundamental factors. Barnanke (2004) expounded this by stating that the sharp increases and extreme volatility of oil prices have led observers to suggest that some part of the rise in the prices reflects a speculative component arising from the activities of traders in the oil market. Whatever the causes of fluctuation, the significance of the world oil prices to Kenya is that they directly impact the ultimate pump prices of oil products in the country. Their fluctuation can cause volatility of prices of oil products.

1.1.2 Petroleum Prices Volatility in Sub-Saharan Africa.

African countries, whether oil importers or exporters, are severely affected by the volatility of international oil prices (UNCTAD, 2005). According to Kojima (2009) the countries that are most vulnerable to oil price shocks are low-income oil importing countries which are disproportionally concentrated in sub-Saharan Africa. This observation is supported by Bacon and Mattar (2005) who found that apart from a few oil exporters, Sub-Saharan Africa consists of a large number of low-income countries, many of which are highly dependent on oil imports as a source of primary energy. High costs of transporting and marketing petroleum products increase end-use prices further and exacerbate the adverse effects of high oil prices.

Bacon and Kojima (2008) observed that governments in sub-Saharan Africa have historically provided protection to domestic refineries. Such protection hampers the development of an efficient sector and, by definition, raises prices paid by all consumers. Where the refineries are state-owned, protection of domestic refineries can also lead to contingent liabilities for the government. Fuel shortages are not uncommon in the region, and they have led to price spikes over and above the price movements on the world market.

A past review of developing countries governments' response to the oil price volatility showed that, against the severe price rises of 2007 and 2008, few governments were able to withstand the pressure to use or increase fiscal measures to lower prices (Kojima, 2009). As a result, some countries that moved to automatic price adjustment mechanisms years ago suspended price adjustment and bore financial losses. Bacon and Kojima, (2008) found that in West Africa four of five countries studied engaged in price smoothing during the run-up to international prices from 2007 through mid-2008 only Senegal maintained a consistent automatic adjustment process. The other four countries, Burkina Faso, Côte d'Ivoire, Mali, and Niger, suspended automatic price adjustment based on a clearly defined import parity structure. In summary, most sub-Saharan countries have been trying various desperate efforts to stabilize prices of oil products with little or no success.

1.1.3 Petroleum Products Price Volatility in Kenya

Kenya solely relies on oil imports to satisfy its oil energy needs. According to Kojima, Matthews and Sexsmith (2010).Kenya has an Open Tender System, whereby crude or petroleum products are purchased by a single company for the entire market on the basis of a public tender and shared among all marketing companies in proportion to their share of the market. The Government of Kenya, (2003) in its Vision 2030 recognizes that Kenya's energy costs are higher than those

of her competitors and that Kenya must, therefore, generate more energy at a lower cost and increase efficiency in energy consumption.

The Kenya Government is, therefore, encouraging foreign interest in oil exploration thus there is a modest upstream oil industry, currently limited to exploration in various parts of Kenya. There has been a confirmation that Kenya has struck oil in Turkana area but the commercial viability of these discoveries is yet to be determined. Petroleum is Kenya's major source of commercial energy and has, over the years, accounted for about 80% of the country's commercial energy requirements (Wanjiku, 2010).

According to Vision 2030, petroleum and electricity are the prime movers of the modern sector of the Kenyan economy and the domestic demand for various petroleum fuels on average stands at 2.5 million tons per year, all of it imported from the Gulf region, either as crude oil for processing at the Kenya Petroleum Refineries Limited or as refined petroleum products. The Institute of Economic Affairs (IEA, 2000) observed that petroleum is important to Kenya as it provides approximately 67% of the industrial and commercial energy needs. In addition, the Kenya Petroleum sector consists of the Kenya Petroleum Refineries Limited (KPRL), Kenya Pipeline Company (KPC), the Ministry of Energy and Petroleum (MOEP) and oil marketing companies (OMCs). International Energy Agency (2010) further elaborated that the KPC operates an 890 kilometers pipeline network into the interior of Kenya from Mombasa through Nairobi to Nakuru, Kisumu and Eldoret.

Prior to mid-1994, the government, in consultation with the oil marketers, set consumer prices for petroleum products in the country (Mecheo & Omiti, 2003). However, since October 1994, the procurement, distribution, and pricing of petroleum products were liberalized with a view to enhancing operational efficiency of the industry and also attracting private capital (Mecheo & Omiti, 2003).In 2006,

the Energy Act No. 12 of 2006 was enacted. This led to the transformation of the then Electricity Regulatory Board (ERB) to the Energy Regulatory Commission (ERC) to also regulate petroleum and renewable energy sectors in addition to electricity. Volatility of pump prices of oil products forced the Government of Kenya to re-introduce price regulation in December 2010.

Universal price subsidies and petroleum product tax reduction are the two most commonly used methods of partially off-setting higher oil prices on the international market (Kojima, 2009). If there is a national oil company or an oil company with some state involvement that is also a price-setter (because it controls a large share of the market), the government may send signals to the company to keep prices low (Kojima, 2009). Prior to re-introduction of price regulation, Kenya had tried to use the National Oil Company of Kenya (NOCK) to stabilize prices of oil products, without much success.

According to Taylor and Doren, (2005), proponents of intervention contend that gasoline markets are not competitive (with some accusing producers of price collusion), that fat profit margins induce little more supply than might otherwise be induced by healthy but "reasonable" profit margins, and that the gasoline profits are largely unanticipated and unearned. As a result, oil companies are reaping very large profits at the expense of consumers (Taylor & Doren, 2005). In line with this, the methodology applied by the ERC was to have a price capping formula with an aim to eliminate high prices being set by oil marketers driven by profit maximization goals.

According to Mwirichia (2011), ERC is a single sector regulatory agency with responsibility for economic and technical regulation of electric power, renewable energy and downstream petroleum sub-sectors including tariff setting and review; licensing; enforcement of compliance; dispute settlement and approval of power purchase and network service contracts. The Energy Act No. 12 of 2006 states in

Section 5(a) (ii) that the objects and functions of ERC include regulating the importation, exportation, transportation, refining, storage and sale of petroleum and petroleum products. Section 102 of the Act empowers the Minister to make regulations upon recommendation by the Commission on petroleum related activities including determination of retail prices for petroleum products (Katisya-Njoroge, 2010).

On December 15, 2010 the Government of Kenya enacted a new legislation, the Energy (Petroleum Pricing)Regulations, 2010which was aimed at preserving availability of specified petroleum products in all parts of Kenya; stabilizing prices of specified petroleum products in Kenya and minimizing the variances in prices of specified petroleum products across the country(Katisya-Njoroge, 2010). The new regulations effectively re-introduced government control on the maximum prices of petroleum products based on a formula decided upon by the Energy Regulation Commission (ERC). The 2010 re-introduction of price regulation followed public outcry on the government from consumer pressure groups and citizens following frequent increases in prices of oil products between 2004 and 2011 (Wanjiku,2010). The citizens were generally of the view that OMCs were colluding to set high prices so that they could cash in on high margins. The OMCs, on their part, blamed the largely government controlled oil supply process along with inefficiencies in the Government administered Open Tender System (OTS), inefficiencies in the technologically outdated KPRL, KPC storage and distribution inefficiencies, a tax system that demands payment of excise and import duties upfront on receipt of products by oil companies.

On the other hand, the Ministry of Energy and Petroleum has been frequently put on the spot by Parliament and consumer pressure groups and trade union representatives as to what it was doing to control rising oil prices owing to the resultant and persistent increase in the cost of living. This led to the Energy (Petroleum Pricing)

Regulations, 2010 that introduced petroleum price regulation for four specified petroleum products. The specific products affected by this price regulation are super petrol (gasoline), regular petrol, kerosene and automotive diesel (gasoil). The price regulations allowed ERC to set the maximum monthly prices of these products at both retail and wholesale levels. Increases in prices of oil products lead to general increases in prices of other essential commodities and services including food, transport and other basic items or services (Mecheo & Omiti, 2003).

The prices of regulated petroleum products in Kenya have been a cause of major public outcry for a long time. Just prior to introduction of price regulation, various stakeholders had expressed strong views that the then retail prices of petroleum products in Kenya were too high and unjustified (Mwirichia, 2011). The period after December 2010 when pump price regulation was re-introduced is important for this study as a key objective of regulation was price stabilization. Kenya is currently an importer of oil and has little it can do to control international prices of oil products, exchange rates and happenings in the futures market. As a result a host of factors such as the role of OPEC, the erosion of spare capacity, inventory supply levels, and futures market trends are grouped together under world prices of oil products. All other factors are then studied individually as deemed fit based on how related they may be. These include the role of exchange rate fluctuations, regulation through taxes, restricted profit margins or losses, local refinery, pipeline and supply chain efficiencies and political shocks.

1.2 Statement of the Problem

Petroleum products are important in driving the economies of all countries in the world but despite this petroleum product prices have been unstable, often affecting the efficiency of the same in propelling growth (Kojima, 2009).Huntington, Al-Fattah, Huang, Gucwa, and Nouri, (2012) studied oil price movements and observed that world Oil prices have fluctuated in a wild roller-coaster ride since 2004 thus

creating massive uncertainty as to what factors created these wild price movements. According to Pirog (2005), oil is not an international commodity whose ownership and ultimate destination is determined by market forces once it leaves the producing country and no country can effectively isolate itself from changes elsewhere in the market, nor is it likely that any nation can take actions that do not indirectly affect other nations. This observation is important when considering the effect of world oil prices on local prices of petroleum products. Ebrahim et al (2013 state that price volatility in the crude oil market is increasing at a faster rate than volatility in other commodity markets, partly due to the status of oil as the most globalized commodity. Fattouh (2011) noted that little attention has been devoted to the process of price discovery in the oil markets and the factors affecting oil price volatility remain under-researched. Further, UNCTAD (2005) observed that developing country Governments face heavy exposure to oil price volatility, either on the export or the import side – and sometimes, both.

Nduru (2009)sought to justify need for price controls and argued that the post deregulation retail prices of petroleum products in Kenya did not follow the changes in international oil prices. Katisya-Njoroge (2010) concluded that the dependence on oil imports and the delayed modernization of the Kenyan refinery, amongst other factors, continues to expose the Kenyan petroleum sector to the ongoing world economic crisis, without identifying the "other factors", hence need to verify these conclusions and those of Nduru (2009).

The Kenyan parliament, in December 2010,re-introduced a price capping formula through the Energy (petroleum Pricing) Regulations, 2010 whose main objective was to stabilize prices of petroleum products. Table 1.1 in Appendix X, however, demonstrates that prices of petroleum products in Kenya have been unstable and reached a high of Kshs 121.13 in May 2012 for a liter of gasoline compared to the price of Kshs 94.03 before regulation in Dec 2010 (an increase of 28.8% in eighteen months). Over the same period, the price of automotive diesel (gasoil) rose from

Kshs 87.45 in December 2010 to Kshs 108.44 in May 2012, an increase of 24% in eighteen months, despite a reduction of taxes on gasoil to cushion consumers and tame inflation (Mwirichia, 2011).This situation is supported by the consumer price indices displayed in Figure 1.1 in Appendix IX demonstrating that prices of oil products have been unstable in the period December 2010 to June 2015.This compares well with the observation by Plourde and Watkins (1998) that since 1986, the Price Index for oil products has been more volatile than for other commodities.

According to Mwirichia (2011), the main factors which affect the level of pump prices in Kenya are the international costs of both crude oil and refined petroleum products, the exchange rate of the Kenya shilling to the dollar and various other in-country costs. Very limited research has been performed on these factors to establish how they individually and collectively hinder stabilization of the prices of oil products in Kenya. The little literature available is contained in unpublished articles and falls short of meeting the basic standards of a scientific research. Given the persistence in volatility of prices of oil products, it is necessary to conduct a detailed scientific research to establish the determinants of volatility in prices of petroleum products in Kenya.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of this study was to investigate the factors affecting volatility in prices of petroleum products in Kenya.

1.3.2 Specific Objectives

The specific objectives of this study were:

1. To examine the effect of world prices of oil on the volatility of pump prices of petroleum products in Kenya.
2. To investigate the effect of exchange rate fluctuations on the volatility of pump prices of petroleum products in Kenya

3. To determine the effect of supply chain costs on the volatility of pump prices of petroleum products in Kenya.
4. To establish the effect of price regulation on the volatility of pump prices of petroleum products in Kenya
5. To determine the effect of political shocks on the volatility of pump prices of petroleum products in Kenya.

1.4 Hypotheses

This study developed null hypotheses in line with the study objectives as listed below:

HO_1. World oil prices do not affect volatility of pump prices of petroleum products in Kenya.

HO_2. Exchange rate fluctuations do not affect volatility of pump prices of petroleum products in Kenya

HO_3. Supply-chain disruptions do not affect volatility of pump prices of petroleum products in Kenya

HO_4. Oil price regulation does not affect volatility of pump prices of petroleum products in Kenya

HO_5. Political shocks do not affect volatility of pump prices of petroleum products in Kenya.

1.5 Justification of the Study

The findings of this study are relevant to various sectors of the Kenyan economy. Specifically the key parties who stand to benefit from the findings in this study are:

Petroleum Subsector

The Institute of Economic Affairs (IEA, 2000) describes the Kenya Petroleum sub sector as consisting of the Kenya Petroleum Refineries Limited (KPRL), Kenya Pipeline Company (KPC), the Ministry of Energy and Petroleum (MOEP) and oil

marketing companies (OMCs). IEA (2010) further elaborates that the KPC operates an 890 kilometre pipeline network into the interior of Kenya from Mombasa through Nairobi to Nakuru, Kisumu and Eldoret. Kenya, like other developing economies, requires large quantities of affordable and good quality petroleum products to sustain investments and growth both in the public and private sector.

The extent to which these objectives can be realized on a sustainable basis is dependent on the degree and extent of efficiency with which the critical factor of petroleum products pricing is dealt with. The issue of pricing of petroleum products in Kenya being critical in the efficiency of many areas in the Kenyan economy, this study provides useful insights on the factors that cause volatility of prices of petroleum products. This enables the energy sector to go a long way in fulfilling its mandate of contribution to growth towards the achievement of the Vision 2030 objective of reducing energy costs and thus boost the modern growth trend.

Policy Makers and Oil Price Regulators

Through a critical examination of factors that cause volatility of prices of oil products and their frequent fluctuations, the study seeks to investigate how these factors can be better controlled. This enables the policy makers and regulators in the energy sector to focus on areas that influence volatility of prices of the oil industry as a whole.

Researchers, Scholars and the Public

The results of this study have added to the limited empirical literature available in Kenya and the findings are useful to researchers and scholars and members of the public interested in the area of study or its implications. The study lays out clearly the key factors that drive the prices of oil products in Kenya and hence allow the stakeholders to consider them in the process of oil pricing.

Commercial Transport Sector

The study shall seek to lay bare the actual factors that hinder oil price stabilization and is therefore of interest to commercial transport sector that is hardest hit by frequent price hikes. The sector may then be better prepared to handle the impact of oil price fluctuations to their business and profits.

Investors in the Oil Sub-Sector

The investors in the oil sub-sector of the energy sector are hardest hit by reduced profitability that is attributed to unexpected swings in oil prices. They therefore stand to gain from the study as they can better forecast future swings and plan for them or mitigate them in advance.

1.6 Scope of the Study

This study covered the determinants of volatility in the prices of oil products in Kenya since price regulation was introduced in December 2010 up to December 2015given that one of the key objectives of price regulation was to stabilize prices of petroleum products. The study covered four grades of petroleum products whose prices are regulated. These are premium petrol or gasoline, kerosene, regular petrol and gasoil or automotive diesel. The study evaluated prices of the specified regulated petroleum products in Nairobi City in Kenya. Nairobi prices are representative of prices in all other parts of Kenya because differences are limited to local transport charges that are determined after taking account of transportation distance and these differences do not contribute to volatility of prices as they are fixed factors.

According to oil industry statistics, Nairobi also consumes 60% of fuel in Kenya and has a concentration of most oil companies. The unit of analysis was the top officials and middle managers and representatives from Oil Marketing Companies (OMCs), Kenya Petroleum Refineries Limited (KPRL), Kenya Pipeline Company (KPC),

Energy Regulatory Authority (ERC), Petroleum Institute of East Africa (PIEA) and The Ministry of Energy and Petroleum (MOEP).The study reviewed pricing models under regulated price structures in order to ensure the main factors affecting pricing of oil products are taken into account. The study covered all licensed oil companies in Kenya in 2010 based on the records of ERC.

1.7 Limitations of the Study

The study faced limitations in respect of the tendency of oil marketing companies and regulators to guard what they deem as classified information. This limitation was overcome through assurances being provided to the data sources in respect of confidentiality, including coding of information sources. Confidentiality agreements between the researcher and the information providers were strictly observed. The study also made it clear in the letters forwarding the questionnaires that all information gathered would exclusively be used for academic purposes only.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature related to the key study variables as depicted in the conceptual framework. The chapter seeks to establish the relationship between these variables. Empirical studies related to the study variables are reviewed in this chapter in order to lay down ground for research. The chapter also justifies the study and reinforces and underpins the conceptual framework. The chapter gives a brief summary of the entire activities that are captured. It captures research gaps from past studies and comprises of; theoretical review, critical review of theories; review of theoretical and empirical studies and their implications and gaps in knowledge.

2.2 Theoretical Literature Review

Oil price behaviour has been analyzed using three main approaches: the economics of exhaustible resources, the supply–demand framework and the informal approach (Fattouh, 2007). The exhaustible resources theory argues that oil prices must exhibit an upward trend (Krautkraemer, 1998). In contrast, in the supply–demand framework, the oil market is modelled using behavioral equations that link oil demand and supply to its various determinants, mainly GDP growth, oil prices and reserves (Dees, Karadeloglou, Kaufmann &Sanchez, 2007). The informal approach is normally used to identify economic, geopolitical and incidental factors that affect demand and supply and hence oil price movements within specific contexts and episodes of oil market history (Fattouh, 2007).

This study included three primary theories that have been used to explain volatility in world oil prices. These are Peak Oil theory, Hotelling's theory and the informal approach theory. Exchange rate theories, regulation theories and futures market

theories shall also be discussed to the extent that they inform the related independent variables of exchange rate fluctuations,.

2.2.1 Peak Oil Theory

Peak Oil theory is based on the assumption that the production history of petroleum follows a symmetrical bell-shaped curve. Once the curve peaks, decline is inevitable. The theory is commonly invoked to justify the development of alternative energy sources that are allegedly renewable and sustainable. Peak Oil theory was originated by Hubbert in1956, who correctly predicted that US oil production, would peak between 1965 and 1970 (Heinberg, 2003).Unanswered was the question of whether or not US production had declined simply because it had become cheaper to purchase imported oil. The theory is based on the observed production rates of both individual oil wells, as well as that of conglomerate fields of oil wells. As technology increases the ability to drill oil quicker and more efficiently, the production of oil gleaned from each well continues to multiply exponentially, until the rate eventually peaks and then progressively declines, sometimes rapidly until the field or well is thoroughly depleted. Supply shortfalls of oil then naturally lead to price inflation, which in turn lead to global energy shortages, extreme conservation measures and a panicked race to develop a wide variety of alternative energy sources, requiring significant changes in both lifestyle and technology in order to avoid world-wide crisis.

Although theoretically plausible, Hubbert's theory has been criticized on several grounds. Boll (2005), for instance, argued that the price of oil bears no relation to the scarcity of oil in the ground or to the cost of getting it out of the ground. Boll (2005) further observed that the OPEC cartel controls 70 per cent of the world's known oil reserves and manipulates how much oil reaches consumers. It thus imposes an artificial scarcity on the market that elevates the price many fold above production cost.

Peak Oil is a theory based upon assumptions. Like other scientific theories, it is subject to empirical corroboration or falsification. Although Hubbert may have correctly predicted the timing of peak US oil production, researchers have criticized several of his other predictions. For example, Deming (2012) observed that Hubbert predicted that the maximum possible US oil production by 2011 would be one billion barrels while actual production was two billion barrels. Hubbert predicted that annual world oil production would peak in the year 2000 at 12.5 billion barrels but it didn't. Another flaw of Peak Oil theory is that it assumes the amount of a resource is a static number determined solely by geological factors yet the size of an exploitable resource also depends upon price and technology (Deming 2012).

Deming (2012) added that there is actually very little that is standard and consistent within the science and accompanying mathematics utilized within Hubbert's logistic model and as time rolled on, the theory grew in both complexity and fragility. The greater the number of trained experts using Hubert's theory to determine "Peak Oil," the greater and wider the variances occurred in the predicted outcomes being forecast. So many unforeseeable and variable factors, such as weather, the economy, war, political upheaval and reliability of global cooperation had plugged into the formula; leading to as many dramatically different outcomes as there were scientists calculating the theory. However, in the context of the current study, Peak Oil theory is still relevant because oil price fluctuations are still tied to supply of oil and any events indicating declining oil reserves would trigger higher prices of crude oil and subsequently higher prices of refined petroleum products.

2.2.2 Hotelling Theory

This theory, attributed to Hotelling (1931), is concerned with the question: given demand and the initial stock of the non-renewable resource, how much of the resource should be extracted every period so as to maximize the profit for the owner of the resource? Hotelling proposes a very intuitive and powerful theory to address

this question. Assuming no extraction costs and given a market price per unit of resource and real risk free interest rate on investment in the economy *r*, Hotelling shows that in a competitive market, the optimum extraction path would be such that the price of non-renewable resource will rise over time at the interest rate *r*.

Hotelling assumed that if the price of oil is expected to rise faster than *r*, then the owner has the incentive to hold on to the resource (Fattouh, 2007). If all suppliers behave in a similar manner, the supply would go down causing the current market price to rise. Given this equilibrating mechanism, the optimum extraction trajectory is the one in which the oil price increases in line with the interest rate.

This theory has several tenets in which the current study relates to. Most analysts using this theory as the basis for understanding the oil market conclude that oil price must rise over time. (Fattouh, 2007).This gradually rising price trend continued to dominate forecasting models even in the 1980s and 1990s, which witnessed many occasions of sharp oil price falls and despite the fact that most empirical studies have shown that mineral prices have been trend-less over time (Krautkraemer, 1998).

Hotelling's theory has many followers; it has generally failed to hold up historically. Chermak and Patrick (2007) observed that Hotelling's theory of exhaustible resources has been tested using data on various exhaustible resources; across different levels of aggregation, time periods and market structure; by means of a variety of theoretical approaches and statistical/econometric techniques; with varying results as to the empirical validity of the theory. Thus, the oil market should be analyzed within a dynamic context.

According to Watkin (2006),Hotelling's model was not intended and did not provide a framework for predicting prices or analyzing the time series properties of prices of an exhaustible resource, aspects that fairly recent literature like: Chermak and Patrick

(2002), Krautkaemer (1998),Barnett and Morse (1963) and Smith (1979) tends to emphasize when rejecting the theory. Furthermore, the application of Hotelling's model to the entire oil industry reduces its usefulness, especially when there is no clear idea about the size of reserves and what should be included in the reserve base. As Watkins (2006) notes, the application of Hotelling's model to the oil industry "distorts Hotelling's insightful work, work directed more at the firm level where the focus is on a deposit of known, fixed quantity."

2.2.3 Informal Approach Theory

The informal approach analyses oil price behavior within a specific economic and political context. Slaibi, Duane and Daouk (2006) found that though previous work on crude oil price modelling had generally focused on two theoretical approaches, either the peak oil theory of optimal control analysis of pricing of a declining resource, or OPEC as a partial monopolist setting oil prices to maximize net present value, and neither had been wholly satisfactory. Boll (2005) supports this by stating that the price of oil bears no relation to the scarcity of oil in the ground or to the cost of getting it out of the ground. Further discussions advanced by Boll (2005), Slaibi et al (2006), Chermak and Patrick (2002), Krautkaemer (1998), Barnett and Morse (1963) and Smith (1979) critically look at the over-reliance to Hotelling theory and Peak Oil theory.

In analyzing the rise in oil prices, Fattouh(2005) identified a wide list of factors including strong demand (mainly from outside OECD), lack of spare capacity in upstream oil, distributional bottlenecks, OPEC supply response, geopolitical and weather shocks and the increasing role of speculators and traders in price formation. Chevalier (2010) introduced speculation (a market factor) as yet another factor affecting volatility of oil prices and defined it as the taking of trading positions in a financial market dealing with oil as a commodity. This speculation happens mostly in the futures market that is today the most important determinant of world prices of crude oil subject to unpredictable oil price shocks. Fattouh (2007) observed that the

informal approach examines the process of determining oil prices which focuses on the role of OPEC, the erosion of spare capacity, the role of speculation and inventories, strong demand, geopolitical and weather shocks, distributional bottlenecks and speculation. Lombardi and Robays(2011) found that while most of the policy and academic literature attributes the oil price fluctuations to changes in fundamentals, Anzuini, Lombardi and Pagano (2010) observed that expansionary monetary policy may have fueled oil price increases.

According to Juvenal and Petrella, (2012), dramatic developments have taken place in the oil market over the last ten years such that oil prices cannot be said to be just driven by supply and demand as in the past. Tang and Xiong (2011) go further and point out that a speculative component may be behind the recent boom in oil prices. Fattouh (2007) however recognized that although the informal approach is essential to understanding current and past developments in the oil market, it could only provide a cursory view about how the oil market and oil prices might develop in the future. Most of the factors attributed to informal approach are widely discussed in the empirical review part of this study. Lombardi and Robays (2011) observed that by identifying fundamental and non-fundamental oil shocks, we can balance the importance of fundamentals against inefficient financial activity.

The rise in oil prices and the increase in oil price volatility recently led many analysts to argue that factors other than changes in elasticities or reserves can also influence oil market developments, at least in the short run (Fattouh, 2007). The informal approach theory is relevant to this study in that factors that hinder volatility of prices of oil products in Kenya are likely to be diverse and go beyond elasticity and reserves. This study was anchored on the informal approach theory to accommodate the factors affecting volatility of oil prices in Kenya due to world market trends or other international determinants and those unique to Kenya are included.

2.2.4 Price-cap Regulation Theory

According to Hertog (2010) there are two broad traditions with respect to the economic theories of regulation. The first tradition assumes that regulators have sufficient information and enforcement powers to effectively promote the public interest. This tradition also assumes that regulators are benevolent and aim to pursue the public interest. Economic theories that proceed from these assumptions are therefore often called 'public interest theories of regulation'. Another tradition in the economic studies of regulation proceeds from different assumptions. Regulators do not have sufficient information with respect to cost, demand, quality and other dimensions of firm behavior. They can therefore only imperfectly, if at all, promote the public interest when controlling firms or societal activities.

Price-cap regulation is an innovation in regulatory policy that was developed in the 1980s and has been applied around the world. According to Cowan (2002), the general problem is that a firm with partial or complete market power must be regulated to prevent it from abusing its dominant position through excessive pricing. An unregulated firm can be expected to set its prices to maximize profits, leading to both deadweight losses and transfers of purchasing power from consumers to the firm, both of which are costly to the regulator. At the same time the regulator wants to encourage the firm to be efficient. A price cap tackles these problems by the very straightforward solution of fixing the firm's price (or the price path over time). The firm thus bears the risks associated with varying exogenous input prices and shifting demand. At the same time the firm has full incentives to reduce its costs, as the price is not adjusted downwards when it succeeds in cutting its own costs.

The key feature of a price cap is that the price level is not responsive to anything. Price-cap regulation (PCR) in practice is, of course, not as straightforward as simple theory would suggest. In particular price caps do not last indefinitely and are thus usually temporary measures to curb excesses for a period. The Energy Regulatory

Commission uses price cap regulation in its attempt to regulate and control prices of petroleum products in Kenya. This theory therefore advised the study in relation to regulation as an independent variable. However, critics of regulation such as Joskow and Noll, (1981) are of the view that economic research has demonstrated convincingly that price and entry regulation based on the research on transportation, and oil and natural-gas production creates economic inefficiencies.

2.2.5 Purchasing Power Parity Theory

The exchange rate theory that this study anchored on is the purchasing power parity (PPP) theory. Purchasing power parity (PPP) is a theory that holds that the nominal exchange rate between two currencies should be equal to the ratio of aggregate price levels between the two countries, so that a unit of currency of one country will have the same purchasing power in a foreign country (Taylor, 2002).The general idea behind purchasing power parity is that a unit of currency should be able to buy the same basket of goods in one country as the equivalent amount of foreign currency, at the going exchange rate, can buy in a foreign country, so that there is parity in the purchasing power of the unit of currency across the two economies.

One very simple way of gauging whether there may be discrepancies from PPP is to compare the prices of similar or identical goods from the basket in the two countries. According to Taylor (2002) the idea that purchasing power parity may hold because of international goods arbitrage is related to the so-called Law of One Price, which holds that the price of an internationally traded good should be the same anywhere in the world once that price is expressed in a common currency, since people could make a riskless profit by shipping the goods from locations where the price is low to locations where the price is high (for example, by arbitraging). If the same goods enter each country's market basket used to construct the aggregate price level—and with the same weight—then the Law of One Price implies that a PPP exchange rate should hold between the countries concerned. This approach however ignores the presence of transactions costs—perhaps arising from transport costs, taxes, tariffs and duties and nontariff barriers—would induce a violation of the Law of One Price.

Engel (2000), for example, looks at the price differentials between similar goods in cities across the United States and Canada and reports evidence broadly in support of this hypothesis: finding that the volatility of the price differential tends to be larger the greater the distance between the cities concerned, and it increases substantially when prices in cities in different countries are compared (the so-called "border effect".

2.3 Conceptual Framework

A conceptual framework is a construct in which each concept plays an integral role. According to Miles and Huberman (1994), a conceptual framework lays out the key factors, constructs, or variables, and presumes relationships among them. Smith (2004) defines a conceptual framework as framework that is structured from a set of broad ideas and theories that help a researcher to properly identify the problem they are looking at frame their questions and find suitable literature. This study was guided by five independent variables. These variables represent the factors that may cause volatility of prices of petroleum products in Kenya. The conceptual framework displays the view that fluctuations in world oil prices, exchange rates, supply chain costs, oil industry regulation (taxes, oil losses, profit margins and Political shocks (political violence, Piracy and terrorism).

The conceptual framework for this study is shown on Figure 2.2 after taking into account the work of other scholars who studied factors influencing their study variables.

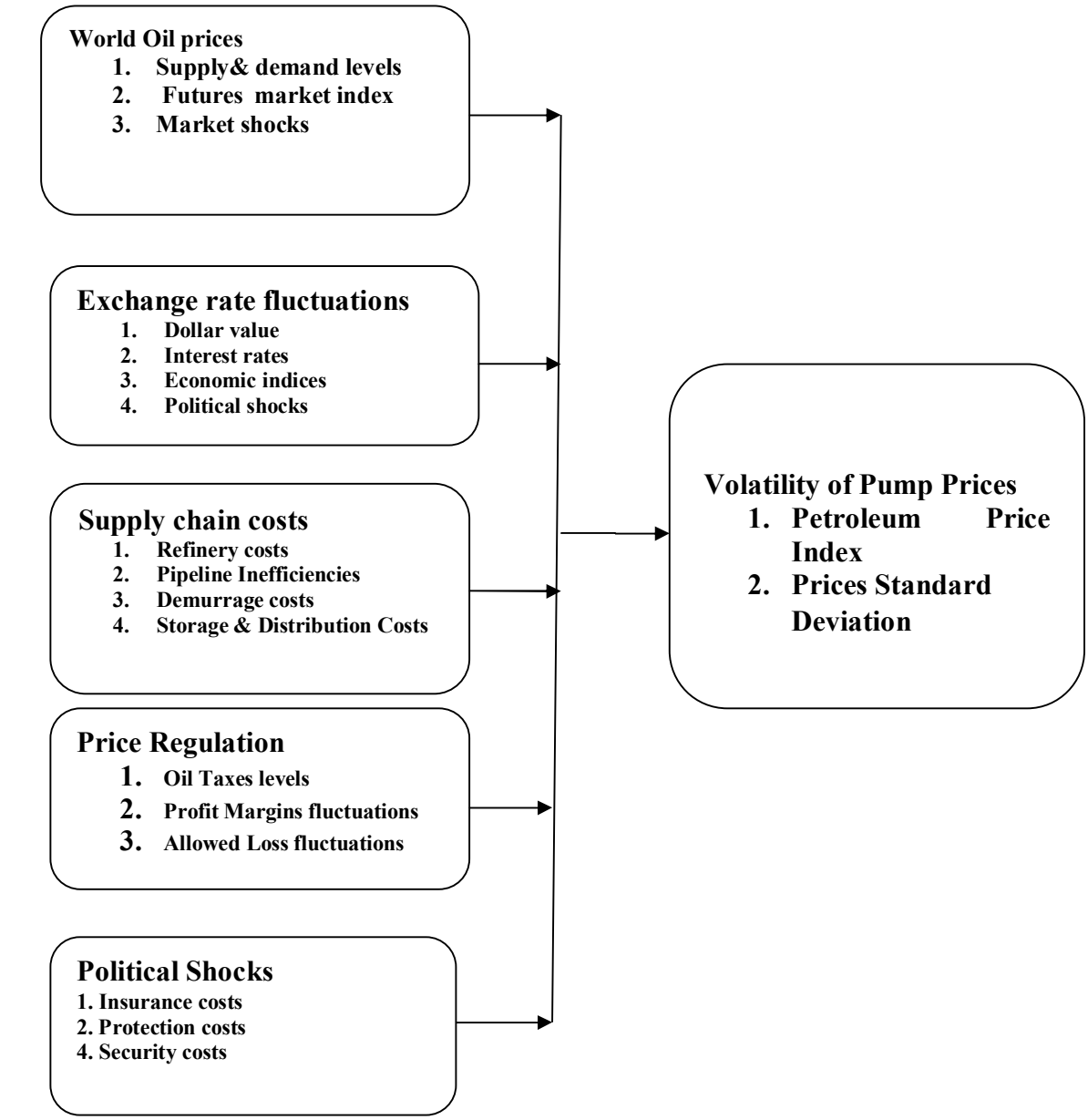


Figure 2.2: Conceptual Framework

2.4 Empirical Literature Review

2.4.1 Volatility of Prices of Petroleum Products

King, Deng and Metz (2012) analyzed the impact of key factors on the price of crude oil focusing on the 2007−2008 period that led to public concern about the increase in oil prices to over$145 per barrel. Their econometric analysis examined separately the individual events associated with day-to-day price changes, the role of financial trading, and two key indicators of physical supply and demand factors, including OPEC decisions, that affect longer-term price trends. Considering both upward and downward price movements as a whole, King et al (2012) found that political events dominated world oil price changes from 2007 through mid-July 2008, and that news about the economy dominated oil price changes during the last half of 2008.

In similar study on measuring the impact of changing oil prices and other macroeconomic variables in Pakistan's economy, Naveed (2010) had the objective of the study as being to measure the impact of changing oil prices, and other variables like consumption, government expenditure and average exchange rates, domestic investment, inflation and foreign domestic investment on GDP in the context of Pakistan's economy. The study was based on secondary data of 30 years. The study examined the impact of volatility in the prices of oil and the findings indicated that changing oil prices have negative relationship with GDP. This study provides a good foundation for further studies on volatility of prices of petroleum products in that it looked at various measurable effects of volatility of prices of oil. Though the study was carried out in Pakistan, and the country may not be comparable to Kenya in terms of economic development, the variables can be used as a basis of study for future studies in Kenya.

A related study by Arinze (2011) on the impact of oil price on the Nigerian economy contends that frequent upward adjustments of petroleum product prices have resulted in inflation, high cost of living, and inequitable distribution of income in Nigeria.

Between 1978 and 2009, the various Nigerian regimes increased fuel prices a total of 18 times. Most of the increase occurred in the 1990-2007 period when the pump prices were adjusted, sometimes twice a year. The study used regression analysis to analyze data and find out the relationship between the variables. The results further revealed that whenever petroleum product prices increase, the inflation rate and the rise price of petroleum products is significant.

In another related study on macroeconomic and welfare consequences of high energy prices in Uganda, Twimukye and Matovu (2009) found that the wave of volatile international oil prices coupled with low hydro energy generation continues to exert negative impacts on the Ugandan economy. The study focused on analyzing the extent to which changes in energy prices (including pump prices) affect the economy and examined policy options that could be undertaken to circumvent the negative effects. The study established that higher oil prices take a larger toll on all sectors including agriculture, manufacturing and services. Moreover, because Uganda is landlocked, it depends largely on an oil pipeline from Mombasa to Eldoret, both in Kenya, from where products are transported by road or rail to Kampala, this has resulted in high import costs and uncertain supply as is explained by major fuel disruptions in case Kenya undergoes any crisis affecting the oil sector. The study highlighted the effects of price volatility in Uganda, but failed to look in-depth on the factors that lead to the volatility in oil prices. In addition, the paper did not have an elaborate methodology that is used for data collection and this weakens the results of the study.

2.4.2 World Prices of Oil

Crude oil is refined to produce petrol, diesel, Kerosene and other refined petroleum products. The cost of crude oil is traditionally the greatest single factor affecting fuel prices over time. A number of empirical studies have shown that world prices of crude oil affect the volatility of petroleum product prices in oil importing countries.

Ming (2009) looked at future crude oil prices in China and if the world oil prices could have an effect on these prices and observed that during the past ten years, the crude oil prices have fluctuated and risen a lot. Prices of petroleum products are determined in the market by global supply and demand but are also influenced by market forces. While the reason of fluctuation is explained by the imbalanced relationship between the oil consumption and production, on the other hand, this also indicates great risks in the petroleum markets. By comparing the macro-economic conditions between the Chinese and the U.S. market, the study on international oil prices did not impact the future of China's crude oil; in this case, the calculated future prices showed the ability to hedging the international oil shocks.

The study by Ming (2009) was carried out using a Granger Causality Test and the Vector Error Correction Model (VECM) which was built to describe the relationship between the calculated future prices with international prices. The study provided interesting results since most of the studies reviewed showed that there was a relationship between world oil prices and the volatility of petroleum products prices in many countries. It would therefore be interesting to carry out more studies on the relationship between world oil prices and their effects on petroleum product prices volatility in Kenya to allow for comparison.

In a comparable study on effects of oil price on government expenditures in Iran, Reza, Nazanin and Karim (2008) observed that in developing countries, income tax is the main source of financing for government spending, often supplemented by borrowing from the public. However, in Iran, the oil revenue, not the income tax, is the key source of government revenue hence spending. As such, when there is too much volatility in price of oil, the government cannot project its revenue accurately. The study found that while the main source of revenue for government of Iran is oil exports, it has no control whatsoever over the price of crude oil. Because crude oil is

a publicly traded commodity, its prices are determined in commodity markets via interaction of demand and supply worldwide and it constantly fluctuates.

The importance of this study to Kenya is to show that even in oil exporting countries, crude oil prices are beyond the control of the country in question and hence world prices of crude oil impact on the local prices of petroleum products. The overall goal of this research was to investigate the effects of oil prices volatility on government expenditures in Iran and to explore the channels through which such effects are carried out. This implied that though the study identifies fluctuation in world oil prices to volatility in prices in Iran, this was not the main focus of the study and therefore, data was limited to this effect. Therefore, the results of this study cannot be wholly relied upon to make conclusions on world oil prices and its effect on volatility of petroleum products in Sub-Saharan Africa and Kenya in particular.

Masima, William and Sexsmith (2010) observed that petroleum products were used across the entire economy in every country they studied in Sub Saharan Africa. The study focused on the petroleum market and how the fluctuation in prices of petroleum products affected the Gross Domestic Product (GDP) of the countries under study. The study established that fluctuation in oil prices often led to micro and macroeconomic consequences. The study associated the fluctuation in oil prices to the unstable world oil prices citing an example where the world oil prices increased four-fold between January 2004 and July 2008 and, after a sharp drop in the latter half of 2008, rose again. The study focused on Burkina Faso, Cote d'lvoire, Mali, Niger, and Senegal in West Africa and Botswana, Kenya, Madagascar, Malawi, South Africa, Tanzania, and Uganda in Eastern and Southern Africa. The study relied on information collected during brief country visits by two consultants in each country. The study looked at fluctuation of prices of petroleum products and its effects on the countries' studied countries' economic growth. The results of the study cannot therefore be generalized to answer the question on factors affecting volatility

of oil prices in sub-Saharan Africa, though there is an attempt in the study to look at the causes of fluctuation of prices in sub-Saharan Africa. Further, the study relied on information gathered on a two day visits by consultants, the short duration of each visit therefore restricts the amount of information that could be collected, and the findings of this study and its recommendations should be interpreted in the light of these data limitations.

In a related study, UNCTAD (2005) looked at the exposure of African Governments to the volatility of international oil prices and what to do about it and observed that African countries, whether oil importers or exporters, are severely affected by volatility of international oil prices. They further observed that any attempts by such governments to predict oil prices have ended up with high margins of error. Fattouh (2011) supported this view from a global perspective and observed that although it is known that oil futures prices converge to a spot price, little attention has been paid into the real meaning of spot prices of oil products and the processes of price formation in oil markets remain under-researched. Kenya re-introduced oil price regulation in 2010 through a formula-based approach the largely relies on world prices of oil products before including other factors. However, while price regulation has price stabilization as a key objective, trends of prices of regulated oil products has been far from stable hence the need to study the existing literature and seek to build on it to further expound on the drivers of volatility in the prices of oil products in Kenya.

2.4.3 Exchange Rates

In this study, exchange rate is simply defined as the amount of Kenya Shillings required to purchase one United States Dollar. The US dollar is the invoicing currency of international crude oil trading. Exchange rate variations in the U.S. dollar can affect the price of oil because oil is priced in US dollars and generally paid for in US dollars. Hence, the fluctuation in US dollar exchange rate is believed to underlie the volatility of crude oil price and especially its forecasting accuracy.

According to Dawson (2004) the relationship between the price of oil and the exchange rate has been established by the literature for oil-producing countries but not for oil-importing countries. The study by Dawson (2004) is relevant to Kenya as, like the Dominican Republic where the study was conducted, Kenya is an oil importing country. Oil is an internationally traded commodity and since Kenya is too small as an economy relative to the United States, the EU and other industrialized nations, price changes in oil are caused by international factors outside of Kenya. Since the demand for oil products is quite inelastic in the short run, a rise in oil prices causes the dollar value of the oil purchased to rise. That is, while the quantity purchased will reduce, the higher price will cause the total cost of oil to rise, not fall. The effect of a declining dollar on oil importing consumer nations varies with respect to how their currency has adjusted to the changing value of the dollar.

The idea that there is a relationship between oil prices and exchange rates has been around for some time (early papers, for example include, Golub (1983) and Krugman (1983). Bloomberg and Harris (1995) provide a good description, based on the law of one price, of how exchange rate movements can affect oil prices. Commodities like oil are fairly homogeneous and internationally traded. The law of one price asserts that as the US dollar weakens relative to other currencies, ceteris paribus, international buyers of oil are willing to pay more US dollars for oil.

In a study on the relationship between exchange rates and oil prices in Canada, Dale (2009) observed that economic models generally found a negative, but sometimes insignificant relationship between energy (or oil) prices and the Canadian dollar. This weak relationship between energy (or oil) prices and the Canadian dollar was clearly due to the offsetting impacts unique to energy prices, since the relationship between stronger prices of other non-energy commodities which Canada exports (forestry products, nickel, gold, aluminum, wheat) and the Canadian dollar was strongly positive. The study found that Canadian dollar appreciation would be partly

due to the higher price of oil and very much due to the correlated increases in the prices of other commodities.

However, the study found that the price of oil is dominated by the U.S. dollars. Therefore, when the U.S. dollar falls relative to the currency in another country, the price of oil is actually lower in that other country. For example, when the Canada/U.S. exchange rate strengthens at an unchanged price of oil in U.S. dollars, the quantity of gasoline demanded in Canada at the lower Canadian dollar price, would increase slightly. With all countries not on the U.S. dollar demanding a higher quantity of oil as a response to the weaker U.S. dollar, the weaker U.S. dollar would therefore put upward pressure on the price of oil. However, the study by Dale (2009) was carried out through review of literature in Canada, a country that is a major producer of oil.

Other studies like:Akram (2004), Bergvall (2004) Chaudhuri and Daniel (1998) and Dawson (2004) found that oil prices significantly affect the relative values of currencies in the study countries (Norway, UAE and Dominican Republic). The general conclusion from these studies was that increases in the international prices of oil products make it relatively more expensive for an oil importing country to purchase its product needs (Dawson, 2004). In addition, the results inclined more to how prices vary with exchange rate and did not go into lengths to explain the variables that the study has used to show the relationship. These studies are therefore not entirely reliable to the current study. Moreover, the models used to arrive to the conclusions have not been explained, leaving the reader who wishes to carry out further investigation in this line, unaware of the guidelines on the methodology.

The study on impact of exchange rate variation on the direction of trade flows in Kuwait (Nayef and Abdullah, 2010) investigated the impact of real exchange rate volatility between Kuwait and its major trading partners on their bilateral trade

volume. The data set to covers 169 countries over the period from 1990 through 2005. The model is estimated using an augmented gravity model with fixed effects specification. Findings show that the impact of Kuwait Dinar (KD) exchange rate volatility vis-à-vis major trading partners is estimated to positively influence export flows from U.S, Singapore, and Korea also becomes positive. An explanation of the positive findings is that since oil and natural gas represent almost above 90 percent of Kuwait exports and global demand is inelastic, then any appreciation in KD exchange rate should not have an effect on Kuwaiti exports. Therefore, any appreciation of KD vis-à-vis major currencies means an appreciation for the U.S. dollar initially; indicating that oil prices become overvalued.

The gravity model is broadly used in the literature of international trade to explain flows between any pair of countries. The basic idea of gravity model is that trade follows between any pair of countries are proportionally influenced by their income and distance. The study reliance on gravity model is faulted in that recently, there are many issues, including omitted variables that have occurred due to using gravity models empirically. Within the framework of gravity model, previous studies used to control for variables such as Gross Domestic products, distance, common language, colonial history and others to see their impact on trade flows, however, there is still a possibility that there are other factors that may affect both exchange rate volatility and trade flows. There is therefore need to carry out more studies on other variables that are related to exchange rates and how they affect petroleum product prices.

Trehan (1986) used vector auto-regressions, to demonstrate that the foreign exchange value of the dollar has a substantial impact on the price of oil in non-dollar functional currency states. Trehan (1986) provided a justification stating that since crude oil traded in the world markets is priced in dollars, oil importers who do not use the dollar as their functional currency must, in effect, obtain dollars to purchase oil. Thus if the value of the dollar changes, the price they pay in terms of their own currencies

will change. This situation is very applicable to Kenya which is currently an importer of oil and which has the Kenya shilling as its functional currency.

The Kenya Shilling is a freely floating currency. This is to say it varies on a day to day basis to other currencies depending on trade imbalances, commodity prices, trade shocks, inflation, etc. All the above studies are relevant in different ways to the situation in Kenya where exchange rate between the Kenya Shilling and the US Dollar influences the ultimate prices of oil products yet no scientific study could be traced demonstrating how exchange rates hinder volatility of prices of oil products in Kenya. To establish the facts, this study, therefore, proposes to include this factor in a scientific research to establish whether and how it influences the volatility of oil prices in Kenya.

2.4.4 Supply Chain Costs

Juvenal and Petrella (2012) made an assessment of the impact of supply chain shocks on oil prices. They use FAVAR model to identify oil shocks from a large data set. They found that oil prices have been historically driven by strength of global demand but speculation contributed to the oil price increases between 2004 and 2008. Consistent with Juvenal and Petrella (2012) and Tang and Xiong (2011), they concluded that speculative shocks in oil prices had a relation to other commodity prices.

These findings were supported by King, Deng and Metz (2012) who analyzed the impact of key factors on the price of crude oil in the period 2006 to 2009 at a time when there was high public concern following the increase in oil prices to over $145 per barrel. They examined separately the individual events associated with day-to-day price changes, the role of financial trading, and two key indicators of physical supply and demand factors, including OPEC decisions, that affect longer-term price trends. They used an econometric model and concluded that political events, particularly acts or threats of violence, were major drivers of upward price

movements during the run-up in oil prices that ended in mid-July 2008.However, Irwin and Sanders (2010) disregarded the idea that speculation played an important role in oil pricing indicating that the level of inventories had not risen in their period of study. They, however, failed to explain the increases in oil prices when fundamentals remained constant and supply and demand shocks were minimal.

On the contrary, Chevalier (2010) concluded that while available statistical data did not clearly establish the links of causality between the open positions of financial investors in the futures markets and prices observed in the spot market, speculation by some financial actors had amplified the upward or downward price movements, increasing the natural volatility of oil prices.

In Kenya, supply chain costs have been considered to play a role in prices of oil products leading to many situations where the government agencies responsible for oil price regulation engage in endless counter claims with oil marketing companies in respect of the correct level of oil prices. This situation even led to the re-introduction of petroleum capping regulations by the Energy Regulatory Commission in 2010 as a way of ensuring oil marketing companies do not unnecessarily inflate prices of oil products. However, some researchers (for example International Energy Research, 2009) argue that supply chain costs cannot withhold physical supply from the market and therefore cannot be responsible for rising oil prices. Moreover, the presence of large investors provides volatility and liquidity to the commodities markets. In summary, if supply chain costs cause a rise in the price of oil above the level that balances supply with commercial demand, then there was excessive oil supply in the market that must be hoarded for future sale.

Another occurrence in Kenya is that refinery inefficiencies have been a hidden factor for a long time until the recent conversion of KPRL from a toll blending to a merchant refinery when KPRL attempted to push the hidden oil losses, usually referred to as yield shifts, to the oil marketers. Oil marketers challenged the refinery

on the loss figures forcing an investigation whose results were not made public. No clarity was also given on whether oil companies would recover any losses pushed to them by KPRL through the monthly oil price revisions. It will, therefore, be essential to perform an empirical study covering the impact of supply chain costs as a hindrance to stabilization of oil prices in Kenya.

KPC on the other hand has had long running issues with oil marketers challenging oil loss figures charged to the marketers. According to Wanjiku (2010) the oil and gas industry has been predominantly in the limelight following the burning and sinking of the deep-water horizon drilling rig in the Gulf of Mexico in 2010. Wanjiku (2010) observes that the catastrophe led to devastating consequences, including volatility in oil prices. Kenya has also experienced oil losses at KPC through pipeline leakages and a recent spill at its Depot in Nairobi which led to a tragic fire incident. From this incident, Kenya has realized that it needs to review its capability and capacity to respond to oil spills, given the consequences.

Wanjiku (2010) drew important insights as to the effects of oil losses and spillages emanating from supply chain costs on price volatility. However, the related article is not a scientific study and does not address the matter comprehensively, but highlights the significance of oil spillage. A reader can therefore come to a conclusion that oil losses and spillages due to supply chain costs, indeed do affect volatility of prices of petroleum products. To justify the same, it is recommended that a detailed scientific study be carried out on the effects of oil spillages in determining volatility in petroleum product prices in Kenya, especially, given the limited data available on the same subject.

2.4.5 Oil Price Regulation

In Kenya, the ERC uses three components of the prices of oil to regulate oil prices. These are the taxes on petroleum products, the profit margins to oil marketing companies and dealers and the allowed oil loss limits. Each of these are therefore

discussed below in more detail as they are critical to testing their ability or otherwise to help in oil price stabilization.

In a study that looked at the relationship between petroleum taxes and world prices in Cambodia Bacon& Kojima (2008), found that taxes make up a sizable fraction of retail fuel in Cambodia. Taxes on petroleum products are a critical source of government revenue for Cambodia because taxing fuel is one of the easiest ways to get revenue: collecting fuel taxes is relatively straightforward and there is generally a robust relationship between consumption of fuels as a group and income consumption tends to go up at the same rate as income. In Cambodia, petroleum products are subject to import, excise, and value-added taxes and a small specific tax. The first three are in percentage terms, and as such price increases are magnified in absolute terms as world prices rise. For example, an excise tax of 33.3 percent on 900 riel is 300 riel, but becomes 900 riel if the fuel price triples. That is to say, taxes levied in percentage terms directly transmit percentage changes in world oil prices to the final end-user prices. In contrast, specific taxes, which are set in riel instead of in percentages, are independent of the price of the fuel, making their "rates" relatively high when world oil prices are low (that is, when translated into percentage terms, the tax rate is high), and conversely low when world oil prices are high.

In Cambodia, import, exercise, and value-added taxes are based on reference prices rather than the actual landed costs, and the government froze the reference prices in 2004, keeping them artificially low when the world oil prices soared in the subsequent years. This step correspondingly prevented the retail prices from rising in tandem with world oil prices, benefitting consumers but at a significant cost to the treasury. Though this study gives some insights as to tax as one of the factors contributing to volatility of prices of petroleum products, it does not comprehensively show us how that relationship comes about. Taylor and Doren (2005), for example, concluded that despite moral issues involved, government

efforts to take excess profits from oil companies either through price controls or taxes have proven to be futile exercises which fail to reduce prices but only manage to reduce supply, increase imports and impose steep costs on the economy as a whole.

In accordance with the tax theory, the government's sole aim is to raise revenue for public expenditure goods for which demand is least sensitive to price increases should tend to bear the highest tax rates. This relationship is not brought out in this study. This could be explained by lack of a theoretical framework that explains the study. In addition, there is no way to show the methodology that led to the conclusions in this study. Furthermore, the petroleum tax regime in Kenya is mostly based on a specific tax amount per litre, therefore is not ad valorem. It is recommended that a study be carried out on the relationship between taxes and volatility of petroleum products putting into considerations the contributions of theory and having an elaborate method of data collection.

A study on taxation and pricing of petroleum products in developing countries by Hossain, (2003) used the modern theory of public economics as the point of departure. The paper outlined basic principle for setting taxes and/or prices of commodities based on two criteria, efficiency and equity. The paper showed that for petroleum products, the basic principles needs modification in the presence of various externalities and market imperfections in a setting where the instruments to address externalities and imperfections are limited. Drawing from the theoretical and empirical review, the paper provides an operational framework and then illustrates how, for a country like Nigeria, the relevant taxes/ subsidies to correct the externalities and to address equity and revenue considerations can be measured with a view to setting prices of petroleum products.

The study looked at how petroleum products should be priced based on efficiency and equity and did not look into how taxes affect the pricing of petroleum products, which is a critical factor in the current study. The study did not make any specific suggestions for how a balance between taxing and prices of petroleum can be achieved to ensure that there is volatility of prices of petroleum products. The study was also carried out in Nigeria, an oil producing country, and therefore, the issues of petroleum products may not be similar to those of Kenya. It is therefore recommended that a study be carried out to look into the factors affecting petroleum products pricing in Kenya, factoring the weaknesses observed in this study.

In a study on international oil price regime origins rationale and assessment, Mabro (2005) observed that petroleum prices do not always move at the same rate – be it up or down – as crude oil prices. The prices paid by consumers for a petroleum product may differ significantly from the ex-refinery price because of excise and value-added taxes which, in many countries, amount to a hefty imposition. For example, in Kenya, the study found that Premium and Regular Gasoline and Gasoil are heavily taxed products in Kenya. The Kenya Revenue Authority introduced a tax rule that oil marketing companies (OMCs) pay duty for products up front effective August 1, 2005. This simply meant that OMCs would be required to pay taxes at the point of product entry i.e. upon receipt of products from vessels or refinery in Mombasa. This had a major effect on the financing of oil purchases as the cash outflow required now included taxes payable upfront on products at the point of entry.

According to Taylor and Doren (2005), proponents of intervention contend that gasoline markets are not competitive (with some accusing producers of price collusion), that fat profit margins induce little more supply than might otherwise be induced by healthy but “reasonable” profit margins, and that the gasoline profits are largely unanticipated and unearned. Taylor and Doren (2005) concluded that due to intervention or government regulation, oil companies reap very large profits at the

expense of consumers. This conclusion needs to be further researched on in Kenya given that in 2012, two of the four major oil marketers reported huge losses despite a regulated pricing mechanism for petroleum products in Kenya.

Universal price subsidies and petroleum product tax reduction are the two most commonly used methods of partially off-setting higher oil prices on the international market (Kojima, 2009). A price stabilization fund, on the other hand, attempts to set domestic prices higher than international prices in times of low world oil prices and save the balance in the fund; when world oil prices exceed a threshold level, money is withdrawn from the fund to subsidize domestic prices (Kojima, 2009). A price stabilization fund may have an intuitive appeal but does not work well in practice, and all such funds were strained in 2007–08 (Bacon &Kojima, 2008). If there is a national oil company or an oil company with some state involvement that is also a price-setter (because it controls a large share of the market), the government may send signals to the company to keep prices low (Kojima, 2009). Prior to re-introduction of price regulation, Kenya had tried to use the National Oil Company of Kenya (NOCK) to stabilize prices of oil products, without much success. The methodology applied by the ERC was to have a price capping formula with an aim to eliminate high prices being set by oil marketers driven by profit maximization goals.

Few governments are able to withstand the pressure to use or increase fiscal measures to lower prices (Kojima, 2009). As a result, some countries that moved to automatic price adjustment mechanisms years ago suspended price adjustment and bore financial losses. In West Africa, for example, four of five countries studied engaged in price smoothing during the run-up to international prices from 2007 through mid-2008 (Bacon & Kojima, 2008); only Senegal maintained a consistent automatic adjustment process. The other four countries, Burkina Faso, Côte d'Ivoire, Mali, and Niger, suspended automatic price adjustment based on a clearly defined import parity structure.

Critics of price regulation like Rockoff (2008) hold the view that price controls do not accomplish what they were intended to do and are generally to be avoided. Martin (2002), on his part, states that the primary criticism levelled against price controls is that by keeping prices artificially low, demand is increased to the point where supply cannot keep up, leading to shortages in the price-controlled product. The Nobel Prize Winner, Milton Friedman, supported this position when he stated "We economists don't know much, but we do know how to create a shortage. If you want to create a shortage of tomatoes, for example, just pass a law that retailers can't sell tomatoes for more than two cents per pound. Instantly you'll have a tomato shortage. It's the same with oil or gas (Sowell, 2008)". Martin (2002) concluded that the created shortages lead to black markets where prices for the same good exceed those of an uncontrolled market.

Taylor and Doren (2005) examined these different arguments with particular attention to retail gasoline markets and found the arguments supporting price control to be generally unpersuasive. They concluded that both economic theory and past experience suggest that aggressive price controls and windfall profits taxes will harm consumers by creating fuel shortages and reducing investment in new supply. This view is supported by Martin, (2002) who pointed out that once controls were removed, prices would immediately increase, which could temporarily shock the economic system. At the global level, these views expressed by various economists tend to discourage price control or regulation and encourage that market forces of supply and demand are left to determine prices. These views are significant to this study since at the global level, OPEC efforts to control prices of oil have failed and currently it is mostly market factors that determine world oil prices. It is therefore clear that opinion is divided on what causes volatility of oil prices whether under regulated or deregulated oil pricing mechanisms. As a factor affecting the ultimate price of oil products, tax in Kenya is mostly a fixed cost as it does not change on a day to day basis. For premium, regular and gasoil fuel grades, it is a major fixed

component of the price as it accounts for about 25% of the total price. However, the indirect impact of the requirement that petroleum taxes be paid at the point of product entry, and its financing implications further complicate the impact of taxes on prices of petroleum products and needs to be studied.

Notably Mabro (2005) focused on oil price regimes, origins and assessment and, though the study gives the reader useful insights as to the effects of taxes on price volatility, it does not comprehensively look into the issue. The study lacks clarity in terms of the source of data on the relationship between Kenyan tax system and taxes on petroleum product and volatility of the prices of the same products. This is a major concern and studies should be carried out to cover this gap. In addition, the study relies entirely on literature review. This may not give the current status of petroleum products prices volatility and the factors that affect the prices. It is important to make sure that the methodology used in a study like this fulfills the requirements of scientific research and provides a clear picture to the reader of the issues under study.

According to Joskowand Noll (1972), regulatory agencies are usually assumed to regulate profits only but what regulators actually do is regulate prices. The calculation of an allowed profit is a station along the road to determining how much of an increase in prices was allowed. Once set, the regulated firm's prices are fixed, pending subsequent regulatory review (except for the effects of automatic-adjustment clauses). This is actually the method followed by ERC in Kenya to regulate prices of petroleum products.

In a study on effects of oil price on government expenditures in Iran, Reza, Nazanin and Karim (2008) observed that the changes in oil prices were earlier, in the 1970s, often influenced by oil marketing companies and dealer profit margins. It was observed that the market was controlled by huge oil companies such as Standard oil

of New Jersey, Royal Dutch Shell, Anglo Persian Oil Company, the Gulf Oil, and Texaco. These companies, which were known as seven sisters had the huge market power on production, refining, and distribution of oil. The oligopoly structure of the structure precluded them from price competition and provided them with a strong economic incentive not to increase the price. They kept the price stable and low because they made huge profit from the variety of products derived from crude oil.

However, since the market has swayed toward oil-exporting countries because of a wave of nationalizations in oil exporting countries that led to the decline influence of seven sister companies and disintegration of oligopoly structure in the oil market. The general observation in the study is that though the study has provided this shift in oil market, there is no documented data on how the current oil marketing companies and dealer profit margins have affected the price volatility of petroleum products today. It is therefore recommended that studies be carried out to show the current effects of marketing oil companies and dealer profit margins on volatility of oil prices.

In a study on the analysis of prospects of the China petroleum future market, Yang (2010) focused on the future of petroleum future markets in China and observed that one of the reasons why China was not cushioned against price fluctuations was because China itself was a monopoly in the supply of oil in the country. Chinese National Petroleum Corporation (CNPC) and China Petroleum and Chemical Corporation ("Sinopec") provides the major oil supply in the domestic market. The study looked at the imports dependence ratio (imports/consumptions) from 1998 (141%) to (45.56%) in 2008. Thus, if China keeps relying on imported oil, it could face great risks in supply and prices due to spill-over effects.

In a study on macroeconomic and welfare consequences of high energy prices in Uganda, Twimukye and Matovu (2009) found that Uganda's downstream oil sector

was liberalized in 1994, and price controls and bureaucratic resource allocation were abolished and a new petroleum supply act promulgated in 2003. This led to licensing of several companies, including international oil companies like Shell, Total, and Caltex to take part in the industry. Although the sector is fairly competitive with even smaller firms operating, the market is dominated by the few international ones including the ones mentioned above. The persistently high prices of petroleum products in spite of the falls in the world crude prices have raised alarms in the population that the industry may be poorly regulated, making players to collude to cheat motorists.

The study carried out thorough review of literature on prices of petroleum products from 2004-2008 provides useful insights for the current study on oil marketing companies and dealer profit margins as a factor influencing the volatility of oil prices in Uganda. However, a closer look at literature review reveals that though this could be true, the study does not provide empirical data to support this argument. The reader then can only speculate that it is very likely that the lack of fair competition has allowed all oil companies to collude to set high prices in order to keep their profit margins as high as possible.

In a study leaning against oil price controls , Taylor and Doren (2005) observed that proponents of regulated pricing of oil products contend that gasoline markets are not competitive; that fat profit margins induce little more supply than might otherwise be induced by healthy but “reasonable” profit margins, and that gasoline profits are largely unanticipated and unearned. This contradicts studies by proponents of oil controls such as Twimukye and Matovu (2009) who are of the view that oil marketing companies are reaping very large profits at the expense of consumers. Similar opinions by oil consumers and interest groups in the Kenya Oil Market led to re-introduction of regulated prices of oil markets in 2010 after persistent increases in prices of oil products were experienced between 2008 and 2010. Despite regulation

of prices of oil products, price fluctuations have continued to persist. However, there exists no scientific study to establish whether these opinions are true or not and therefore it is important to conduct a research in this area. It is therefore recommended that more studies be carried out on whether profit margins by oil marketing companies play a role in causing volatility in prices of petroleum products in Kenya to verify these observations.

In a study on Indian's petroleum sector refined product pricing and refinery investment, Kieran and Dagmar (2010) provided a holistic examination of pricing and investment dynamics in India's downstream petroleum sector. The study focused on the ability of key downstream companies to meet rapidly growing Indian product demand, and the prospective emergence of India as major global refined product exporter, an outcome with considerable potential implications for the evolution of global and regional product markets. The study ended with an examination of product market pricing and observes that petroleum pricing policy is entirely unsustainable in its current form.

The study observed that in order to lessen the burden of dealing with petroleum prices, the Government of India, besides reduction of taxes, was looking into the issue of oil spillage as a factor affecting the volatility of oil prices in the region. This was being looked at in terms of the capacity of the country to have the right storage and distribution facilities to avoid oil losses. According to Kieran and Dagmar (2010) the major issue affecting the pricing of petroleum products is that of taxes. However, the authors observed that the government was exploring the issue of oil spillage as a factor affecting petroleum prices, but admitted that data on the same was minimal. This implied that there was a possibility that oil losses through spillages and operational factors lead to volatility in oil prices though the subject had not been explored comprehensively.

2.4.6 Political Shocks

King, Deng and Metz (2012) observed that the world supply of oil is reduced by war, terrorism, and guerrilla activity that are the result of political volatility or conflict and that political volatility and conflict in the Middle East and in Nigeria, in particular, had a significant impact on oil production and the world price of oil. The study concluded that political events and economic news, as well as two key indicators of physical supply and demand factors, had a significant effect on oil prices.

Labys (2006) observed that higher oil prices could lead to higher inflation, lower corporate profits, higher unemployment and reduced national economic growth and that higher price volatility could lead to a reduction in investment, leading in turn to a long term reduction in supply, higher prices, and even reduced macroeconomic activity. Labys (2006) further observed that increasing volatility could impose economic disruption costs and higher transactions costs on consumers and producers, adding to inflation, or cutting rates of growth, or both. Regnier (2007) found that oil and energy price volatility increased following the 1973 oil crisis. In addition, this increase was accompanied by an increase in price volatility for all commodities. In the late 1970s, however, price volatility for most products returned to pre-1973 levels, while oil price volatility continued to increase.

2.5 Summary

Literature review showed that oil marketers operated in a unique environment where factors from international sources and those from local sources played a role in determining volatility in prices of oil products. World oil prices, exchange rates, supply chain costs, price regulation as well as political shocks affect ultimate volatility of oil prices. The oil sector the world over, in Kenya, plays a crucial role in driving the economy of any country that is heavily dependent on oil products as a source of energy.

2.6 Research Gap

From the reviewed empirical literature the scholars identified various factors which affect volatility of oil prices: Ming (2009) studied the impact of world crude oil prices on crude oil prices in China; Bloomberg and Harris (1995) examined how exchange rate movements can affect oil prices. Juvenal and Petrella (2012) analysed whether political shocks cause volatility of oil prices and included an assessment of supply chain shocks on oil prices. King et al (2012) also examined the impact of political shocks such as political events and public outcry on the price of crude oil while Bacon and Masima (2008) studied the relationship between petroleum taxes and world oil prices. While there has been significant effort to study factors that cause volatility of the world oil prices, a great deal of work remains to be conducted on the determinants of volatility in pump prices of oil products in Kenya given there is also little success by ERC in this regard. Going by the available literature on oil prices, very limited research has been performed in this area in Kenya and therefore this study sought to fill this gap.

CHAPTER THREE
RESEARCH METHODOLOGY

3.0 Introduction

This chapter sets out various approaches that were followed in executing the study, thereby satisfying the study's objectives. This chapter also presents methods used for collection and analysis of data. It comprises of research design, target population, sampling frame, sample, sample size, sampling technique, data collection tools, pilot test, and data analysis.

Research refers to the search for knowledge. It is an art of scientific investigation. Kothari, (2004) describe research as the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. Lesinger and Stephenson in the Encyclopedia of Social Sciences, define research as "the manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art".

Clifford Woody explained that research comprises of defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing and evaluating data; making deductions and reaching conclusions; and at last carefully testing the conclusions to determine whether they fit the formulated hypothesis. Business research is thus an organized, systematic, data-based, critical, objective, scientific inquiry or investigation into a specific problem undertaken with the purpose of finding solutions to it. Research provides the needed information that guides managers to make informed decisions to successfully deal with problems.

3.1 Research Philosophy

All research studies are rooted in the philosophy of science. Auguste Comte (1798 to 1857) developed a system of positive philosophy and held that science and history culminate in a new science of humanity, to which he gave the name ″sociology". Gould (1984) observes that positivism as a term is usually understood as a particular way of thinking. Epistemology, on the other hand, takes a scientific approach.

Epistemology is the branch of philosophy that deals with questions concerning the nature, scope, and sources of knowledge (DeRose, 2005). According to Sextus (1985), dogmatists claim that the universal is established from the particulars by means of induction. Sextus (1985) further observes that if researchers review only some particulars and not all, their induction was unreliable, since it is possible that some of the particulars omitted in the induction may contradict the universal. In addition, if on the other hand their review is to include all the particulars, theirs was an impossible task, because particulars are infinite and indefinite. This study was inspired by epistemology. According to Kelly (2001), epistemology begins with the irritating stimulus of un-learnability arguments and seeks to use scientific research approach to ensure that data obtained is relevant, manageable and can be analyzed and summarized leading to accurate and useful conclusions that can be applied in real life.

3.2 Research Design

Mugenda and Mugenda (2003) described research design as a conceptual structure within which research is conducted. Research design is an outline of research study which indicates what the researcher did from writing the hypothesis and its operational implications to the final analysis of data. A research design is the arrangement of conditions for data collection and analysis of data in a manner that aims to combine relevance to research purpose with economy in research procedure (Selltiz, Wrightsman& Cook, 1962).The research design thus refers to the overall strategy that the researcher chose to integrate the different components of the study in a coherent and logical way, thereby, ensuring the study was effectively addressed the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data (Kirshenblatt-Gimblett, 2006).

According to Kothari, (2004) Social science research approaches are classified as descriptive, exploratory or explanatory. Descriptive research attempts to produce

accurate representation of persons, events and situations while the exploratory research is aimed at seeking new insights into phenomena, raise questions and assess the phenomena in new light (Torochim, 2006; Sekaran, 2006; and Winter 2000). Explanatory research seeks to study a situation or a problem so as to explain the relationships between variables (Saunders, Goldenberg & Gallimore, 2008).

This study adopted a causal research design (also called explanatory research design), which ensured ease in understanding the insight and ideas about the problem. This research design helped the researcher to understand why the dependent variable works the way it does through a process of proving a causal link between variables and eliminating other possibilities.The study aimed to investigate five specific independent variables and test their influence on stabilization of prices of petroleum products as formulated from the review of the literature.

Causal research design was used to measure what impact a specific change had on existing norms and assumptions. Most social scientists seek causal explanations that reflect tests of hypotheses. Causal effect occurs when variation in one phenomenon, an independent variable, leads to or results, on average, in variation in another phenomenon, the dependent variable (Bachman, 2007).Causal research is an investigative act which helps to identify the relationship between two variables and determines which variable might be causing certain behavior in the variable being explained.

This study involved using questionnaires, interviews and secondary data collection, and generalizing the results of the sample to the population from which it was drawn. In addition, explanatory research design investigated the relationship between two or more variables. This design measured the extent of relationship between the variables and was suitable for this study since it attempted to specify the nature of functional relationship between two or more variables.

3.3 Population

Population has been defined as a large collection of all subjects from where a sample

is drawn. Sekaran (2000) defines target population as the totality of cases that conform to some designated specification, which could be people, events, or things of interest to the researcher. In this study there was a target population. Target population is the entire group of individuals to which researchers are interested in generalizing their conclusions (Castillo& Cross, 2008). The population of this study comprised of the 65 licensed oil marketing companies as listed on Appendix IV, 600 independent oil dealers, one petroleum lobby group (PIEA), one regulator (ERC), Kenya Pipeline Company, Kenya Petroleum Refineries Limited, National Oil Company of Kenya and Ministry of Energy and Petroleum all of whom play different roles in the Petroleum industry of the Energy sector in Kenya.

3.4 Sample and Sampling Frame

A sampling frame is a physical representation of all the elements in the population from which the sample is drawn (Sekaran & Bougie, 2011). Turner (2003) defines a sampling frame as the set of source materials from which the sample is selected. Creswell (2003) defines sample frame as the list of accessible population of people, events or documents that could be included in a survey and from which the researcher will pick a sample to collect data. Due to the non-homogeneity of the population, the study adopted a stratified sampling approach. Stratified sampling allows inclusion and generalizability to a larger population with statistically determinable margin of error and allows use of inferential statistics (Neuman, 2000).

The sampling frame of this study was derived from the database of the Energy Regulatory Commission which regulates and licenses oil companies in Kenya. The list contained oil companies licensed by the Ministry as at 1st January 2013 as shown in Appendix IV. In addition, ERC.MOEP, PIEA and oil dealerships of the oil marketing companies were added to ensure a more complete coverage. These organizations make up the oil industry in Kenya, with MOEP and ERC being policy makers and regulators, KPC and KPRL being storage, distributors and supply chain channels, OMCs and oil dealers being marketers and retailers while PIEA is a lobby

group. These therefore formed the population upon which this research study was based and from which a sample was selected.

Table 3.1 Population Sampling Frame

Category	Target respondents	Target Population	% of Total Population
OMCs	Supply & Sales Managers	65	9.490%
Oil Dealers	Dealers & Managers	600	87.59%
ERC	Regulatory Officials	1	0.146%
NOCK	Supply & Sales Managers	1	0.146%
MOEP	Office of the Permanent Secretary Head of Oil Sector	6	0.876%
KPC	Supply & Distribution Managers	6	0.876%
KPRL	Supply & Distribution Manager	5	0.730%
PIEA	Managing Director	1	0.146%
Total		**685**	**100.00%**

Source: Research Study (2016)

3.5 Sample and Sampling Technique

A sample is a subset of a population (Hyndman, 2008). It is a true representative of the entire population to be studied (Leary, 2001). According to Mugenda and Mugenda (2003) and Gay (1981) 10 percent of the accessible population is considered adequate. The study selected all respondents where population was less than 30.Where population was larger than 30 and less than 500, 30% of the target population was selected as a sample fulfilling the minimum threshold suggested by Neuman (2000) and also Sekaran (2006) who recommended 30% of the target

population as being adequate. The sampling technique to be followed in this study was stratified random sampling. Stratified random sampling is a sampling technique that involves the division of a population into smaller groups known as strata. In stratified random sampling, the strata are formed based on members' shared attributes or characteristics. A random sample from each stratum was taken in a number proportional to the stratum's size when compared to the population. These subsets of the strata are then pooled to form a random sample.

Table 3.2 Sample Size

Category	Target	Sample
OMCs	General Managers	10
	Supply/Distribution Managers	10
	Finance Managers	10
Oil Dealerships	Oil Dealers	60
ERC	Regulatory Officers	1
NOCK	Supply/Distribution Managers	1
MOEP	Ministry Officials	1
KPC	Supply /Distribution Manager	1
KPRL	Supply/Distribution Manager	1
PIEA	General Manager	1
Total		**96**

The sample was14.01% of the accessible population obtained as follows:
Sample Size/Population X 100 thus 96X100/685 = 14.01%. The criterion used was to ensure at least 10% of the population in each category was included or where the population is less than 30 the entire population was taken (Newman 2000; Mugenda & Mugenda, 2003).

The main advantage with stratified sampling is how it captures key population characteristics in the sample. This sampling technique produces characteristics in the sample that are proportional to the overall population. Stratified sampling works well

for populations with a variety of attributes, as is the case with oil industry players where OMCs, MOEP, KPC, KPRL, ERC and PIEA have different characteristics and interests in the petroleum business in Kenya.

3.6 Data Collection Instruments

According to Denzin and Lincoln (2000), a data collection instrument is a document containing questions presented in a systematic, highly precise fashion. The data collection instrument purpose is to enable the evaluator to obtain uniform data that can be compared, summed, and, subjected to additional statistical analysis. The main instrument for primary data collection was a semi-structured questionnaire. Questionnaires are effective data collection instruments that allow respondents to give much of their opinions concerning the researched problem. Information obtained from questionnaires was free from bias and researchers influence and therefore accurate and valid.

Research assistants were sent to respondents with written questionnaires on a drop and pick later basis after physically meeting the respondents to allow them to ask questions face to face and get explanations on the study and its objectives. Leedy and Ormrod, (2010) observe that face to face interviews have a distinct advantage of enabling the researcher to establish rapport with potential participants and therefore gain their cooperation and yield highest response rate. They also allowed the researcher to clarify ambiguous answers and when appropriate, seek follow-up information. Disadvantages include that this approach is impractical when large samples are involved and is time consuming and expensive. Secondary data was obtained from the Ministry of Energy and Petroleum, ERC, KPC and KPRL records and websites.

3.7 Data Collection Procedure

Data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. A self-administered questionnaire and face-to-face standardized interview schedules were the two principal tools of primary data collection. The choice to use questionnaires was based on the fact that they can be sent to a large number of people and thus save the researcher time and money.

According to Leedy and Ormrod (2010) people are also more truthful while responding to the questionnaires due to the fact that their responses are anonymous. But they also have drawbacks. Majority of the people who receive questionnaires do not return them and those who do might not be representative of the originally selected sample (Leedy and Ormrod, 2010). Target questions were used in the questionnaire and addressed the investigative questions of the study. The questions were both structured and unstructured. structured questions presented the respondents with a fixed set of choices, often called closed questions) while unstructured questions did not limit responses but provided a frame of references for respondents answers, sometimes referred to as open-ended questions (Cooper & Schindler, 2006). Closed ended questions were designed with alternative answers expressed in a Likert scale-style. Likert- type scales utilizes the item analysis approach where a particular item is evaluated between respondents whose total score is high and those whose score is low. The items or statements that best meets this sort of discrimination was included in the final instrument (Kothari, 2004).

Closed questions were chosen to provide the standardized data and were presented in an appropriate format that lends itself to being quantified and compared. Also it was utilized in providing pre-coded data, which can be analyzed easily. Secondary data was obtained mostly from the relevant internet sites including ERC website for

monthly published price press releases and world oil price data, tax rates from KRA websites, exchange rates and interest rates from CBK web sites. Articles on recent oil price trends in Kenya were also a source of secondary data. The average world prices of oil products are available from ERC website. Data on exchange rates was sourced as primary and secondary data from the Central Bank of Kenya (CBK) website and from the sampled oil industry sources. Data on political shocks was obtained from primary sources through interviews and open and close ended questionnaire sent to oil industry players. Data on regulatory costs was obtained as secondary data from ERC and KRA websites but further data was obtained as primary data through questionnaires to government authorities and regulatory bodies.

3.8 Pilot Testing

According to Hulley (2007) a pilot study, is a small scale preliminary study conducted in order to evaluate feasibility, time, cost, adverse events, and effect size (statistical variability) in an attempt to predict an appropriate sample size and improve upon the study design prior to performance of a full-scale research project. The data collection instrument, which is the questionnaire, was pilot tested on 5% of the sample size to ensure that it was manageable, relevant and effective. The 5% was from those not selected for the study. Each of the stakeholders/strata's was represented. The stratification was necessary given the varied type of data sources such as regulatory agencies, Oil marketing companies and secondary data sources. Kenya pipeline Company, Kenya Petroleum Refineries Limited etc.

Creswell (2003) states that the size of a sample to be used for pilot testing varies depending on the time, cost and practicability, but would tend to be between 5-10 per cent of that of the main survey. However, discretion was applied when arriving at pilot test respondents and where necessary more than 10% of the population of respondents was pilot tested. The exercise targeted at least one respondent from each stratum by discretion but could sample up to 10 respondents. These respondents did not participate in the final research and therefore the findings of the study were free of redundancy.

In order to minimize the possible instrumentations error and hence increase the reliability of the data collected, the reliability of the pre-test observation schedule was tested using scores obtained from a single test administered to individuals from within the sampling frame and hence save time (Kothari, 2004). Cronbach's coefficient Alpha was then computed using statistical package for social science (SPSS) to determine how items correlate among themselves. Cronbach's alpha is a general form of the Kunder-Richardson (K-R) 20 formula used to access internal consistency of an instrument based on split-half reliabilities of data from all possible halves of the instrument. It reduces time required to compute a reliability coefficient in other methods (Mugenda and Mugenda, 2003). Pilot test results on using Cronbach's Coefficient Alpha test indicated a coefficient of 0.83 for world oil prices, 0.75 for exchange rates, 0.84 for supply chain costs, 0.79for regulatory costs and 0.85for political shocks. These results are in line with findings by Saunders, Lewis and Thornhill (2009) and Christensen, Johnson and Turner (2011) who stated that scales of 0.7 and above, indicate satisfactory reliability. Based on these recommendations, the data collection instrument was proved to have adequate internal consistency, therefore, reliable for the entire study sample.

A pilot test was performed using a 5% of the sample of this study to test validity of the instrument. Accuracy and meaningfulness of inferences was measured using content validity test. Content validity measures the degree to which data collected using particular instruments represents a specific domain of indicators or content of particular concept. Content validity was verified through use of respondents amongst those included in the pilot tests by reviewing the instrument and offering their advice.

3.9 Data Analysis and Presentation

Data analysis is the process of transforming raw data into usable information, often presented in the form of a published analytical article, in order to add value to the statistical output. Data analysis is essential for understanding results from surveys, administrative sources and pilot studies; for providing information on data gaps; for designing and redesigning surveys; for planning new statistical activities; and for formulating quality objectives. Data presentation refers to the communication of collected information in a clear and concise manner.

Data from the questionnaires and interviews schedules was coded and the response on each item put into specific main themes. The quantitative data obtained from these research instruments was analyzed by use of frequencies and inferential statistics. Descriptive statistics in form of frequencies, means and standard deviations were utilized to analyze data from observation schedules. Qualitative analysis involved content analysis and identification of common themes emerging from the responses to the interview schedule. Hsieh and Shannon (2005) define content analysis as a widely used qualitative research technique where rather than being a single method, applications of content analysis show three distinct approaches: conventional, directed, or summative. All three approaches are used to interpret meaning from the content of text data and, hence, adhere to the naturalistic paradigm. The researcher categorized data, sorted out, recorded and then interpreted it. Findings from completed interview schedules were tabulated, tallied, frequency counts done and corresponding percentages calculated. Kothari (2004) suggested that qualitative data provides a description and interpretation of what things mean to people. This study used qualitative data in the interpretation of perceptions of the relevant stakeholders on the volatility of prices of petroleum products in Kenya.

The model adopted for this study was based on the work of King, Deng and Metz

(2012) who analyzed proportion of daily price movements that can be attributed to different factors using a non-linear econometric model. The study used this approach to analyze the monthly percentage change in the regulated prices of oil products in Kenya on a set of variables that corresponded to the factors that are likely to cause oil price fluctuation each month. Existing studies were used to guide determination of potential factors. It is worth noting that though King et al (2012) analyzed daily price changes, the Kenya regulated oil price changes are effected monthly. Despite this difference in the time spans over which the price changes occur, the method applied by King et al (2012) is applicable to the Kenya situation as what both studies seek to do is to establish the impact of each driver to oil changes in the particular periods studied.

This approach that looks at changes in the individual factors helped identify the factors that cause volatility in prices of oil products in Kenya. The study further analyzed the percentage changes in crude oil prices between time periods using both the US Dollar and Kenya Shilling values and then compared the percentage changes in the two values. The study appreciates that there may be other factors that influence the volatility in prices of petroleum products apart from the variables being investigated. These factors, where identified during this study, were highlighted in the data analysis for the purpose of inclusion in future studies but were not investigated. In the regression model to be estimated (see Section 3.9.1), such variables are captured by the random error term.

The econometric model used in this study was comparable to the one used by King, Deng and Metz (2012). Using this econometric model, the study regressed the monthly percentage change in the ERC pump prices on a set of variables, identified from the literature, that typically explain movements in the retail prices of petroleum products. The model takes the form at time t. and is referred to as model 1 for ease of reference:

$$Y_t = \beta_0+\beta_1(WOP)_t+\beta_2(EXR)_t+\beta_3(SCH)_t+\beta_4(REG)_t+\beta_5(POL)_t+\mu \quad \text{(Model 1)}$$

Where, Y_t denoted the average percentage change in price of a particular oil product in a given month t, WOP represents World Oil Prices, EXR represents Exchange Rates, SCH is a vector of Supply Chain Costs, REG is a vector of Regulatory Costs and POL represents Political Shocks. In addition, determinants of volatility in oil prices that were not specifically covered were considered under the random error term (μ).

At time $t-1$, the model takes the form and is referred to as model 2 for ease of reference:

$$Y_{t-1} = \beta_0+\beta_1(WOP)_{t-1}+\beta_2(EXR)_{t-1}+ \beta_3(SCH)_{t-1}+\beta_4(REG)_{t-1}+\beta_5(POL)_{t-1} +\mu \text{ (Model 2)}$$

This model form is important as Granger causality test was developed for analysis of the effect of one time series on another one, thus each test is between two time series (Bahadori & Liu, 2012). In this study, the test was between cause and effect of price changes between any two periods, thus any two months. This model was extended to different time frames divided into months as prices are revised on a monthly basis in Kenya and started with the most recent month as t and going back by referring to the immediate past month as $t-1$, $t-2$ and so on. The impact of the various drivers were then tested by comparing the price fluctuations between each two subsequent time periods and the components or drivers that led to such volatility in prices analyzed to establish their effect.

The econometric analysis examined separately the individual role played by each factor determining volatility of oil prices in the period December 2010 to June 2015 following a pattern similar to that applied by King et al (2012) except that the latter examined daily price change factors, while this study examined drivers of monthly price changes in Kenya. The monthly approach was advised by the fact that the price regulator (ERC) determines prices valid for a month unlike in the world stage where daily price changes are applied. December 2010 was selected as the start period because it coincides with the time when price cap regulations were introduced in Kenya by ERC. The study period was considered adequate to help arrive at conclusions that can be applied over longer periods as it comprised of 55 months of

regulated pricing and hence trends can be developed.

The study followed Granger causality analysisto model the relationship between the explanatory variables and a response variable by fitting a non-linear equation to observed data. Every value of the independent variable (WOP, EXR, SCH, REG and POL) was associated with a value of the dependent variable Y. The regression line described how the mean response changes with the explanatory variables. The observed value for Y varied about their means and was assumed to have the same standard deviation. The fitted values (WOP, EXR, SCH, REG and POL) estimated the parameters of the population regression line. Since the observed values for Y may vary about their means, the multiple regression models included an error term **μ**for this variation. The error term **μ**in a regression model captures the effect of factors that have not been included in the model.

This study employed Granger causality tests to analyze the lead and lag relations among oil prices in a multivariate system. Granger causality analysis (GCA) is a method for investigating whether one time series can correctly forecast another (Granger, 1969).The Granger causality requires a prior knowledge about the maximum lag and is suitable for time series studies (Bahadori m,& Liu, 2012).This study therefore performed tests to establish lead and lag relations. A statistical significance test was applied to the coefficients of the multiple regression model. Specifically, applying an approach similar to the one used by King et al (2012) vector auto-regression tests (VAR) was used to conduct causality tests. The VAR is a means of conducting Granger causality tests. VAR models (vector autoregressive models) are used for multivariate time series like the one applicable to this study. The structure adopted is such that each variable is a linear function of past lags of itself and past lags of the other variables. Assuming three different time series variables, denoted by t, t-1, and t-2.The vector autoregressive model of order 1, denoted as VAR(1), was as follows:

$$Yt = \beta_1 + \beta_2 Y_{t-1} + \beta_3 x_{t-1} + \mu$$

$Y_{t-1} = \beta_1 + \beta_2 Y_{t-2} + \beta_3 x_{t-2} + \mu$

$Y_{t-2} = \beta_1 + \beta_2 Y_{t-3} + \beta_3 x_{t-3} + \mu$

Where each variable was a linear function of the lag 1 values for all variables in the set and β_1, β_2, andβ_3 are coefficients and Y represents the dependent variable (pump price) while X represents the independent variable (world oil prices, exchange rates, supply chain costs, regulatory costs or political shocks).

By using an F-test to jointly test for the significance of the lags on the explanatory variables, this tested for 'Granger causality' between the variables. The F-test was only applied on coefficient estimates of the lagged X where Y is the dependent variable and lagged Y where X is the dependent variable using the Wald test. The Wald test, as described by Polit (1996) and Agresti (1990), is one of a number of ways of testing whether the parameters associated with a group of explanatory variables are zero and testing the significance of particular explanatory variables in a statistical model. For each explanatory variable in the model there was an associated parameter.

Tests for stationarity were also performed in line with the approach taken by King et al (2012). According to Challis and Kitney (1991) Stationarity, is defined as a quality of a process in which the statistical parameters (mean and standard deviation) of the process do not change with time. The most important property of a stationary process is that the auto-correlation function (ACF) depends on lag alone and does not change with the time at which the function was calculated.

Correlations between the independent variables were also tested in the same way as in recent study (Chen, Hamilton, Thomason, Gotlib, Saad & Cox, 2009) that use signed path coefficients to perform t-test at group level statistics. King et al (2012) also employed Granger causality tests to analyze the lead and lag relations among oil prices in a multivariate system and estimate a vector error correction model (VECM).

The VECM approach is preferred because it allows the researcher to perform a long-run analysis. However, Büyükşahin and Harris (2011) combine it with the Autoregressive Distributed Lag (ARDL) approach. The final step was to run Granger causality tests using stationary variables and draw inferences.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter deals with the analysis of both secondary and primary data. The data analysis is in harmony with the specific objectives where patterns were investigated, interpreted and inferences drawn on them. The chapter begins with review of the results of secondary data analysis followed by a review of primary data analysis.

4.2 Secondary Data Analysis

4.2.1 Descriptive Statistics for Secondary Data

Table 4.1 presents the descriptive statistics for the dependent and independent variables from 55 observations. The 55 observations represented the number of months in the time series being the period from December 2010 to June 2015.

Table 4.1: Secondary Data Descriptive Statistics

Variable / Statistic	Pump Prices	World Oil Prices	Exchange Rates	Regulatory Costs	Supply-Chain Costs	Political Shocks
Observations	55	55	55	55	55	55
Mean	99.75	52.64	85.72	34.71	12.44	66.86
Median	101.73	54.87	85.23	34.02	11.37	67.00
Maximum	111.58	62.387	101.30	37.03	26.49	70.00
Minimum	79.60	26.71	75.79	32.91	1.43	65.00
Std. Dev.	7.48	7.33	5.44	1.12	5.53	0.95

From the table, the mean of the pump prices of the four grades of petroleum products for the period December 2010 to June 2015 was KES 99.75 with a standard deviation of KES7.48 indicating moderate variability in pump prices over time. The minimum

and maximum values of pump prices over the same period of time were KES 79.5975 and KES 111.581 respectively. The mean of the pump prices of the four grades of petroleum products imported into Kenya (Premium Motor Spirit, Automotive Gasoil, Illuminating Kerosene and Regular Motor Spirit) for the period December 2010 to June 2015 was KES 52.639 with a standard deviation of KES 7.332 indicating high variability in World oil prices.

The minimum and maximum values of world oil prices of refined petroleum products imported into Kenya (PMS, AGO, IK and RMS) over the same period of time were KES 26.714 and KES 62.387 respectively. The mean of nominal exchange rates for the period December 2010 to June 2015 was KES 85.717 with a standard deviation of KES 5.435 indicating relatively high variability in exchange rate over time. In this study, the nominal exchange rate is defined as the number of units of the Kenya Shilling that can purchase a unit of the US Dollar as published by the Central Bank of Kenya. An increase in the amount of Kenya Shillings required to purchase one US Dollar is referred to as a depreciation of the Kenya Shilling while a decrease is termed as a nominal appreciation of the Kenya Shilling to the US Dollar. The minimum and maximum values of exchange rate over the same period of time were KES 75.790 and KES 101.300 respectively. The total mean of political shocks for the period December 2010 to June 2014 was KES 66.855 with a standard deviation of KES 0.951 indicating low variability in political shocks over time. The minimum and maximum values of regulatory costs over the same period of time were KES 32.913 and KES 37.030 respectively with a standard deviation of 1.122. Supply chain costs had a standard deviation of KES 5.528 with a minimum and maximum of 1.431 and 26.485 respectively and a mean of 12.443 showing high variability.

4.2.2. Unit Root Tests

Unit root testing using the Augmented Dickey-Fuller (ADF) approach was conducted in order to establish whether the data set was stationary. The key objective in testing for stationarity was to ensure that the variables revert back to their mean even when there are shocks. The variables were first tested for stationarity at levels using the data set as collected. In all cases, except for the supply chain costs, the variables were found to be non-stationary as their p-values were greater than the critical p-value of 0.05. These results are displayed in Table 4.2

Table 4.2: Unit Root Test for Variables at levels

Null Hypothesis	T-Statistic	Prob.*
WOP has a unit root	-1.55	0.50
EXR has a unit root	-1.77	0.39
REG has a unit Root	-1.55	0.50
SCH has a unit root	-3.14	0.003
POL has a unit root	-2.26	0.19

Because the tests to be run on the data require the variables to be stationary, the stationary variables were first differenced and a unit root test was then run on the differenced series, consistent with the guide given by Hyndman and Athanasopoulos (2013). The results of these unit root tests after the first difference are indicated in Table 4.3.The p-values reported indicate the variables are stationary after first differencing and indicating that the series was integrated of order one.

Table 4.3: Unit Root Test Results for Variables after First Differencing

Null Hypothesis	Observations	t-Statistic	p-value	Result
First Difference pump prices have a unit root	52	-4.201	0.002	Stationary
First difference world oil prices have a unit root	52	-7.739	0.000	Stationary
First difference exchange rates have a unit root	52	-5.343	0.000	Stationary
First difference regulatory costs have a unit root	52	-7.739	0.000	Stationary
First difference political shocks have a unit root	52	-7.909	0.000	Stationary

The results show that, in all cases, the p-value is below the critical value at 5% level of significance; thus, the study rejected the null hypotheses that the differenced variables had unit roots and accepted the alternate hypothesis that the variables are stationary. This result meant that after the first difference the variables could now be subjected to granger causality and regression analysis as stationarity had now been established to exist. The null-hypothesis for an ADF test is that the data are non-stationary. So large p-values are indicative of non-stationarity, and small p-values suggest stationarity.

4.2.3: Pairwise Granger Causality Tests

The Granger causality testing is a widely used methodology for inferring the causation between variables in regression analysis (Zhang &Liu, 2014). The study used pairwise granger causality tests to test the null hypotheses that the dependent variable does not Granger-cause an independent variable and vice versa for each of the variables. The study applied the decision rule, as given by Zhang and Liu (2014),

that where the value of the F-statistic is low and the probability value (p-value) is high, researchers should reject the null hypothesis and where the F-statistic is high and the probability value is low, researchers should accept the null hypothesis to interpret these results. The results of these tests are displayed in Table 4.4, where changes in world oil prices were found to Granger-cause changes in pump prices but changes in pump prices were not found to Granger-cause changes in world oil prices. This unidirectional result suggests that world oil prices play a role in determining volatility of pump prices in Kenya. Results of similar tests on granger causality relationship between exchange rates and pump prices indicated that changes in pump prices Granger-cause changes in exchange rates but changes in exchange rates do not Granger-cause changes in pump prices. This result also confirms that the cause and effect relation between exchange rates and pump prices is unidirectional.

In the case of regulatory costs, the results indicated that changes in regulatory costs Granger-cause changes in pump prices but changes in pump prices do not Granger-cause changes in regulatory costs. This unidirectional cause and effect result is expected as indeed regulation is meant to tame pump prices and not vice versa. In yet another unidirectional cause and effect relationship, changes in supply chain costs were found to Granger-cause changes in pump prices while changes in pump prices did not Granger-cause changes in supply chain costs.

Another result was that Political Shocks did not Granger-cause changes in pump prices and changes in pump prices did not Granger-cause changes in political shocks. This is an interesting result as political shocks are usually perceived to cause shifts in oil prices. Considering that Kenya is a fairly politically stable country this result is not entirely unexpected as world political shocks are already factored in the variable world oil prices.

King et al (2012) and Büyükşahin and Harris, (2011), amongst other studies, employed Granger causality tests to analyze relations among oil prices and political

events and found that political shocks had a significant effect on crude oil prices. It is worth noting that Granger causality tests indicate the presence or absence of causality but not the extent of causality and go beyond identifying the presence of correlation but do not indicate the extent of correlation. To estimate the magnitude of these effects and persistence of shocks on several variables on pump prices, the study relied on Vector auto-regression (VAR) models.The vector autoregression (VAR) is an econometric model used to capture the linear interdependencies among multiple time series. VAR models generalize the univariate autoregressive model (AR model) by allowing for more than one evolving variable. Sims (1980) argued that VARs held out the promise of providing a coherent and credible approach to data description, forecasting, structural inference and policy analysis.

Table 4.4: Pairwise Granger Causality Tests

Null Hypothesis:	F-Statistic	Prob.	Decision
World Oil Prices do not Granger-cause pump prices	4.793	0.01	Reject Ho
Pump prices do not Granger-cause world oil prices	1.061	0.35	Accept Ho
Exchange rates do not Granger-cause pump prices	0.718	0.59	Accept Ho
Pump prices do not Granger-cause exchange rates	3.362	0.02	Reject Ho
Regulatory costs do not Granger-cause pump prices	4.793	0.01	Reject Ho
Pump prices do not Granger-cause Regulatory costs	1.061	0.35	Accept Ho
Political shocks do not Granger-cause pump prices	0.632	0.60	Accept Ho
Pump prices do not Granger-cause political shocks	1.999	0.13	Accept Ho
Supply chain costs do not Granger-cause pump prices	4.793	0.01	Reject Ho
Pump prices do not Granger-cause supply chain costs	2.037	0.14	Accept Ho

4.2.4 Correlation between Variables

Table 4.5 shows that pump prices are positively (r = 0.7315) and statistically significantly related to world oil prices as are regulatory costs (r = 0.2226) and supply chain costs (r = 0.3459). Exchange rates are also shown in Table 4.5 to be negatively (r = -0.3643) and significantly related to oil pump prices as are political shocks (r = -0.230945). These results are in line with those by Dale (2009) who

observed that economic models generally found a negative, but sometimes insignificant relationship between oil prices and the Canadian dollar. The study by Dale (2009) further found that Canadian dollar appreciation would be partly due to the higher price of oil and very much due to the correlated increases in the prices of other commodities. Notably, a rise exchange rate implies a depreciation of the Kenya Shilling while a fall implies an appreciation and hence the negative relationship should be viewed in this sense.

A high exchange rate implies a worsening of the value of the Kenya Shilling and tends to negatively influence oil prices leading to price increases and the reverse is also true. Dawson (2004) studied the effect of oil prices on exchange rates in the Dominican Republic and found that as the price of oil increases, more US Dollars were demanded in order to pay for the oil imports and this led to currency depreciation in the Dominican Republic that relied on oil imports. These results are consistent with those by Akram (2004), Bergvall (2004), Amano and van Norden (1998), and Chaudhuri and Daniel (1998) who found that oil prices significantly affected the relative value of currencies of Norway, four Nordic countries and the United Arab Emirates. A study by Cooper (1994), however, found that it is exchange rates that affect oil prices but this study was conducted in oil producing industrial economy while Kenya is a small oil importing economy with little or no impact on world oil prices. For this study therefore, the results that exchange rates are not a key determinant of pump prices is supported by scholarly articles by Akram (2004), Bergvall (2004), Amano and van Norden (1998), and Chaudhuri and Daniel (1998) as well as Dawson, (2004). A future study on whether pump prices determine shifts in exchange rate in Kenya is recommended as this study focussed on whether exchange rates determine pump price volatility.

Table 4.5 also displays the correlation between the explanatory variables and the respective instrumental variables. Instrumental variable methods allow consistent estimation when the explanatory variables (covariates) are correlated with the error

terms of a regression relationship. In empirical studies, the method of instrumental variables (IV) is used to estimate causal relationships when controlled experiments are not feasible or when a treatment is not successfully delivered to every unit in a randomized experiment (Imbens&Angrist, 1994). The instruments help to obtain consistent estimates and therefore avoid the correlations between the covariates and the error term. The instrumental variables used in this study were interest rates that instrumented exchange rates, crude oil price indices that instrumented world oil prices, supply indices that instrumented supply chain costs and regulatory indices that instrumented pump prices.

Interest rates, supply indices, crude oil price indices and regulatory indices were obtained from databases of the Central Bank of Kenya, Petroleum Institute of East Africa and Energy Regulatory Commission. The choice of these instruments is mostly guided by other studies on oil pricing that used instrument variables including Chen and Graham (2008) who used the omitted variable concept to select their instruments for oil pricing studies.

According to Angrist and Krueger (2001), a good instrument is correlated with the endogenous regressor for reasons the researcher can verify and explain, but uncorrelated with the outcome variable for reasons beyond its effect on the endogenous regressor. Angrist and Krueger (1999) further state that good instruments often come from detailed knowledge of the economic mechanism and institutions determining the regressor of interest and based on this recommendation, this study used factors usually involved in discussions around oil pricing but not factored in the Energy Regulatory Commission formula in Kenya. These include interest rates, political indices, supply indices and regulatory constraints.

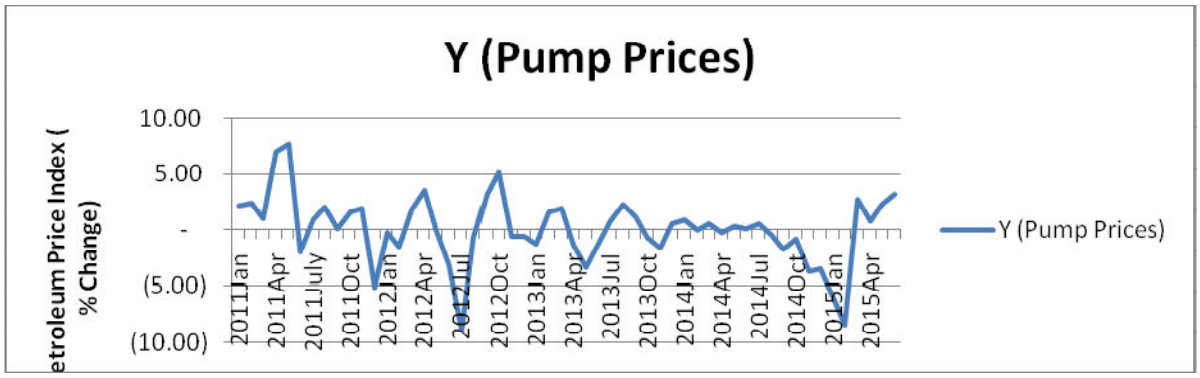
Table 4.5: Correlation Matrix for Explanatory and Instrumental Variables

Variable	WOP	EXR	SCH	POL	REG	INT	PI	SI	PP
World Oil Prices (WOP)	1.00								
Exchange Rates (EXR)	-0.270	1.000							
Supply Chain costs (SCH)	0.113	0.024	1.000						
Political shocks (POL)	0.062	-0.127	-0.259	1.000					
Regulatory indices (REG)	0.230	-0.004	0.101	-0.162	1.000				
Interest rates (INT)	0.273	0.378	-0.010	-0.144	0.195	1.000			
Crude Oil Price indices (PI)	-0.0676	-0.360	-0.001	-0.204	0.005	0.079	1.000		
Supply indices (SI)	-0.163	-0.143	-0.250	0.327	-0.070	-0.340	-0.264	1.000	
Pump Prices (PP)	0.558	-0.365	0.089	-0.231	0.223	0.376	0.513	-0.142	1.000

4.2.5 Volatility of Pump Prices, World Oil Prices and Exchange Rates

Figure 4.1 demonstrates that pump prices did not display a stable trend over the study period though at times relative volatility was evident for short durations. The changes identified in Figure 4.1 are between -9% and 8%. The European Central Bank (1998) defines a maximum change of up to 2% as being a sign of volatility and therefore changes above this percentage are signs of price volatility. As a result, for the period December 2010 to December 2014, the prices of petroleum products were found to exhibit volatility with short durations of relative volatility. It is therefore, important

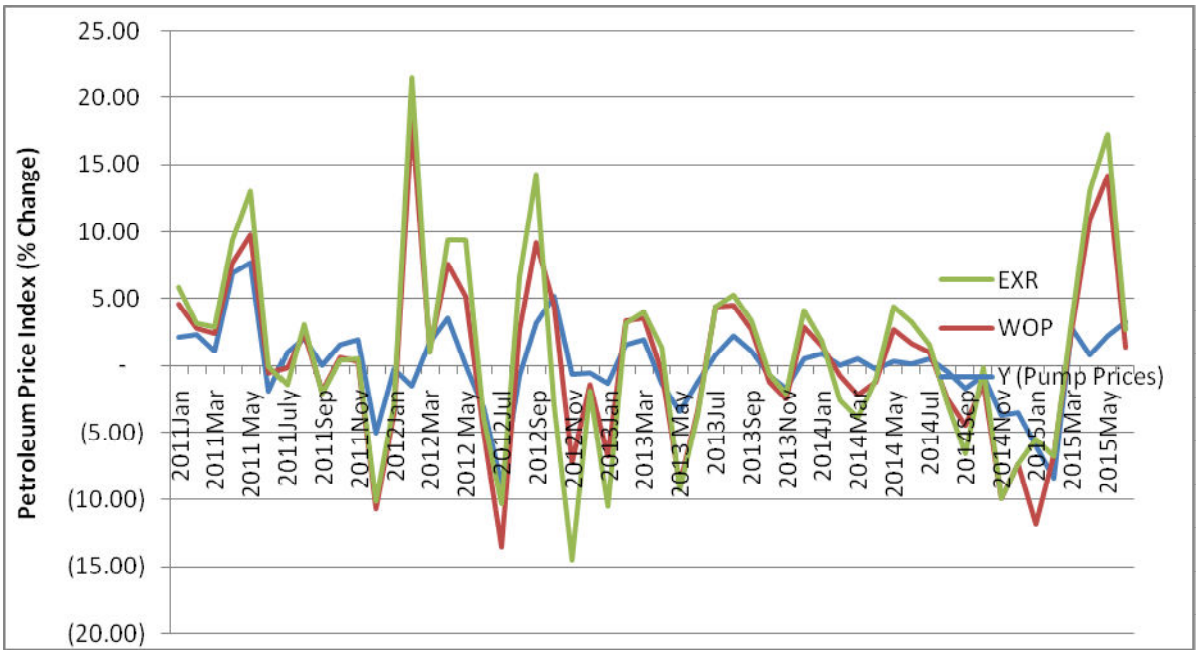
to establish the factors causing this volatility in pump prices. One way of doing this is by establishing the trend between pump prices and the independent variables under this study.



(The figure plots first consumer price indices of Pump Price of petroleum commodities in Kenya.)

Figure 4.1: Volatility of Pump Prices

Figure 4.2 demonstrates that pump prices, world oil prices and exchange rates did not display a stable trend over the study period though at times relative volatility was evident for short durations. The variations identified in Figure 4.2 are more pronounced for world oil prices and exchange rates than they are for pump prices. For the period December 2010 to December 2014, the prices of petroleum products were found to exhibit volatility with short durations of relative volatility. A sharp drop is evident towards 2015.



(This figure displays consumer price indices of exchange rates and world oil prices compared to those of pump prices in Kenya)

Figure 4.2: Volatility of Pump Prices, World Oil Prices & Exchange Rates

4.2.6: Relationship between Pump Prices and their Determinants

Figure 4.3 demonstrates the trend relationship between each of the independent variables (world oil prices, exchange rates, regulatory costs, supply chain costs and political shocks compared with the trends of the average pump prices of the four petroleum grades under study. Figure 4.3 shows that the trend between world oil prices and pump prices is similar though pump prices display a lag effect in responding to changes in world oil prices. However, the trend of pump prices compared to exchange rate trends is not direct and it appears there are times when falling pump prices contradict the rising exchange rates. It is also visible from Figure 4.3 that the full impact of changes in world oil prices is not felt in Kenya as sharp increases and decreases in world oil prices are only met with modest changes in pump prices in the same direction apparently with a lag. Thus, a strong and direct trend with a visible lag is evident for world oil prices and pump prices but a more

complex relationship between exchange rate trends and pump prices is displayed. Regulatory costs and political shocks indicate a more stable trend over the period of study.

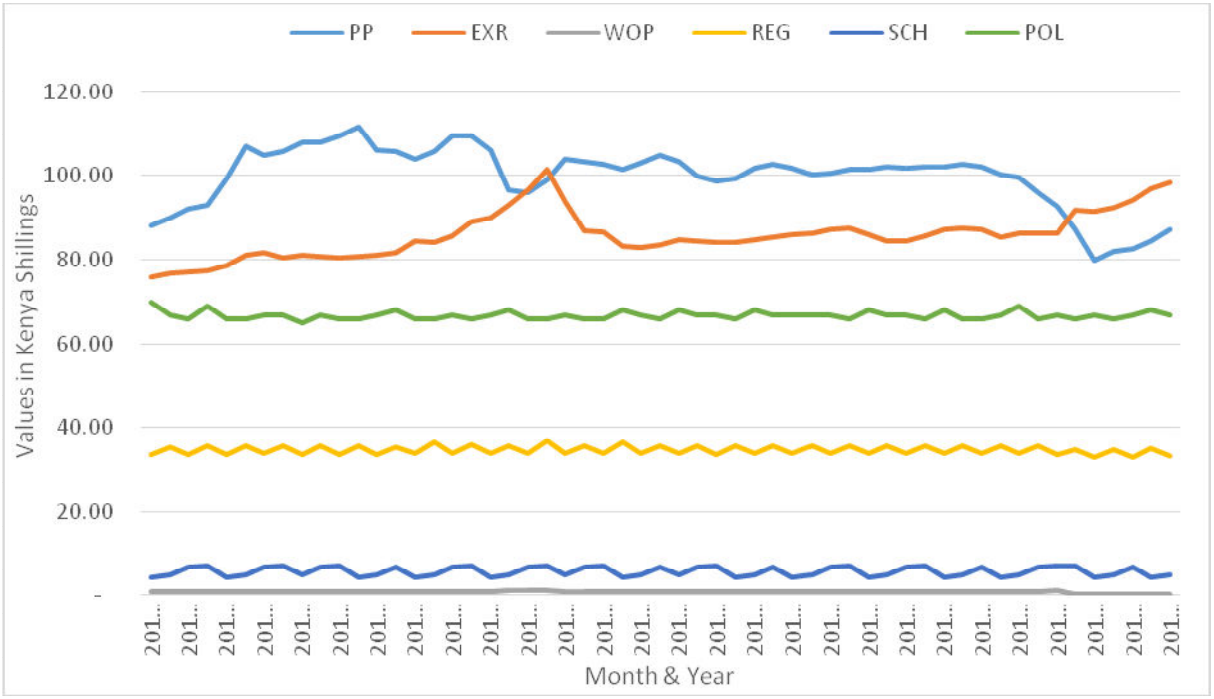


Figure 4.3: Trend of Pump Prices & Their Determinants

4.2.7: Model Estimation from Secondary Data

From this study, one of the granger causality test results was that pump prices Granger-cause exchange rates while exchange rates also Granger-cause pump prices. Because of this cross-causality, and the fact that there might be other important variables omitted in the model specification, both of which can potentially introduce endogeneity in the equation, ordinary least squares (OLS) regression is not appropriate and hence this study uses the general method of moments (GMM) to estimate the relationship between pump prices and its explanatory variables. Further tests following GMM regression analysis were thus found to be necessary in order to determine the contribution of each of the variables to the overall pump prices and

thus quantify the changes in pump prices attributable to each of the independent variables.

According to Baum, Schaffer, and Stillman (2003), an omnipresent problem in empirical work is heteroskedasticity and though the consistency of the instrument variables coefficient estimates is not affected by the presence of heteroskedasticity, the standard instrumental variables estimates of the standard errors are inconsistent, preventing valid inference. The usual forms of the diagnostic tests for endogeneity and over-identifying restrictions would also have been invalid if heteroskedasticity was present. Baum, Schaffer, and Stallman (2003) further state that these problems can be partially addressed through the use of heteroscedasticity-consistent or robust standard errors and statistics. The conventional instrumental variables estimator (though consistent) is, however, inefficient in the presence of heteroscedasticity and the usual approach today when facing heteroskedasticity of unknown form is to use the generalized method of moments (GMM), introduced by Hansen(1982). Table 4.6 displays results of endogeneity tests between instrument variables and the exogenous variables.

Table 4.6: Endogeneity Test between Instrument and Exogenous Variables

	Value	df	Probability
Difference in J-stats	2.451071	13	0.9993
J-statistic summary:			
	Value		
Restricted J-statistic	6.232678		
Unrestricted J-statistic	3.781606		

GMM makes use of the orthogonality conditions to allow for efficient estimation in the presence of heteroscedasticity of unknown form. This study, therefore, used this method in the model estimation and instrumental variable suitability testing. In Table 4.7 the GMM method was used to compute the standard error and covariance using an estimation weighting matrix. The p-values in all cases except for lags of exchange rates, supply chain costs and lag two of political shocks were below the critical value of 0.05 at 95% confidence level and hence the instrument variables were not weak and were suitable for model estimation.

Table 4.7: Standard Error and Covariance Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant (or Intercept)	179.6674	29.34139	6.123345	0.0000
World Oil Prices	11.30650	1.706154	6.626891	0.0000
La One of World Oil Prices	-11.35320	3.256032	-3.486822	0.0013
Lag Two of World Oil Prices	6.303131	2.713942	2.322500	0.0260
Exchange Rates	-0.236667	0.081386	-2.907961	0.0062
Lag One of Exchange Rates	-0.074348	0.120370	-0.617661	0.5407
Lag Two of Exchange Rates	-0.011093	0.093034	-0.119233	0.9058
Supply chain Costs	-0.075824	0.095348	-0.795234	0.4317
Lag One of Supply chain Costs	-0.168651	0.082843	-2.035797	0.0492
Lag Two of Supply chain Costs	-0.150812	0.041521	-3.632216	0.0009
Political Shocks	-0.791974	0.182793	-4.332622	0.0001
Lag One of Political Shocks	-0.498268	0.211262	-2.358529	0.0239
Lag two of Political Shocks	-0.549412	0.349105	-1.573773	0.1243
Lag One of Pump Prices	1.077469	0.058761	18.33662	0.0000
Lag Two of Pump Prices	-0.415122	0.061657	-6.732779	0.0000

R-squared	0.911876	Mean dependent var	100.4693
Adjusted R-squared	0.877605	S.D. dependent var	7.269956
S.E. of regression	2.543391	Sum squared resid	232.8782
Durbin-Watson stat	2.268615	J-statistic	14.05802
Instrument rank	33	Prob(J-statistic)	0.725301

The instrumental variables used in the GMM regression were interest rates that instrumented exchange rates, crude oil price indices that instrumented world oil and

pump prices, supply indices that instrumented supply chain costs and regulatory indices that instrumented supply chain costs. Interest rates, supply indices and regulatory indices were obtained for databases of the Central Bank of Kenya, Petroleum Institute of East Africa and Energy Regulatory Commission.

Regression analysis was performed using the iterated General Method of Moments (iGMM) the results of which are displayed in Table 4.8. However, under the un-iterated GMM method, the efficient estimators have the tendency to over-reject the null hypothesis in small samples by causing large t-statistics. To solve this problem, Ferson and Foerster (1994) recommended the use of the iterated GMM (which is shown to provide reasonable standard errors even in samples as small as 60). As the sample size of this study was 55 observations, the study used the iterated version of GMM as recommended by Ferson and Foerster (1994). This helped to avoid reporting significant variables erroneously.

These results indicate that, changes in past pump prices (both lag one and two) are statistically significant determinants of pump prices with their p-values being 0.000 and 0.06 at 95% and 90% level of confidence respectively. World oil prices were also a statistically significant variable in determination of pump prices with a p-value of 0.000. Political shocks were the also key determinants in changes in pump prices as they were statistically significant with a p-value of 0.08 which was lower than the 0.1 critical value at 90% level of confidence. Equally, supply chain costs proved to be statistically significant determinants of pump prices at 90% confidence level with a p-value of 0.069. The results on Table 4.8 also enabled the study to estimate the relevant equation for the study model.

These results mean that a change in world oil prices of one unit (USD 1) per barrel (or USD 0.02 per litre) in world oil prices would elicit a change in pump prices in Kenya by Kshs 29.56 per barrel (Kshs 0.50 per litre). A negative shift in political shocks by one unit would elicit a negative impact on pump prices by Kenya Shillings 2.60 in the immediate next period, Kenya Shillings 2.54 in the next two periods. This

means that political shocks affect pump prices in the subsequent two months from first change. One unit increase in supply chain costs elicits an increase in pump prices by Kenya Shillings 0.414 in the immediate period or month. A change in immediate past period pump prices by one unit (1 Kshs) would lead to a change in current pump prices in Kenya by Kshs. 0.82 in the same direction and a change in last two periods pump prices by Kshs. 1 would elicit a change in pump prices by Kshs 0.48 in the same direction. Johnson (2002) argued that a search costmary lead to long lags in the response of gasoline prices. Godby, Lintner, Stengos and Wand (2000) empirically explore the behavior of gasoline and oil prices and suggest that only oil price changes that are bigger than some threshold level lead to revision of gasoline prices. Similar results were obtained by Radchenko (2005) who points to possible nonlinearities in retail gasoline prices and the role that different kinds of oil price fluctuations play in the gasoline price response.

These factors and their stated impacts are, therefore, the determinants of volatility in pump prices of petroleum products in Kenya. World oil prices and past lags of pump prices are the most significant determinants of volatility in pump prices from these results. The results are in line with findings by Masima, William and Sexsmith (2010) who observed that fluctuation in oil prices is associated to unstable world oil prices. A curious observation from these results is that exchange rates are not a statistically significant determinant of volatility in prices of petroleum products in Kenya as is notable from the p-value results of 0.847, 0.276 and 0.534 for the immediate period, lag one and lag two respectively. This result is consistent with findings by Dale (2009) who observed that economic models generally found a negative, but sometimes insignificant relationship between oil prices and the Canadian dollar. Notably, exchange rates in Kenya are freely floating and change on a daily basis yet oil pump prices are revised on a monthly basis hence exchange rate impacts are generally an average for the period.

A review of the secondary data showed that regulatory costs, including taxes and allowed losses and gross margins, have been generally constant over the study

period. A study in a different time period where changes do take place on regulatory factors could generate different results. As a result, regulatory costs were not treated as a variable during the model estimation in this study but were included amongst the instrument variables in the GMM equation estimation. The study, however observed that taxation was a significant component of the pump prices constituting Kenya shillings 32 per litre but remained relatively stable over the study period as did profit margins at Kenya shillings 10 per litre. The J-statistic from the equation estimation results on Table 4.8 is 1.633 with a p-value of 0.897. Based on these results, the null hypothesis that the over-identification restrictions are valid is not rejected, concluding that the instrument set is appropriate, consistent with insights of Baum, Schaffer, and Stillman (2003).

Table 4.8: Equation Estimation for Determinants of Volatility of Pump Prices

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant (or intercept)	510.100	141.055	3.616	0.001
World Oil Prices	29.555	6.062	4.876	0.000
Lag one of World Oil Prices	-4.309	11.087	-0.389	0.700
Lag two of World Oil Prices	-5.844	11.039	-0.529	0.600
Exchange Rates	-0.062	0.318	-0.194	0.847
Lag one of Exchange Rates	-0.583	0.527	-1.107	0.276
Lag two of Exchange Rates	0.157	0.250	0.628	0.534
Supply Chain Costs	-0.415	0.221	-1.876	0.069
Lag One of Supply Chain costs	-0.034	0.178	-0.193	0.848
Lag One of Supply Chain costs	-0.169	0.284	-0.596	0.555
Political Costs	-1.120	0.748	-1.497	0.143
Lag one of Political Costs	-2.600	1.439	-1.803	0.080
Lag two of Political Costs	-2.538	0.549	-4.624	0.000
Lag one of Pump Prices	0.823	0.156	5.293	0.000
Lag two of Pump Prices	-0.476	0.249	-1.914	0.064
Adjusted R-squared	0.687			
Durbin-Watson stat	1.928	J-statistic		1.633
Instrument rank	20	Prob (J-statistic)		0.897

4.2.8 Lag Order Structure Selection

To determine the suitability of the lag structure for the model, the study applied the unrestricted vector auto-regression (VAR) test on all the variables and obtained the results in Table 4.9. These VAR estimates were used to further run lag structure tests in order to determine the optimal lag structure for the model under study. The standard errors are shown in parenthesis while the t-statistics are shown in square braces

Table 4.9: Vector Auto regression Estimates

	World Oil Prices	Exchange Rates	Supply Chain	Political Shocks	Lag 1 Pump Prices
Lag One of world Oil Prices	0.672	1.604	0.991	0.836	5.727
	(0.148)	(3.179)	(1.471)	(1.413)	(4.470)
	[4.530]	[0.505]	[0.674]	[0.592]	[1.281]
Lag Two of World Oil Prices	0.0290	-5.681	1.145	-0.146	1.735
	(0.152)	(3.250)	(1.505)	(1.445)	(4.571)
	[0.191]	[-1.748]	[0.761]	[-0.101]	[0.379]
Lag One of Exchange Rates	0.006	1.111	-0.065	0.0404	-0.143
	(0.006)	(0.134)	(0.062)	(0.059)	(0.188)
	[0.903]	[8.321]	[-1.053]	[0.681]	[-0.762]
Lag Two of Exchange Rates	-0.003	-0.266	0.066	-0.052	-0.009
	(0.006)	(0.132)	(0.061)	(0.059)	(0.185)
	[-0.448]	[-2.025]	[1.081]	[-0.882]	[-0.049]
Lag One of Supply Chain Costs	-0.013	0.0244	-0.224	-0.122	-0.318
	(0.012)	(0.255)	(0.118)	(0.113)	(0.359)
	[-1.111]	[0.096]	[-1.898]	[-1.078]	[-0.885]
Lag Two of Supply Chain costs	-0.016	-0.302	-0.686	-0.021	-0.056
	(0.012)	(0.253)	(0.117)	(0.112)	(0.355)
	[-1.330]	[-1.193]	[-5.867]	[-0.189]	[-0.159]
Lag One of Political Shocks	0.009	0.325	-0.127	-0.374	-1.071
	(0.016)	(0.341)	(0.158)	(0.151)	(0.479)
	[0.579]	[0.954]	[-0.802]	[-2.472]	[-2.236]
Lag Two of Political Shocks	0.031	0.225	-0.125	-0.274	-0.282
	(0.017)	(0.367)	(0.170)	(0.163)	(0.516)
	[1.820]	[0.613]	[-0.734]	[-1.681]	[-0.546]
lag one pump prices	0.012	-0.234	-0.022	0.030	1.120
	(0.005)	(0.109)	(0.050)	(0.048)	(0.153)
	[2.281]	[-2.155]	[-0.446]	[0.625]	[7.326]
lag two pump prices	-0.005	0.250	0.005	-0.063	-0.378
	(0.005)	(0.101)	(0.047)	(0.045)	(0.141)
	[-1.076]	[2.482]	[0.101]	[-1.406]	[-2.670]
	[-1.639]	[-0.471]	[1.413]	[6.146]	[2.125]
R-squared	0.758	0.887	0.504	0.225	0.886

Lag order selection was the performed using for different methods (FPE, AIC, SC and HQ). Following these methods, and as shown in Table 4.10, the study settled on lag order 2 that was supported by four of the six information criteria used. The post estimation tests (including auto-correlation and heteroskedasticity) confirmed that the model was not mis-specified and was suitable for hypothesis testing.

Table 4.10: Lag Order Structure Selection

Lag	LogL	LR	FPE	AIC	SC
0	-399.384	NA	7.286	16.175	16.367
1	-299.999	174.916	0.374	13.199	14.347
2	-249.857	78.223*	0.141*	12.194*	14.298*
3	-235.148	20.005	0.231	12.606	15.665
4	-202.980	37.314	0.203	12.319	16.334

* 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

4.2.9 Decomposition of Variance

Standard variance decomposition tests were taken to test the impact of volatility of each explanatory variable on pump prices as shown on Table 4.11. From these results, a standard deviation shock in world oil prices was found to lead to over 8.82% fluctuations in pump prices in the short run (3 months) and 35.39% in the long run (ten months). The variance decomposition of exchange rates shows that a unit

shock in exchange rates was found to lead to over 3.99% fluctuations in pump prices in the short run and 7.15% in the long run. For supply chain costs a unit shock led to a shock of 77.23% in the short run in the short run and 1.34% in the long run. Table 4.11 further shows that a unit of political shocks led to 29.23% fluctuations in pump prices in the short run and 17.14% shock in the long run. Shock in lag one of pump prices show that a unit shock leads to a shock of 57.18% in the short run and 38.98% in the long run.

Table 4.11: Variance Decomposition of Pump Prices

Period	WOP	EXR	SCH	POL	Lag One of PP
1	2.575932	0.712790	0.863967	17.35978	78.48753
2	4.936266	2.178605	0.847155	28.17295	63.86502
3	8.822784	3.996745	0.772348	29.23011	57.17801
4	13.79040	5.466957	0.718191	26.49833	53.52612
5	18.84400	6.428366	0.801111	24.17274	49.75379
6	23.48056	6.954088	0.972801	22.24791	46.34464
7	27.42241	7.172000	1.061759	20.50534	43.83849
8	30.63711	7.233220	1.128394	19.11641	41.88486
9	33.27142	7.215344	1.242323	18.02451	40.24640
10	35.38779	7.152722	1.342877	17.13804	38.97856

4.2.10 Impulse Response Tests

The results of variance decomposition tests set the stage ready for the next test that was to help determine the impulse response of the residue on the dependent variables. The test results of this are indicated in Figure 4.4 where using a Choleski decomposition on a VAR model with world oil prices, exchange rates, supply chain costs, political shocks and lag one of pump prices the study generated the impulse response functions for the pump prices. A one standard deviation shock to the past (lag one) pump prices increases the current pump prices in the short run but the

shock tends to decline steadily after 2 months, though the effect remains statistically significant over time. A one standard deviation shock in world oil prices steadily leads to higher pump prices but stabilizes after 5 months. Shocks in exchange rates, political factors and supply chain costs generally remain less statistically significant.

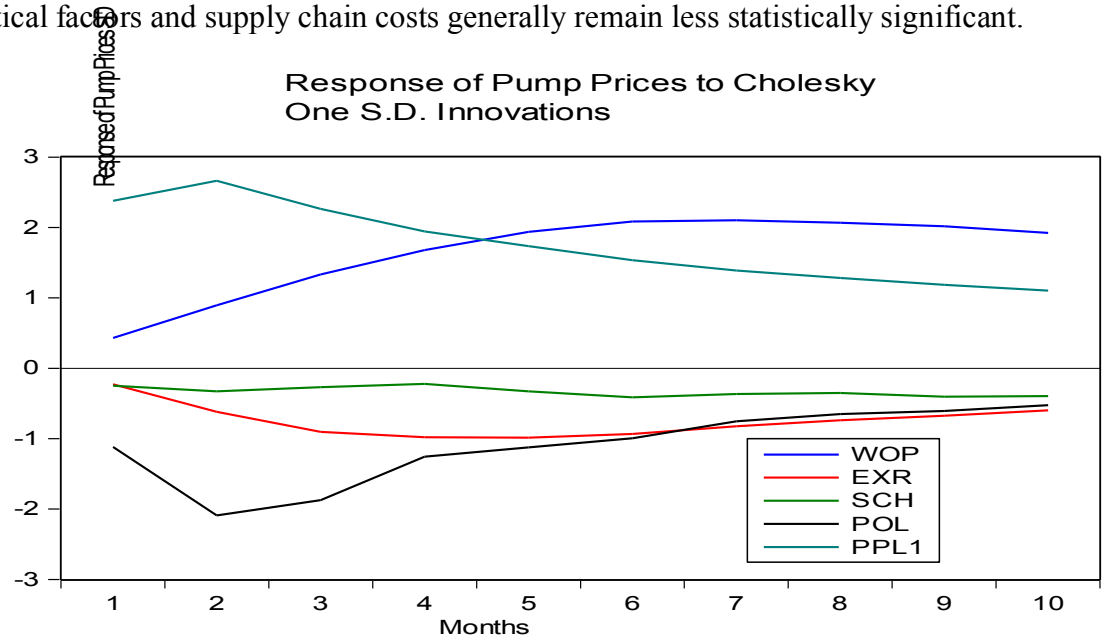


Figure 4.4: Impulse Responses of Explanatory Variables on Pump Prices

4.2.11 Autocorrelation Test for Study Model

Having made an estimation of the equation the study conducted a test for auto-correlation between the variables. The results indicated that there was no autocorrelation in the variables as the test gave a result of a probability value of 00.1059 or 10.59% implying that the correlations between the variables were not statistically significant at the 0.05 (5%) level of significance or at 95% level of confidence. These results are displayed in Table 4.12. These tests and results are consistent with the study by Chenet al. (2009) that used signed path coefficients to perform t-test at group level statistics.

Table 4.12: Breusch-Godfrey Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

Obs*R-squared	4.491140	Prob. Chi-Square(2)	0.1059

4.2.12 Test for Heteroskedasticity Among Variables

Following the determination of the model equation using the iterated Generalized Method of Moments and also having confirmed that the adjusted model did not contain serial correlations, the study employed the heteroskedasticity white test to examine the null hypothesis that there was no heteroskedasticity amongst the dependent variables. This test generated a result of a probability chi-square value of 0.0.0051 as displayed on Table 4.13. Based on this result and adjustment of standard errors for heteroscedasticity and autocorrelation in the Eviews statistical package, the null hypothesis that there was no heteroscedasticity was rejected and a conclusion that there was heteroscedasticity amongst the variables was arrived at. These result implied that the variance error term was not constant and therefore the model was good for hypothesis testing.

Table 4.13: Heteroscedasticity among Variables

F-statistic	5.123049	Prob. F(20,31)	0.0000
Obs*R-squared	39.92156	Prob. Chi-Square(20)	0.0051
Scaled explained SS	34.78549	Prob. Chi-Square(20)	0.0213

4.2.13 Fitted Graph and Residue

The actual and fitted graph of the model, including a display that the residue was constant around the mean, is displayed in Figure 4.5.

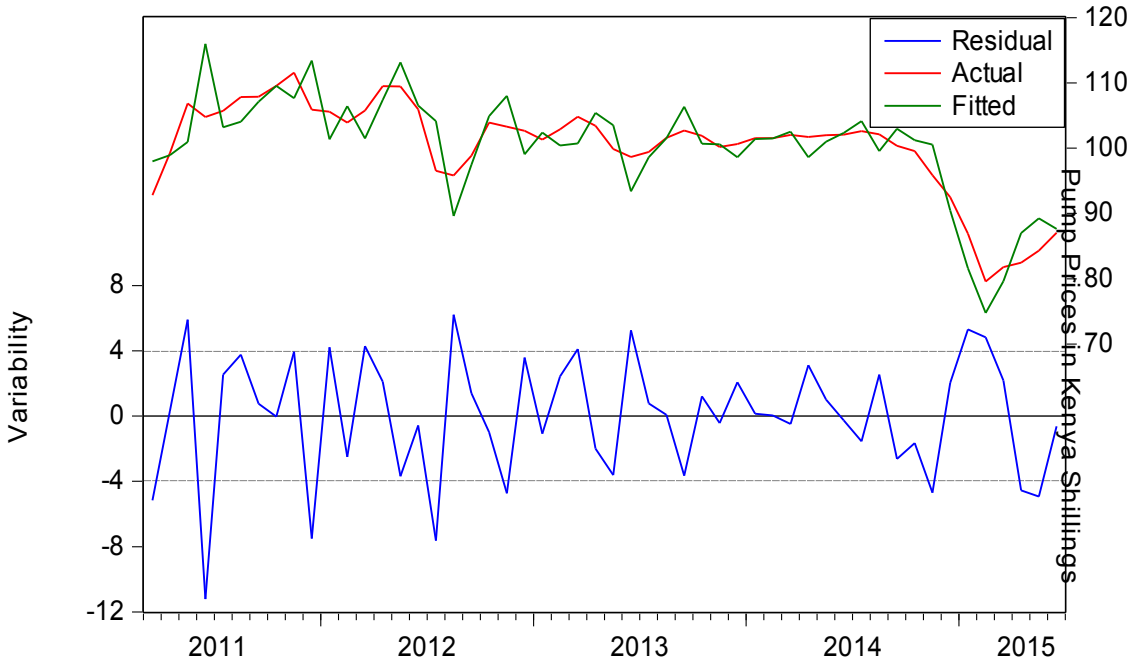


Figure 4.5: Pump Prices Trend and Residue

4.3 Primary Data Analysis

Primary data analysis was conducted to summarize, interpret and explain the results of data analysis of responses from primary sources. These are recorded in this section.

4.3.1 Response Rate

The number of questionnaires, administered to all the respondents, was 150. A total of 115 questionnaires were properly filled and returned by respondents. This represented an overall response success rate of 77%. According to Mugenda and Mugenda (2003), a response rate of 50% or more is adequate. Babbie (2004) also

asserted that return rates of 50% are acceptable to analyze and publish, 60% is good and 70% is very good. Table 4.14 presents the results.

Table 4.14: Response Rate

Response Rate	Frequency	Percent
Returned	115	77%
Unreturned	35	23%
Total	150	100%

4.3.2 Demographic Information

This section presents the demographic characteristics such as gender, level of education, years worked in the organization, size of the organization and years of firms' existence.

4.3.2.1 Category or Type of Company

The respondents were asked to indicate the category or type of the company they represented. Figure 4.6 shows that 57% of the respondents were from oil marketing companies, 30% indicated oil dealership, and 7% indicated the Ministry of energy and Petroleum and National Oil Company, 3% Energy Regulatory Commission and 3% Petroleum Institute of East Africa. This result confirms the Institute of Economic Affairs (International Energy Association, 2000) observation that Kenya Petroleum sector consists of the Ministry of Energy and Petroleum (MOEP) and oil marketing companies (OMCs) and oil dealerships.

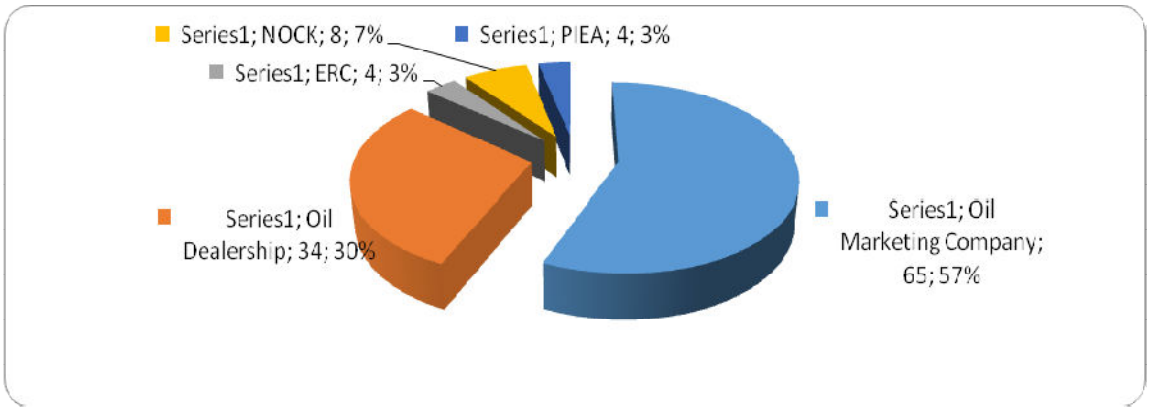


Figure 4.6: Category or Type of Company

4.3.2.2 Gender of the Respondents

The respondents were asked to indicate their gender. Table 4.2indicates that majority of the respondents (80%) were male and 20% were female. The findings imply that petroleum sector is a male dominated field. This corroborates results by Ellis et al. (2007), who found that in spite of women being major actors in Kenya's economy, and notably in agriculture and the informal business sector, men dominate in the formal sector citing the ratio of men to women in formal sector as 0.74: 0.26.

Table 4.15: Gender of the Respondents

Gender	Frequency	Percent
Male	92	80
Female	23	20
Total	115	100

4.3.2.3 Age of the Respondents

The respondents were asked to indicate their age. Figure 4.7 indicates that 35% of the respondents were aged between 46 and55 years old while another 35% were between 26 and 35 years old and 295 were between 35 and 45 years old. The

findings imply that the respondents were mature enough and had an experience in the petroleum sector thus accurate responses were expected.

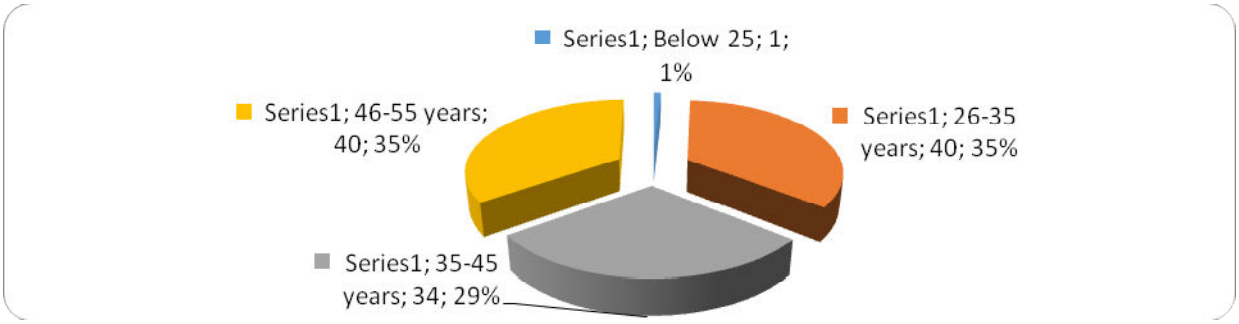


Figure 4.7: Age of the Respondents

4.3.2.4 Position

The respondents were asked to indicate the positions they held in their organization. Table 4.16 shows that 50.4% of the respondents were oil dealers, while 18.3% were supply managers and 7.8% were regulatory officers. The findings imply that the respondents were well spread in all positions hence stratification was possible with no bias.

Table 4.16: Position of the Respondents

Position	Frequency	Percent
Supply Manager	21	18.3
Finance Manager	5	4.3
Regulatory Official	9	7.8
Oil Dealer/Manager	58	50.4
Ministry Official	4	3.5
Other	18	15.7
Total	115	100

4.3.2.5 Length of Employment

The study sought to find out the years each of the respondents had worked in their organization. Figure 4.8 shows that 52% of the respondents had worked for the organization for up to 6 years, 26% for 6 to 10 years and 17% for 5 to10 years. The findings imply that most of the respondents had worked long enough in the firms and hence had good knowledge on the issues that the study was investigating.

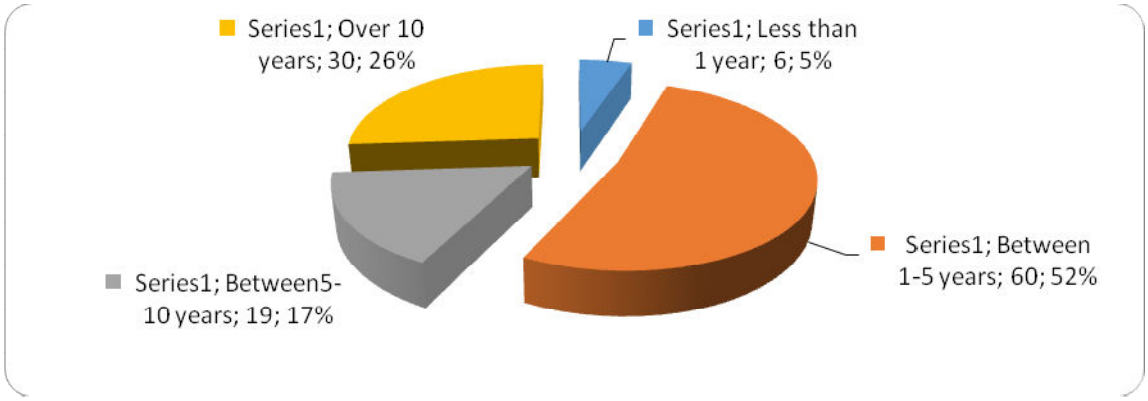


Figure 4.8: Length of Employment

4.4 Findings and Discussions from Primary Data Analysis

This section presents the findings and discussion of the variables on the factors affecting volatility in prices of petroleum products in Kenya from primary data analysis. These include: world prices, exchange rate, supply chain cost, regulatory cost, political cost and lag of pump prices. The reliability tests were carried out on each variable followed by the sampling adequacy, factor analysis, descriptive

statistics and finally the inferential statistics. Combined effect analysis was also presented.

4.4.1World Prices

4.4.1.1 Reliability Tests

Primary data analysis reliability tests were conducted using Cronbach's Alpha Coefficient test on world prices and a coefficient of 0.813 was found as shown in Table 4.17. The statements under the world prices variable of this study were thus concluded to have adequate internal consistency, therefore, reliable for the analysis and generalization on the population. Findings by Saunders, Lewis and Thornhill (2009) and Christensen, Johnson and Turner (2011) that scales of 0.7 and above, indicate satisfactory reliability, confirm this observation.

Table 4.17: Reliability Test for World Prices

Variable	World Prices
Cronbach's Alpha	0.813
Number of Items	5

4.4.1.2 Sampling Adequacy

To examine whether the data collected was adequate and appropriate for inferential statistical tests such as the factor analysis, regression analysis and other statistical tests, two main tests were performed namely; Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Barlett's Test of Sphericity. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy provides an index (between 0 and 1) of the proportion of variance among the variables that might be common variance (Kaiser,

1970). For a data set to be regarded as adequate and appropriate for statistical analysis, the value of KMO should be greater than 0.5 (Field, 2000).

According to Bartlett (1950), Bartlett's test approximates a chi-square distribution for large samples of over 30 items. Consequently, it is usually assumed that the sample correlation came from a multivariate normal population with the variables being analysed being independent. If they are not, then the data are appropriate for analysis using factor analysis. Very small values of significance (below 0.05) indicate a high probability that there are significant relationships between the variables, whereas higher values (0.1 or above) indicate the data is inappropriate for factor analysis.

Findings in Table 4.19 showed that the KMO statistic was 0.666 which was significant; that is, greater than the critical level of significance of the test. In addition to the KMO test, the Bartlett's Test of Sphericity was also significant (Chi-square = 298.61 with 10 degree of freedom, at $p < 0.05$). The results of the KMO and Bartlett's Test are summarized in Table 4.18. These results provide an excellent justification for further statistical analysis to be conducted.

Table 4.18: World Prices KMO Sampling Adequacy and Bartlett's Sphericity Tests

Kaiser-Meyer-Olkin Measure	0.666
Bartlett's Chi- Square	298.611
Bartlett's df	10
Bartlett's Sig.	0.000

4.4.1.3 Factor Analysis

Factor analysis was conducted after successful testing of validity and reliability using KMO coefficient and Cronbach alpha results. Factor analysis was conducted using Principal Components Method (PCM). The extraction of the factors followed the Kaiser Criterion where an eigen value of 1 or more indicates a unique factor. Total Variance analysis indicates that the 5 statements on world prices can be factored into 1. The total variance explained by the extracted factor is 58.06% as shown in Table 4.19.

Table 4.19: World Prices Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.903	58.063	58.063	2.903	58.063	58.063
2	0.918	18.355	76.418			
3	0.696	13.928	90.345			
4	0.387	7.742	98.087			
5	0.096	1.913	100			

Extraction Method: Principal Component Analysis.

Table 4.20 shows the factor loadings for world oil prices. All the statements attracted coefficients of more than 0.4 hence all the statements were retained for analysis. According to Rahn (2010) a factor loading equal to or greater than 0.4 is considered adequate.

Table 4.20 Factor Loading for World Prices

Item	Factor Loading
World oil prices cause volatility of pump prices	0.815
International supply and demand causes volatility in pump prices	0.881
Cartel like behaviors in the international oil market affect volatility in prices of petroleum products in Kenya	0.745
International political events cause volatility of pump prices	0.711
International futures market for oil causes volatility in pump	0.633

Extraction Method: Principal Component Analysis.

4.4.1.4 Descriptive Analysis

Table 4.21 shows that 82.6% of the respondents agreed that world oil prices cause volatility in prices of petroleum products in Kenya, 81.8% agreed that international supply and demand factors cause volatility in prices of petroleum products in Kenya and 59.1% agreed that cartel like behaviors in the international oil market affect volatility in prices of petroleum products in Kenya. In addition 66.9% of the respondents agreed that political events cause volatility of prices of petroleum products in Kenya and 54.8% agreed that International futures market for oil causes volatility in prices of petroleum products in Kenya. The mean score for responses for this section was 3.81 which indicates that majority of the respondents agreed that world prices was a key driver on the volatility of oil prices of petroleum products in Kenya. The study findings agree with those of Ming (2009) who looked at future crude oil prices in China using a Granger Causality tests and the Vector Error Correction Model (VECM) and observed that during the past ten years, the crude oil prices have fluctuated a lot. The study provided interesting results since most of the studies reviewed showed that there was a relationship between world oil prices and the volatility of petroleum products prices in many countries.

Table 4.21: World Prices Descriptive Analysis

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Likert Mean
World oil prices cause or affect volatility in prices of petroleum product prices in Kenya	0.0%	10.4%	7.0%	43.5%	39.1%	4.11
International supply and demand factors cause or affect volatility in prices of petroleum products in Kenya	0.9%	7.8%	9.6%	46.1%	35.7%	4.08
Cartel like behaviors in the international oil market affect volatility in prices of petroleum products in Kenya	3.5%	15.7%	21.7%	37.4%	21.7%	3.58
International political events affect volatility of prices of petroleum products in Kenya	3.5%	12.2%	17.4%	47.8%	19.1%	3.67
International futures market for oil affects volatility of prices of petroleum products in Kenya	0.0%	12.2%	33.0%	38.3%	16.5%	3.59
Average	1.6%	11.7%	17.7%	42.6%	26.4%	3.81

Results from primary data analysis in Table 4.22 indicate that there was a positive and significant relationship between world oil prices and pump prices. This was evidenced by the p-value of 0.000 which is less than that of critical value (0.05)

Table 4.22: Relationship between World Prices and Pump Prices

Variable		Average Prices	World prices
Pump Prices	Pearson Correlation	1	
	Sig. (2-tailed)		
World prices	Pearson Correlation	0.664	1
	Sig. (2-tailed)	0.000	

4.4.2 Exchange Rate

4.4.2.1 Reliability Tests

Using Cronbach's Coefficient Alpha test on exchange rate, a coefficient of 0.748 was found as shown in Table 4.23. These results corroborates findings by Saunders, Lewis and Thornhill (2009) and Christensen, Johnson and Turner (2011) who stated that scales of 0.7 and above, indicate satisfactory reliability. Based on these recommendations, the statements under the exchange rate variable of this study were concluded to have adequate internal consistency, therefore, reliable for the analysis and generalization on the population.

Table 4.23: Reliability Test for Exchange Rate

Variable	Exchange Rate
Cronbach's Alpha	0.748
Number of Items	3

4.4.2.2 Sampling Adequacy

To examine whether the data collected was adequate and appropriate for inferential statistical tests such as the factor analysis, regression analysis and other statistical tests, two main tests were performed namely; Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Barlett's Test of Sphericity. For a data set to be regarded as adequate and appropriate for statistical analysis, the value of KMO should be greater than 0.5 (Field, 2000).

Findings in Table 4.24 showed that the KMO statistic was 0.612 which was significantly high being greater than the critical level of significance of the test which was set at 0.5 (Field, 2000). In addition to the KMO test, the Bartlett's Test of Sphericity was also highly significant (Chi-square = 107.634 with 3 degree of freedom, at $p < 0.05$). The results of the KMO and Bartlett's Test are summarized in Table 4.24. These results provide an excellent justification for further statistical analysis to be conducted.

Table 4.24: Exchange Rate KMO Sampling Adequacy and Bartlett's Sphericity Tests

Kaiser-Meyer-Olkin Measure	0.612
Bartlett's Chi- Square	107.634
Bartlett's df	3
Bartlett's Sig.	0.000

4.4.2.3 Factor Analysis

Factor analysis was conducted after successful testing of validity and reliability using KMO coefficient and Cronbach Alpha results. Factor analysis was conducted using Principal Components Method (PCM). The extraction of the factors followed the

Kaiser Criterion where an eigen value of 1 or more indicates a unique factor. Total Variance analysis indicates that the 3 statements on exchange rates can be factored into 1 factor. The total variance explained by the extracted factor is 68.61% as shown in Table 4.25.

Table 4.25: Exchange Rate Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.058	68.611	68.611	2.058	68.611	68.611
2	0.659	21.982	90.594			
3	0.282	9.406	100			

Extraction Method: Principal Component Analysis.

Table 4.26 shows the factor loadings for exchange rate. All the statements attracted coefficients of more than 0.4 hence all the statements were retained for analysis. According to Rahn (2010) a factor loading equal to or greater than 0.4 is considered adequate.

Table 4.26: Factor Loading for Exchange Rate

Statement	Factor Loading
Exchange rate depreciation of the Kenya Shilling to the US Dollar affects volatility in petroleum products prices in Kenya	0.840
Exchange rate appreciation of the Kenya Shilling to the US Dollar affects volatility in petroleum products prices in Kenya	0.730
The freely floating nature of the exchange rate between the Kenya Shilling to the US Dollar affects volatility in pump prices	0.905

Extraction Method: Principal Component Analysis

4.4.2.4 Descriptive Analysis

The second objective of the study was to investigate the effect of exchange rate fluctuations on the volatility of prices of petroleum products in Kenya. Table 4.27 illustrates that 85.2% of the respondents agreed that exchange rate depreciation of the Kenya Shilling to the US Dollar causes volatility in petroleum products prices in Kenya, 57.4% agreed that exchange rate appreciation of the Kenya Shilling to the US Dollar causes volatility in petroleum products prices in Kenya and 71.3% agreed that the freely floating nature of the exchange rate between the Kenya Shilling to the US Dollar affects volatility in prices of petroleum products in Kenya. The mean score for this section was 3.78 which indicates that majority of the respondents agreed that exchange rate fluctuations influenced the volatility of oil prices.

The study results corroborate findings by Bloomberg and Harris (1995) that provided a good description, based on the law of one price, of how exchange rate movements can affect oil prices. Commodities like oil are fairly homogeneous and

internationally traded. The law of one price asserts that as the US dollar weakens relative to other currencies, ceteris paribus, international buyers of oil are willing to pay more US dollars for oil.

Table 4.27: Exchange Rate Descriptive Analysis

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Likert Mean
Exchange rate depreciation of the Kenya Shilling to the US Dollar causes volatility of petroleum products prices in Kenya	4.3%	5.2%	5.2%	31.3%	53.9%	4.25
Exchange rate appreciation of the Kenya Shilling to the US Dollar causes volatility of petroleum products prices in Kenya	7.8%	29.6%	5.2%	38.3%	19.1%	3.31
The free floating nature of the exchange rate between the Kenya Shilling to the US Dollar causes volatility of prices of petroleum products prices in Kenya	4.3%	5.2%	19.1%	50.4%	20.9%	3.78
Average	5.5%	13.3%	9.8%	40.0%	31.3%	3.78

4.4.2.5 Relationship between Exchange Rate and Oil Pump Prices

Table 4.28 shows the correlation results which indicate that there was a positive and significant relationship between exchange rate and oil prices. This was evidenced by the p value of 0.000 which is less than that of critical value (0.05).

Table 4.28: Relationship between Exchange Rate and Oil Prices

Variable		Average Prices	Exchange Rate
Average Prices	Pearson Correlation	1	
	Sig. (2-tailed)		
Exchange Rate	Pearson Correlation	0.574	1
	Sig. (2-tailed)	0.000	

4.4.3 Supply Chain Costs

4.4.3.1 Reliability Tests

Using Cronbach's Coefficient Alpha test on supply chain costs, a coefficient of 0.841 was found as shown in Table 4.29. These results corroborates findings by Saunders, Lewis and Thornhill (2009) and Christensen, Johnson and Turner (2011) who stated that scales of 0.7 and above, indicate satisfactory reliability. Based on these recommendations, the statements under the supply chain costs variable of this study were concluded to have adequate internal consistency and were, therefore, reliable for the analysis and generalization on the population.

Table 4.29: Reliability Test for Supply Chain Disruption

Variable	Supply chain costs
Cronbach's Alpha	0.841
N of Items	4

4.4.3.2 Sampling Adequacy

To examine whether the data collected was adequate and appropriate for inferential statistical tests such as the factor analysis, regression analysis and other statistical tests, two main tests were performed namely; Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Barlett's Test of Sphericity. For a data set to be regarded as adequate and appropriate for statistical analysis, the value of KMO should be greater than 0.5 (Field, 2000).

Findings in Table 4.30 showed that the KMO statistic was 0.745 which was significantly high; that is greater than the critical level of significance of the test which was set at 0.5 (Field, 2000). In addition to the KMO test, the Bartlett's Test of Sphericity was also highly significant (Chi-square = 246.483 with 6 degree of freedom, at $p < 0.05$). The results of the KMO and Bartlett's Test are summarized in Table 4.41. These results provide a justification for further statistical analysis to be conducted.

Table 4.30: Supply Chain Costs KMO Sampling Adequacy & Sphericity Tests

Kaiser-Meyer-Olkin Measure	0.745
Bartlett's Chi- Square	246.483
Bartlett's df	6
Bartlett's Sig.	0.000

4.4.3.3 Factor Analysis

Factor analysis was conducted after successful testing of validity and reliability using KMO coefficient and Cronbach Alpha results. Factor analysis was conducted using Principal Components Method (PCM). The extraction of the factors followed the

Kaiser Criterion where an eigen value of 1 or more indicates a unique factor. Total Variance analysis indicates that the 4 statements on supply chain costs can be factored into one. The total variance explained by the extracted factor is 68.66% as shown in Table 4.31.

Table 4.31: Supply Chain Costs Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.746	68.66	68.66	2.746	68.66	68.66
2	0.683	17.085	85.746			
3	0.435	10.875	96.621			
4	0.135	3.379	100			

Extraction Method: Principal Component Analysis.

Table 4.32 shows the factor loadings for supply chain costs. All the statements attracted coefficients of more than 0.4 hence all the statements were retained for analysis. According to Rahn (2010) a factor loading equal to or greater than 0.4 is considered adequate.

Table 4.32: Factor Loading for Supply chain costs

Statement	Factor Loading
Refinery inefficiencies cause volatility and/or affect volatility of prices of petroleum products in Kenya	0.654
Inefficiencies in distribution of petroleum products by KPC cause volatility and/or affect volatility of prices of petroleum products in Kenya	0.902
Product storage constraints cause volatility and/or affect volatility of oil prices in Kenya	0.914
Customs clearance procedures cause volatility and/or affect volatility of oil prices in Kenya	0.819

Extraction Method: Principal Component Analysis.

4.4.3.4 Descriptive Analysis

The third objective of the study was to determine the effect of supply chain costs on the prices of petroleum products in Kenya. Results on Table 4.33 shows that 66.1% of the respondents agreed that refinery inefficiencies affect volatility in pump prices of petroleum products in Kenya, 63.5% agreed that inefficiencies in distribution of petroleum products by KPC affect volatility in pump prices of petroleum products in Kenya, 60% agreed that product storage constraints affect volatility in oil pump prices in Kenya and 39.1% agreed that customs clearance procedures affect volatility of oil pump prices in Kenya. The mean score for this section was 3.52 which indicates that majority of the respondents agreed that supply chain costs influenced the volatility of pump prices.

The study findings agree with those of King, Deng and Metz (2012) who analyzed the impact of key factors on the price of crude oil in the period 2006 to 2009 using an econometric model and concluded that political events, particularly acts or threats of

violence, were major drivers of upward price movements during the run-up in oil prices that ended in mid-July 2008.

Table 4.33: Supply Chain Costs Descriptive Analysis

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Likert Mean
Refinery inefficiencies cause volatility of petroleum products in Kenya	11.3%	5.2%	17.4%	26.1%	40.0%	3.78
Inefficiencies in distribution of petroleum products by KPC cause volatility of prices of petroleum products in Kenya	12.2%	7.8%	16.5%	31.3%	32.2%	3.63
Product storage constraints cause volatility of oil prices in Kenya	11.3%	5.2%	23.5%	27.0%	33.0%	3.65
Customs clearance procedures cause volatility of oil prices in Kenya	18.3%	19.1%	23.5%	21.7%	17.4%	3.01
Average	13.3%	9.3%	20.2%	26.5%	30.7%	3.52

4.4.3.5 Relationship between Supply Chain Costs and Oil Pump Prices

Table 4.34 shows the correlation results which indicate that there was a positive and significant relationship between supply chain costs and oil prices. This was evidenced by the p-value of 0.000 which is less than that of critical value (0.05).

Table 4.34: Relationship between Supply Chain Costs and Oil Prices

Variable		Average Prices	Supply chain costs
Average Prices	Pearson Correlation	1	
	Sig. (2-tailed)		
Supply chain costs	Pearson Correlation	0.757	1
	Sig. (2-tailed)	0.000	

4.4.4 Regulatory Costs

4.4.4.1 Reliability Tests

Using Cronbach's Coefficient Alpha test on regulatory costs, a coefficient of 0.784 was found as shown in Table 4.35. These results corroborate findings by Saunders, Lewis and Thornhill (2009) and Christensen, Johnson and Turner (2011) who stated that scales of 0.7 and above, indicate satisfactory reliability. Based on these recommendations, the statements under the regulatory costs variable of this study were concluded to have adequate internal consistency, therefore, reliable for the analysis and generalization on the population.

Table 4.35: Reliability Test for Regulatory Costs

Variable	Regulatory costs
Cronbach's Alpha	0.784
N of Items	4

4.4.4.2 Sampling Adequacy

To examine whether the data collected was adequate and appropriate for inferential statistical tests such as the factor analysis, regression analysis and other statistical tests, two main tests were performed namely; Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Barlett's Test of Sphericity. For a data set to be regarded as adequate and appropriate for statistical analysis, the value of KMO should be greater than 0.5 (Field, 2000).

Findings in Table 4.36 showed that the KMO statistic was 0.743 which was significantly high; that is greater than the critical level of significance of the test of 0.05 (Field, 2000). In addition to the KMO test, the Bartlett's Test of Sphericity was also highly significant (Chi-square = 128.636 with 6 degree of freedom, at $p < 0.05$). The results of the KMO and Bartlett's Test are summarized in Table 4.36. These results provide an excellent justification for further statistical analysis to be conducted.

Table 4.36: Regulatory Costs KMO Sampling Adequacy & Bartlett's Sphericity

Kaiser-Meyer-Olkin Measure	0.743
Bartlett's Chi- Square	128.636
Bartlett's df	6
Bartlett's Sig.	0.000

4.4.4.3 Factor Analysis

Factor analysis was conducted after successful testing of validity and reliability using KMO coefficient and cronbach alpha results. Factor analysis was conducted using Principal Components Method (PCM). The extraction of the factors followed the

Kaiser Criterion where an Eigen value of one or more indicates a unique factor. Total variance analysis indicates that the four statements on regulatory costs can be factored into one factor. The total variance explained by the extracted factor is 61.19% as shown in Table 4.37.

Table 4.37: Regulatory costs Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.448	61.19	61.19	2.448	61.19	61.19
2	0.703	17.568	78.758			
3	0.503	12.571	91.33			
4	0.347	8.67	100			

Extraction Method: Principal Component Analysis.

Table 4.38 shows the factor loadings for regulatory costs. All the statements attracted coefficients of more than 0.4 hence all the statements were retained for analysis. According to Rahn (2010) and Zandi (2006) a factor loading equal to or greater than 0.4 is considered adequate. This is further supported by Black (2002) who asserts that a factor loading of 0.4 has good factor volatility and deemed to lead to desirable and acceptable solutions.

Table 4.38: Factor Loading for Regulatory Costs

Statement	Factor Loading
Taxes on petroleum products cause volatility and/or affect volatility of prices of petroleum product prices in Kenya	0.785
Profit margins on oil products cause volatility and/or affect volatility of petroleum products prices in Kenya	0.855
Oil losses cause volatility and/or affect volatility of oil prices in Kenya	0.757
Protection of government controlled oil companies cause volatility and/or affect volatility of oil prices in Kenya	0.726

Extraction Method: Principal Component Analysis.

4.4.4.4 Descriptive Analysis

The fourth objective of the study was to establish the effect of price regulation on the prices of petroleum products in Kenya. Results on Table 4.39 show that 46.1% of the respondents disagreed that taxes on petroleum products affect volatility in pump prices, 59.4% disagreed that profit margins on oil products cause volatility in pump prices, 39.1% disagreed that oil losses affect volatility of pump prices and 60.9% agreed that government protection affects volatility of pump prices. The mean score for this section was 2.93 which indicates that majority of the respondents disagreed that regulatory costs affect the volatility of oil prices.

Table 4.39: Regulatory Costs Descriptive Analysis

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Likert Mean
Taxes on petroleum products cause volatility and/or affect volatility of oil pump prices	13.9%	32.2%	8.7%	26.1%	19.1%	3.04
Profit margins on oil products cause volatility and/or affect volatility of oil pump prices	22.5%	36.9%	16.2%	19.8%	4.5%	2.47
Oil losses cause volatility and/or affect volatility of oil pump prices	10.4%	28.7%	25.2%	24.3%	11.3%	2.97
Protection of government controlled oil companies causes volatility and/or affects volatility of oil pump prices	18.2%	8.2%	12.7%	52.7%	8.2%	3.25
Average	16.3%	26.5%	15.7%	30.7%	10.8%	2.93

4.4.4.5 Relationship between Regulatory Costs and Oil Pump Prices

Table 4.40 shows the correlation results which indicate that there was a positive and significant relationship between regulatory costs and oil prices. This was evidenced by the p-value of 0.000 which is less than that of critical value (0.05).

Table 4.40: Relationship between Regulatory Costs and Oil Prices

Variable		Average Prices	Regulatory costs
Average Prices	Pearson Correlation	1	
	Sig. (2-tailed)		
Regulatory costs	Pearson Correlation	0.501	1
	Sig. (2-tailed)	0.000	

4.4.5 Political Shocks

4.4.5.1 Reliability Tests

Using Cronbach's Coefficient Alpha test on political shocks, a coefficient of 0.852 was found as shown in Table 4.41. These results corroborates findings by Saunders Lewis and Thornhill (2009) and Christensen, Johnson and Turner (2011) who stated that scales of 0.7 and above, indicate satisfactory reliability. Based on these recommendations, the statements under the political shocks variable of this study were concluded to have adequate internal consistency, therefore, reliable for the analysis and generalization on the population.

Table 4.41: Reliability Test for Political Shocks

Variable	Political Shocks
Cronbach's Alpha	0.852
No. of Items	4

4.4.5.2 Sampling Adequacy

To examine whether the data collected was adequate and appropriate for inferential statistical tests such as the factor analysis, regression analysis and other statistical tests, two main tests were performed namely; Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Barlett's Test of Sphericity. For a data set to be regarded as adequate and appropriate for statistical analysis, the value of KMO should be greater than 0.5 (Field, 2000). Findings in Table 4.42 showed that the KMO statistic was 0.76 which was significantly high; that is greater than the critical level of significance of the test which was set at 0.5 (Field, 2000). In addition to the KMO test, the Bartlett's Test of Sphericity was also highly significant (Chi-square = 242.773 with 6 degree of freedom, at $p < 0.05$). The results of the KMO and Bartlett's Test are summarized in Table 4.42. These results provide an excellent justification for further statistical analysis to be conducted.

Table 4.42: Political Shocks KMO Sampling Adequacy and Bartlett's Sphericity Tests

Kaiser-Meyer-Olkin Measure	0.76
Bartlett's Chi- Square	242.773
Bartlett's df	6
Bartlett's Sig.	0.000

4.4.5.3 Factor Analysis

Factor analysis was conducted after successful testing of validity and reliability using KMO coefficient and Cronbach Alpha results. Factor analysis was conducted using Principal Components Method (PCM). The extraction of the factors followed the Kaiser Criterion where an Eigen value of one or more indicates a unique factor. Total

Variance analysis indicates that the 4 statements on political shocks can be factored into one. The total variance explained by the extracted factor is 70.04% as shown in Table 4.43.

Table 4.43: Political Shocks Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.802	70.044	70.044	2.802	70.044	70.044
2	0.664	16.609	86.653			
3	0.367	9.169	95.822			
4	0.167	4.178	100			

Extraction Method: Principal Component Analysis.

Table 4.44 shows the factor loadings for political shocks. All the statements attracted coefficients of more than 0.4 hence all the statements were retained for analysis. According to Rahn (2010) a factor loading equal to or greater than 0.4 is considered adequate.

Table 4.44: Factor Loading for Political Shocks

Statement	Factor Loading
Political shocks cause volatility and/or affect volatility of petroleum product prices in Kenya	0.853
Acts of terrorism and piracy cause volatility and/or affect volatility of petroleum products prices in Kenya	0.688
Regime changes cause volatility and/or affect volatility of petroleum products prices in Kenya	0.89
Political policies cause volatility and/or affect volatility of prices of petroleum products in Kenya.	0.899

Extraction Method: Principal Component Analysis.

4.4.5.4 Descriptive Analysis

The fifth and last objective of the study was to determine the effect of political shocks on the prices of petroleum products in Kenya. Results on Table 4.45 shows that 50.5% of the respondents agreed that political shocks affects volatility of petroleum product prices in Kenya, 62.6% agreed that acts of terrorism and piracy affect volatility of petroleum products prices in Kenya, 42.6% agreed that regime changes affect volatility in petroleum products prices in Kenya and 54.7% agreed that political policies affect volatility of prices of petroleum products in Kenya. The mean score for this section was 3.26 which indicates that majority of the respondents agreed that political shocks affect the volatility of oil prices.

The findings are consistent with those of Macro (2005) who observed that petroleum prices do not always move at the same rate (be it up or down) as crude oil prices. The

prices paid by consumers for a petroleum product may differ significantly from the ex-refinery price because of various factors

Table 4.45: Political Shocks Descriptive Analysis

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Likert Mean
Political shocks cause volatility and/or affect volatility of petroleum product prices in Kenya	8.7%	18.3%	22.6 %	43.5%	7.0%	3.22
Acts of terrorism and piracy cause volatility and/or affect volatility of petroleum products prices in Kenya	11.3%	13.9%	12.2 %	46.1%	16.5%	3.43
Regime changes cause volatility and/or affect volatility of petroleum products prices in Kenya	20.9%	13.0%	23.5 %	20.9%	21.7%	3.1
Political policies cause volatility and/or affect volatility of prices of petroleum products in Kenya.	13.0%	20.0%	12.2 %	33.0%	21.7%	3.3
Average	13.5%	16.3%	17.6 %	35.9%	16.7%	3.26

4.4.5.5 Relationship Between Political Shocks and Oil Pump Prices

Table 4.46 shows the correlation results which indicate that there was a positive and significant relationship between political shocks and oil prices. This was evidenced by the p-value of 0.000 which is less than that of critical value (0.05)

Table 4.46: Relationship between Political Shocks and Oil Prices

Variable		Average Prices	Political Shocks
Average Prices	Pearson Correlation	1	
	Sig. (2-tailed)		
Political Shocks	Pearson Correlation	0.607	1
	Sig. (2-tailed)	0.000	

4.5 Overall Model Estimation from Primary Data Analysis

The overall model significance was presented in Table 4.47. An F-statistic of 47.772 indicated that the overall model taking account of all explanatory variables was significant. The findings imply that the explanatory variables were statistically significant in explaining volatility of oil pump prices in Kenya.

Regression analysis was conducted to empirically determine whether the explanatory variables (world oil prices, exchange rates, regulatory costs, supply chain costs and political shocks) were statistically significant determinants of volatility of pump prices in Kenya. Regression results in Table 4.47 indicate the goodness of fit for the regression between world prices and pump prices was satisfactory. This result displays significant correlation coefficients (Table 4.47) and should be read together with Regression results in Table 4.47 indicate that supply chain costs significantly explain pump prices at 1% level of significance.

Regression results for exchange rates indicate that the statistical significance of the variables for the regression between exchange rate and oil pump prices was observed. The exchange rate coefficients are presented in Table 4.47. The results show that exchange rate fluctuations contribute significantly to the model since the p-value for the constant and gradient are less than 0.05. The findings imply that depreciation of the Kenyan Shilling by unit led to an increment in oil pump prices at the rate of 7.456, which is however, not significant. This confirms the positive effect of exchange rate on volatility of oil pump prices in Kenya and is consistent with findings by Trehan (1986) who demonstrated that the foreign exchange value of the US Dollar has a substantial impact on the price of oil in non-dollar functional currency states since crude oil traded in the world markets is priced in dollars. Oil importers who do not use the dollar as their functional currency must, in effect, obtain dollars to purchase oil.

Regression results in Table 4.47indicate the relationship between regulatory costs and oil pump prices was statistically significant at 1% level of confidence. The overall model significance was presented in Table 4.47. An F-statistic of 37.824 indicated that the overall model was significant. The results imply that regulatory costs were statistically significant in explaining volatility of pump prices in Kenya. The regression analysis in the Table 4.47 indicates that oil pump prices are positively and significantly affected by variations in political shocks. The results further indicated that 36.6% of the variations in oil pump prices are explained by the variations in fluctuation in political shocks. The model is also established to be significant in explaining the observed relationship (Prob>F=0.00). From Table 4.47 it is also clear that the most significant determinants of pump prices in Kenya are world oil prices and supply chain costs as evidenced by p-values of 0.000. Exchange rates, regulatory costs and political shocks have p-values above 0.05 indicating they are not statistically significant determinants of pump prices in Kenya. Each variable was standardized by the Statistical Package (SPSS) by subtracting its mean from

each of its values and then dividing these new values by the standard deviation of the variable. Standardizing all variables in a multiple regression yields standardized regression coefficients that show the change in the dependent variable measured in standard deviations. It is important to note that the t-statistics and the standard errors refer to the standardized Beta coefficients.

Table 4.47: Overall Model Estimation

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	55.363	3.631		15.249	.000
	World Oil Prices	5.375	1.259	.336	4.270	.000
	Exchange Rates	1.061	1.149	.082	.924	.358
	Supply Chain Costs	6.036	.894	.557	6.750	.000
	Regulatory Costs	-.618	1.253	-.051	-.494	.623
	Political Shocks	.377	1.063	.034	.355	.724

F	Sig.	R	R Square
47.772	.000[b]	.829[a]	.687

a. Predictors: (Constant), Political Shocks, World Oil Prices, Supply Chain Costs, Exchange Rates, Regulatory Costs

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of major findings of the study, relevant discussions, conclusions and the necessary recommendations. The study sought to investigate the factors affecting volatility in prices of petroleum products in Kenya. The summary of key findings, conclusions and recommendations is done in line with the objectives of the study based on the output of the descriptive and inferential statistical analyses guided to test the research hypothesis of the study.

5.2 Summary of Findings

The findings of tests on each of the five independent variables are recorded in this section along with a demonstration of the relationship between the objectives of the study and the results.

5.2.1 World Prices and Pump Prices

The first objective of the study was to examine the effect of world prices of oil on the volatility of prices of petroleum products in Kenya. Results of secondary data analysis showed that world oil prices affect volatility of prices of petroleum product prices in Kenya and they were a statistically significant determinant of pump prices. World oil prices were also found to Granger-cause pump prices. This was collaborated by results of primary data analysis that indicated that world oil prices affect volatility of pump prices of petroleum products in Kenya.

Regression and correlation results indicated that there was a positive and significant relationship between world oil prices and volatility of petroleum products. Lags of world oil prices also had a statistically significant influence on volatility of pump prices as observed in the secondary data analysis. This implies that world oil prices

and their lags a key determinant of volatility of pump prices of petroleum products in Kenya.

5.2.2 Exchange Rate and Pump Prices

The second objective of the study was to investigate the effect of exchange rate fluctuations on the volatility of pump prices of petroleum products in Kenya. Secondary data analysis and tests concluded that exchange rates do not Granger-cause pump prices of petroleum products in Kenya and also were not statistically significant determinants of pump prices. This contradicts findings from primary data analysis that implied that changes in pump prices are affected by changes in exchange rates. The primary data results thus indicated that exchange rate fluctuations are not key determinants of volatility of pump prices. This contradicts the responses from the respondents who agreed that exchange rate depreciation or appreciation of the Kenya Shilling to the US Dollar causes volatility in petroleum pump prices in Kenya but is in line with results of secondary data analysis where exchange rates came out as being statistically insignificant in determination of pump prices. 57.4% agreed that exchange rate appreciation of the Kenya Shilling to the US Dollar causes volatility in petroleum pump products prices in Kenya. Results of both primary and secondary data analysis indicated that the free floating nature of the exchange rate of the Kenya Shilling to the US Dollar did not significantly affect pump prices of petroleum products prices in Kenya. Regression and correlation results indicated that there was a negative and insignificant relationship between exchange rate fluctuations and volatility of oil petroleum products.

It is notable that as oil prices are denominated in US dollars, as the dollar strengthens, oil prices tend to fall for U.S. consumers. However, petroleum product purchases by oil marketers in Kenya are not denominated in dollars, as the currency of trade in Kenya is the shilling, so the fall in dollar-denominated oil prices does not mean a similar trend for oil prices in Kenya Shillings. Indeed, results of secondary data analysis indicate that there is no strong relationship between exchange rates and

pump prices and therefore they did not come out as a key determinant of volatility in pump prices of petroleum products in Kenya.

5.2.3 Supply Chain Costs and Pump Prices

The third objective of the study was to determine the effect of supply chain costs on the volatility of pump prices of petroleum products in Kenya. Results indicated that refinery and KPC inefficiencies, product storage constraints and customs clearance procedures affect the volatility of prices of petroleum products in Kenya. 66.1% of the respondents agreed that refinery inefficiencies affect volatility of prices of petroleum products in Kenya, 63.5% agreed that inefficiencies in distribution of petroleum products by KPC affect volatility in prices of petroleum products in Kenya, 60% agreed that product storage constraints affect volatility of oil prices in Kenya and 39.1% agreed that customs clearance procedures affect volatility of oil prices in Kenya.

The mean score for this section was 3.52 which indicates that majority of the respondents agreed that supply chain costs influenced the volatility of oil prices. Regression and correlation results of secondary data analysis indicated that there was a positive and significant relationship between supply chain costs and volatility of pump prices in Kenya.

5.2.4 Regulatory Costs and Pump Prices

The fourth objective of the study was to establish the effect of price regulation on the volatility of pump prices of petroleum products in Kenya. Results of both primary and secondary data analysis indicated that regulatory costs were key drivers of pump prices volatility. This was evidenced by granger causality test results and the responses from the respondents who disagreed that taxes on petroleum products affect volatility of pump prices of petroleum product prices in Kenya, profit margins on oil products cause volatility in prices of petroleum products in Kenya, oil losses

affect volatility of oil prices in Kenya and protection of government controlled oil companies affects volatility of oil prices in Kenya.

Regression and correlation results indicated that there was a no significant relationship between regulatory costs and volatility of oil petroleum products. This was, however, attributed to the visible volatility of regulatory costs over the study period and this study observes that a study in a period of more volatility in regulatory costs could indeed arrive at different results. The findings imply that regulatory costs were not statistically significant in explaining volatility of oil pump prices in Kenya for the period of this study.

5.2.5 Political Shocks and Pump Prices

The fifth and last objective of the study was to determine the effect of political shocks on the pump prices of petroleum products in Kenya. Results showed that political shocks affect volatility of petroleum pump prices in Kenya.

Some of the political shocks that affect the volatility of pump prices are acts of terrorism and piracy, regime changes and political policies. Primary, secondary data and related regression and correlation results indicated that there was a positive and significant between political shocks and volatility of oil prices in Kenya.

5.2.6 Lags of Pump Prices

Time series analysis established that lags of pump prices contributed in a statistically significant manner to volatility of pump prices of petroleum products in Kenya. This finding was evident in the secondary data regression analysis tests performed. For this study both lag one and lag two of pump prices proved to be statistically significant in determining the volatility in pump prices of petroleum products in Kenya.

Secondary data analysis results for lag one and two of pump prices generated p-values of 0.001 and 0.000 respectively. These p-values were less than the critical value at 95% level of confidence thus indicating that lags of pump prices were statistically significant determinants of volatility in pump prices of petroleum products in Kenya.

5.3 Conclusions

The study concluded that world oil prices, political shocks and past two lags of pump prices affect pump prices and inferred that these variables affected the pump prices in Kenya. Regulatory costs were also mostly stable and did not cause volatility in pump prices. The impact of supply chain costs on volatility of pump prices of petroleum products in Kenya was also not statistically significant. However, the study observed that exchange rates did not explain pump prices in Kenya. The study further concluded that the pump pricing of petroleum products in Kenya is volatile and complex, and is regulated by more than one government body. Few of the Oil Marketing companies operating in Kenya are well developed with the exception of the four international conglomerates that dominate the sector. The study observed that the oil sector supply chain is very important in ensuring volatility of pump prices of petroleum products.

The study findings indicate thatthe world witnessed a high volatility of oil prices over the study period (2010 to 2015). The two greatest factors influencing volatility of petroleum product prices were the world prices of oil products and regulatory costs. Another finding is that Petroleum Taxes comprise a huge component of the oil price of between 30 and 50% depending on international oil pricing and so the government should streamline its taxation regulation to ensure that taxes do not cause volatility of oil prices. The indirect impact of the requirement that petroleum taxes be paid at the point of product entry, and its financing implications further

complicates the impact of taxes on prices of petroleum products as this factor was not part of this study.

As with any commodity, the movement of oil prices and petroleum products are due to a variety of factors. The largest indicator is the forces of the global demand and supply. Surging crude oil demand over the years was being fueled by strong economic growth, particularly in the industrialized countries such as the United States, China and India. The supply factor is largely affected by the large oil producing countries such as the OPEC countries. Other factors include political volatility and weather conditions in oil producing regions.

The Kenyan petroleum industry is versatile and highly complex, and is regulated by more than one government body, hence it is highly regulated. Most of the firms operating here are well developed and large with many outlets, with international conglomerates doing very well in the sector. The study therefore observed that the sectors' supply chain is very important to the sector development.

The study examined the effect of foreign currency exchange rate fluctuations on changes in retail oil prices in Kenya. The analysis on the movement of the two variables indicates a change in the same direction. The study therefore confirms that indeed a change in foreign currency exchange rate affects retail fuel prices in a similar manner. This study however concludes that fluctuations in foreign currency exchange rate alone did not highly affect the volatility of pump prices of oil products in Kenya. The study is therefore in line with previous studies that suggest that many other factors including taxes, spillage, profit margins, transport rates as well as speculation determine changes in oil prices.

5.4 Recommendations

Based on the results, findings and conclusions the following recommendations have been deciphered:

The study recommends that in order to lessen the burden of dealing with petroleum prices, the government should consider reduction of regulatory costs (petroleum taxes and profit margins) and also look into the issue of oil losses. This should be looked at in terms of the capacity of the country to have adequate storage and distribution facilities to avoid oil losses and to be able to stock enough products in periods when world oil prices are low that are then released to the market in periods when oil prices are high thus creating a stabilization effect.

The study also recommends that in order to lessen the burden of dealing with pump prices, the government should examine the costs of inefficiency in the supply chain process that lead to oil losses and demurrage costs. This should be looked at in terms of the capacity of the country to have the right storage and distribution facilities to avoid oil losses. The government should streamline its taxation regulation to ensure that excise and value-added taxes do not amount to hefty imposition on oil companies who pass the same onto consumers. The indirect impact of the requirement that petroleum taxes be paid at the point of product entry, as its financing implications mainly complicates the impact of taxes on prices of petroleum products.

The government should help in mitigating political costs by managing the political risks and ensuring that requisite legislation is in place to ensure that the measure is upheld and the supply chain is able to develop. The risk mitigation factors were found effective in improving the performance of supply to a level beyond political interference.

With the current fuel price regulation, oil marketing companies' and dealers' margins are guaranteed. However, the government in collaboration with oil marketing companies needs to check whether ERC's pricing formula caters for all applicable costs. This will determine whether lack of price volatility in Kenya is due to an ineffective pricing formula as the study found that changes in pump prices in Kenya are not fully aligned to international price trends.

The study observed that various risk factors have an impact on petroleum sector supply chain performance and therefore it recommends that firms operating in the industry should consider all the risk factors such as the procurement risk factors, storage constraints and transport risk factors so as to be able to maximize the supply chain performance in the sector. It recommends extensive look into these factors to determine which are applicable at the firm level by the supply chain managers in the firms.

5.5 Areas of Further Study

This study recommends further studies to be conducted on causality relationships between oil pump prices and exchange rates given that, the results indicated that exchange rates do not granger cause pump prices. This is important since pump prices always factor in an exchange rate element contrary to the findings of this study. The central bank should be empowered, both in terms of resources and human capacity to be in a position at all times to control the country's foreign exchange rate fluctuations, quite independently from the influence of currency changes abroad.

This study also recommends that future studies look into the effect of advance tax payments on the pricing and profitability of oil products which was not part of this study but could be affecting the pump prices. This recommendation is based on the fact that most oil companies are dependent on borrowed funds that they use to

finance such taxes that are paid at the point of product entry. Given that taxes comprise approximately 50% of pump prices such a study is necessary and would unearth the facts behind product purchase financing.

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APPENDICES

APPENDIX I: QUESTIONNAIRE FOR MIDDLE MANAGERS

Section A: Background information

1. Name of Organization (Optional) ……..
2. Category type (please tick as appropriate)
   a. Oil Marketing Company ☐
   b. Oil Dealership ☐
   c. ERC ☐
   d. NOCK ☐
   e. MOEP ☐
   f. KPC ☐
   g. KPRL ☐
   h. PIEA ☐

RESPONDENTS PARTICULARS

Gender Male ☐ Female ☐

Age Bracket

i. Below 25 ☐
ii. 26-35 years ☐
iii. 35-45 years ☐
iv. 46-55 years ☐
v. Over 55 years ☐

Position

i) Supply Manager ☐
ii) Finance Manager ☐
iii) Regulatory Official ☐
iv) General Manager ☐
v) Oil Dealer/Manager ☐

vi) Ministry Official ☐

vi) Other ☐

6. For how long have you been working for the institution?

i) Less than 1 year ☐

ii) Between 1-5 years ☐

iii) Between5-10 years ☐

iv) Over 10 years ☐

Section B: World Oil Prices

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	1	**2**	**3**	**4**	**5**
World oil prices cause volatility in prices of petroleum product prices in Kenya					
International supply and demand factors cause volatility in prices of petroleum products in Kenya					
Cartel like behaviours in the international oil market affect volatility in prices of petroleum products in Kenya					
International political events cause volatility of prices of petroleum products in Kenya					

International futures market for oil causes volatility in prices of petroleum products in Kenya					

7. How would you rate the effect of fluctuations in world prices of oil products on the volatility of prices of oil products in Kenya?

a) Significant ☐
b) Insignificant ☐

In view of the rating above, please explain why:

---

8. What measures would you recommend to better control volatility in prices of oil products in Kenya?

Section C: Exchange Rates:

Statement	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
	1	**2**	**3**	**4**	**5**
Exchange rate depreciation of the Kenya Shilling to the US Dollar causes volatility in petroleum products prices in Kenya					

Exchange rate appreciation of the Kenya Shilling to the US Dollar causes volatility in petroleum products prices in Kenya					
The free floating nature of the exchange rate between the Kenya Shilling to the US Dollar affects volatility in prices of petroleum products prices in Kenya					

7. How would you rate the effect of exchange rate fluctuations on the volatility of prices of oil products in Kenya?

a) Significant ☐
b) Insignificant ☐

In view of the rating above, please explain why:

---

8. What measures would you recommend to better control the effect of exchange rate fluctuations on prices of petroleum products in Kenya?

8. According to you, what can be done to ensure that exchange rate fluctuation between the Kenya Shilling and the US Dollar cause volatility of petroleum products prices in Kenya?

Section D: Supply chain costs

Statement	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	1	2	3	4	5
Refinery inefficiencies affect volatility of prices of petroleum products in Kenya					
Inefficiencies in distribution of petroleum products by KPC affect volatility in prices of petroleum products in Kenya					
Product storage constraints affect volatility of oil prices in Kenya					
Customs clearance procedures affect volatility of oil prices in Kenya					

9. How would you rate the effect of supply chain costs on the volatility of prices of oil products in Kenya?

a) Significant ☐
b) Insignificant ☐

In view of the rating above, please explain why:

10. What measures would you recommend to better improve supply chain efficiency in Kenya?

11. What can be done to minimize the effect of supply chain costs on volatility in prices of petroleum products prices in Kenya?

Section E: Regulatory costs (Allowed Oil Losses, Taxes and Profit Margins)

Statement	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
	1	**2**	**3**	**4**	**5**
Taxes on petroleum products affect volatility in prices of petroleum product prices in Kenya					
Profit margins on oil products cause volatility in of petroleum products prices in Kenya					
Oil losses affect volatility of oil prices in Kenya					
Protection of government controlled oil companies affects volatility of oil prices in Kenya					

12. How would you rate the effect of regulatory costs on the volatility of prices of oil products in Kenya?

a) Significant ☐
b) Insignificant ☐

In view of the rating above, please explain why:

---

13. What measures would you recommend to better improve oil price regulation in Kenya?

14. What can be done to minimize the effect of oil price regulation on volatility in prices ofpetroleum products prices in Kenya?

Section F: Political events of prices of oil products in Kenya

Statement	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
	1	**2**	**3**	**4**	**5**
political shocks affects volatility of petroleum product prices in Kenya					
Acts of terrorism and piracy affect volatility of petroleum products prices in Kenya					

Regime changes affect volatility in petroleum products prices in Kenya					
Political policies affect volatility of prices of petroleum products in Kenya.					

15. How would you rate the effect of political shocks on the volatility of prices of oil products in Kenya?

a) Significant ☐
b) Insignificant ☐

In view of the rating above, please explain why:

Section G: Petroleum Products Prices

a) What were the monthly prices for the following products over the last Six years in Kenya?

Month /Product	Month	2010	2011	2012	2013	2014	2015	2016
Premium Motor Spirit	Jan Feb Mar April May Jun Jul Aug Sep Oct Nov Dec							
Regular Motor spirit	Jan Feb Mar April May Jun Jul Aug Sep Oct Nov Dec							

Month /Product	Month	2010	2011	2012	2013	2014	2015	2016
Kerosene	Jan Feb Mar April May Jun Jul Aug Sep Oct Nov Dec							
Automotive Diesel	Jan Feb Mar April May Jun Jul Aug Sep Oct Nov Dec							

APPENDIX II: INTERVIEW SCHEDULE FOR TOP OFFICIALS

1. What is the impact of world prices of crude and refined oil on the volatility of prices of petroleum products in Kenya?
2. What is the relationship between exchange rates and the volatility of prices of petroleum products in Kenya?
3. Do taxes contribute to volatility of prices of petroleum products in Kenya?
4. Do oil losses hinder volatility of prices of petroleum products in Kenya?
5. What is the relationship between Oil Marketing Companies profit margins and volatility of prices of petroleum products in Kenya?
6. How does price regulation impact volatility of oil prices in Kenya?
7. How do political shocks affect volatility of oil prices in Kenya?

APPENDIX III: MATRIX TABLE OF VARIABLES

Independent Variable	**Focus of study for measurement**	**Previous Authors**
(World Prices& Exchange Rates)	Fluctuation of prices Volatility of world oil prices Volatility of world oil prices Fluctuation of currency Exchange rate variation Fluctuation of currency Volatility of international oil prices Relationship between oil prices and exchange rates Impact of exchange rates on oil prices	Ming (2009 Reza, Nazanin and Karim(2008) Masima and Sexsmith (2009) Dale (2009) Nanez and Abdullah (2010) Pyro (2005) UNCTAD (2011) Dawson (2004) Golub (1983), Bloomberg & Harris (1995), Trepan (1986)
Supply chain costs (Speculation, pipelineand refinery inefficiencies)	Speculation as a driver of oil price volatility Impact of public concern on oil prices Role of speculation on oil prices Role of speculation on oil prices	Juvenal &Petrella (2012), Killian (2009), Tand & Xiong (2011) King, Deng & Metz (2012) Chevalier (2010) Irwin & Sanders
Regulatory costs (Taxes, Oil losses,	Tax rates Principles for setting tax rates	Hossain (2003) Mabro (2005)

profit margins)	Tax rates Oil losses Capacity to contain oil losses Monopoly in price determination Regulation of oil marketing companies	Kieran and Dogmar (2010) Wanjiku (2010) Reza, Nazanin and Karim (2008) Twimukye&Matovu (2009)
Political shocks (Corruption, Political shocks, inflation, public outcry and protectionism)	Regulation of Oil prices – critique Use of price subsidies and stabilization funds Oil prices and inflation	Rock Off (2008), Martin (2002), Sowell (2008) Kojima (2009) Tailor &Doren Labys (2006), Regnier (2007)

Dependent Variable	Focus of study for measurement	Previous Authors
Stabilization of prices of petroleum products	Effects of prices on GDP, inflation, decreased purchasing power, decreased government revenue and expenditure Key factors affecting oil prices Inflation, High cost of living Inequitable income distribution Effects on supply of petroleum products	Naveed (2010) King, Deng & Metz (2012) Arinze (2011) Twimukye&Matovu (2009)

APPENDIX IV: LIST OF OIL COMPANIES IN KENYA

1. Tradiverse Kenya Limited
2. Orix Oil Kenya Limited
3. Cape Suppliers Limited
4. Dalbit Petroleum Limited
5. Regnol Oil (K) Limited
6. Oilcom (K) Limited
7. Stabex International Limited
8. KenolKobil Limited
9. Mill Hill Petroleum Limited
10. East African Gasoil Limited
11. Astrol Petroleum Company Limited
12. Finejet Limited
13. Keroka Petroleum Limited
14. Eppic Oil (K) Limited
15. Ocean Energy Limited
16. Libya Oil Kenya Limited
17. Tecaflex Limited
18. Olympic Petroleum Limited
19. Muloil Limited
20. Kenlloyd logistics Limited
21. Quantum Petroleum Limited
22. Motor Gallery Limited
23. Bilal Petroleum Company Limited
24. Riva Petroleum Dealers Limited
25. Bakri Int. Energy Company Limited
26. Ainushamsi Energy Limited
27. Topaz Petroleum Limited

28. RamjiHaribhaiDevani Limited
29. Gulf Energy Limited
30. Alba Petroleum Limited
31. Sovereign Oil Limited
32. Afrioil International Limited
33. Hass Petroleum Kenya Limited
34. Gapco Kenya Limited
35. Riva Oils Company Limited
36. Vivo Energy Kenya Limited
37. Falcon Oil Limited
38. Galana Oil Kenya Limited
39. Fossil Fuels Limited
40. Petro Oil Kenya Limited
41. Banoda Oil Limited
42. Tosha Petroleum (Kenya) Limited
43. Hashi Energy Limited
44. National Oil Corporation of Kenya
45. Royal Energy (K) Limited
46. Trojan International Limited
47. Al-Amana Invetsments Limited
48. Global Petroleum Products Kenya Ltd
49. Essar Petroleum (East Africa) Limited
50. Emkay International Limited
51. Jade Petroleum Limited
52. Fast Energy Limited
53. Total Kenya Limited
54. Intoil Limited
55. Towba Petroleum Company limited
56. One Petroleum Limited

57. Jaguar Petroleum Limited
58. Eagle Energy Limited
59. Oryx Energies Kenya Limited
60. Mogas Kenya Limited
61. Oil City Limited
62. Kencor Petroleum Limited
63. Engen Kenya Limited
64. Milio East Africa Limited
65. Kenya Petroleum Refineries Limited

Source: Energy Regulatory Commission, 2013

APPENDIX V: LETTER OF INTRODUCTION

Date……

The General Manager

……. Limited

P O BOX ……..Nairobi

Dear Sir/Madam,

RE: COLLECTION OF RESEARCH DATA

I am a postgraduate student of the Jomo Kenyatta University of Agriculture & Technology pursuing a PhD in Business Administration. I wish to conduct a study entitled *"Determinants of Volatility of PumpPrices of Petroleum Products in Kenya"*. Your organization has been identified as a key player in the oil sector in Kenya and hence the decision to have your participation in this important study. Information will be gathered by use of formal questionnaires and interviews. I therefore request you to kindly allow my research assistants to issue questionnaires to the sampled employees and managers in your organization. Responses will be handled ethically and with utmost confidentiality and the findings will be used exclusively for academic purposes.

Yours Sincerely

Johnson Munyua

Student Reg No. HD433/1118/2010

APPENDIX VI: THEORETICAL LITERATURE CRITIQUE MATRIX

Theory/Proponent	What Theory Contends	Critique of the Theory
Informal approach theory Slaibi, Duane and Daouk (2006) Boll (2005), Slaibi et al (2006), Chermak& Patrick (2002), Krautkaemer (1998), Barnett and Morse (1963) and Smith (1979) Fattouh (2005) Lombardi and Robays (2011)	The informal approach analyses oil price behavior within a specific economic and political context. The price of oil bears no relation to the scarcity of oil in the ground or to the cost of getting it out of the ground. The over-reliance to Hotelling theory and Peak Oil theory was not in order and a mixed approach is preferred. A wide list of drivers including strong demand, lack of spare capacity in upstream oil, distributional bottlenecks, OPEC supply response, geopolitical and weather shocks and the increasing role of speculators and traders in price formation is what drives oil prices and not any one factor.	Although the informal approach is essential to understanding current and past developments in the oil market, it can only provide a cursory view about how the oil market and oil prices might develop in the future. By identifying fundamental and non-fundamental oil shocks, we can balance the importance of fundamentals against inefficient financial activity.

APPENDIX VII: EMPIRICAL LITERATURE CRITIQUE MATRIX

Author	Topic	Country of Study	Findings	Critique
Ming (2009)	Future crude oil prices in China and if the world oil prices could have an effect on these prices.	China	There was a relationship between the calculated future prices with international prices in China.	The calculated future prices, however, showed the ability to hedge against the international oil shocks.
Reza, Nazanin and Karim (2008)	Effects of oil price on government expenditures in Iran	Iran	Crude oil is a publicly traded commodity, and its prices are determined in commodity markets via interaction of demand and supply worldwide and it constantly fluctuates. Iran, like other countries, has no control over the price of crude oil.	Data was limited to theeffect of oil price on government expenditures in Iran. Therefore, the results of the study cannot be wholly relied upon to make conclusions on world oil prices.

Author	Topic	Country of Study	Findings	Critique
Masima, William and Sexsmith (2010)	Petroleum markets in sub-Saharan Africa: an analysis and assessment of 12 countries.	Cross country analysis (12 Sub-saharan African countries).	Petroleum products were used across the entire economy in every country studied in Sub Saharan Africa. Fluctuation in oil prices often led to micro and macroeconomic consequences. The study associated the fluctuation in oil prices to the unstable world oil prices.	Study results cannot be generalized to answer the questionsvolatility of oil prices in sub-Saharan Africa. The study relied on information gathered on two day visits by consultants; the short duration of each visit therefore restricts the amount of information that could be collected.
UNCTAD (2005)	The exposure of African Governments to the volatility of international oil prices and what to do about it.	Tanzania	African countries, whether oil importers or exporters, are severely affected by volatility of international oil	Although it is known that oil futures prices converge to a spot price, little attention has been paid into the real

Author	Topic	Country of Study	Findings	Critique
			prices. They further observe that any attempts by such governments to predict oil prices have ended up with high margins of error.	meaning of spot prices of oil products. The processes of price formation in oil markets remain under-researched.
Dawson (2004)	The Effect of Oil Prices on Exchange Rates: A Case Study of the Dominican Republic.	Dominican Republic	Since the demand for oil products is quite inelastic in the short run, a rise in oil prices causes the dollar value of the oil purchased to rise.	The relation between the price of oil and the exchange rate has been established by the literature for oil-producing countries but not for oil-importing countries.
Bloomberg and Harris (1995)	how exchange How exchange rate movements can affect oil prices.	Kanpur (India)	The law of one price asserts that as the US dollar weakens relative to other currencies, ceteris paribus, international buyers of oil are	

Author	Topic	Country of Study	Findings	Critique
			willing to pay more US dollars for oil.	
Dale (2009)	The relationship between exchange rates and oil prices in Canada	Canada	There was a negative, but sometimes insignificant relationship between energy (or oil) prices and the Canadian dollar.	Dale (2009) study was carried out through review of literature in a major oil producing country and may have little relevance to oil importing countries. Other studies e.g. Akram (2004), Bergvall (2004) Chadhuri and Daniel (1998) and Dawson (2004) find that oil prices significantly affect the relative values of currencies in the study countries (Norway, UAE and Dominican

Author	Topic	Country of Study	Findings	Critique
				Republic).
Nayef& Abdullah, (2010)	The impact of exchange rate variation on the direction of trade flows in Kuwait	Kuwait	The impact of Kuwait Dinar (KD) exchange rate volatility vis-à-vis major trading partners is estimated to positively influence export flows.	Reliance on gravity model is faulted as there are many issues, including omitted variables that have occurred due to using the model empirically
Trehan (1986)	Exchange Rates & the US Economy	US	The foreign exchange value of the dollar has a substantial impact on the price of oil in non-dollar functional currency states.	The study was performed in the US, where the home currency is the functional and oil trading currency.
Juvenal &Petrella (2012)	Analyze whether speculation in the oil market was a driver of volatility in oil prices and include an		Oil prices have been historically driven by strength of global demand but speculation contributed to the oil price increases between 2004 and	

Author	Topic	Country of Study	Findings	Critique
	assessment of supply chain shocks on oil prices.		2008.	
King, Deng and Metz (2012)	The impact of key factors on the price of crude oil in the period 2006 to 2009.		Political events, particularly acts or threats of violence, were major drivers of upward price movements during the run-up in oil prices that ended in mid-July 2008.	Irwin and Sanders, (2010) counters this saying that the level of inventories had not risen.
Irwin and Sanders, (2010)		Kenya	Speculation played an important role in oil pricing indicating that the level of inventories had not risen in their period of study.	Irwin and Sanders, (2010) do not explain the increases in oil prices when fundamentals remained constant and supply and demand shocks were minimal.
Chevalier (2010)	Oil Price Volatility. Report of the working Group	France	Speculation by some financial actors has amplified the	Available statistical data do not clearly establish the links

Author	Topic	Country of Study	Findings	Critique
	on Volatility of Oil Prices		upwards or downwards price movements, increasing the natural volatility of oil prices.	of causality between the open positions of financial investors in the futures markets and prices observed in the spot market.
Bacon (2009)	The relationship between petroleum taxes and world prices.		Taxes make up a sizable fraction of retail fuel in Cambodia	Though the study gives some insights as to tax as one of the factors contributing to volatility of prices of petroleum products, it does not comprehensively show how that relationship comes about.
Taylor and Doren, (2005)			Government efforts to take excess profits from oil companies either through	Study upholds conclusions made by other studies

Author	Topic	Country of Study	Findings	Critique
			price controls or taxes have failed to reduce prices but only manage to reduce supply, increase imports and impose steep costs on the economy as a whole.	
Reza, Nazanin and Karim (2008)	Effects of oil price on government expenditures in Iran	Iran	Changes in oil prices were earlier, in the 1970s, often influenced by oil marketing companies and dealer profit margins.	Today there is no documented data on how the current oil marketing companies and dealer profit margins have affected the price volatility of petroleum products today.
Kieran and Dagmar (2010)	India's petroleum sector refined product pricing	India	The Government of India, besides reduction of taxes, is looking into the	Data available on the impact of oil losses on petroleum pricing

Author	Topic	Country of Study	Findings	Critique
	and refinery investment		issue of oil spillage as a factor affecting the volatility of oil prices in the region.	is minimal.
Kojima, 2009	Change in End-User Petroleum Product Prices: A Comparison of 48 Countries	Cross Country Study – 48 countries	Against the severe price rises of 2007 and 2008, few governments were able to withstand the pressure to use or increase fiscal measures to lower prices.	Oil is an internationally traded commodity hence local fiscal measures to control oil prices have limited success.
Tailor &Doren, (2005)	The case against price controls and windfall profit taxes	US	Due to intervention or government regulation, oil companies reap very large profits at the expense of consumers.	Oil companies' profitability in Kenya is low. Two top oil marketing companies made significant pre-tax losses in 2012.
Bacon and Kojima, (2008)	The "people" factor in cooperatives:	Canada	A price stabilization fund may have an	Price controls do not accomplish what they were

Author	Topic	Country of Study	Findings	Critique
	An analysis of members' attitudes and behavior.		intuitive appeal but does not work well in practice	intended to do and are generally to be avoided (Rockoff, 2008).
Labys (2006)	Globalization, Oil Price Volatility, and the U.S. Economy	US	Increasing price volatility can impose economic disruption costs and higher transactions costs on consumers and producers, adding to inflation, or cutting rates of growth, or both.	Price controls do not work well in practice

APPENDIX VIII: OPERATIONALIZATION OF VARIABLES

Variable Name	Type of Variable	Data Collection method	Type of Scale	Type of analysis	Indicator	Level of analysis
Volatility of Prices of Oil Products	Dependent Variable	Data Sheet	Interval	Quantitative	Price volatility Price Indices	Inferential statistics
World Prices of Oil Products	Independent Variable	Questionnaire & informal Interview Secondary data on oil prices	Interval & Nominal	Qualitative & Quantitative	World Oil Price volatility Price Indices	Descriptive & Inferential statistics
Exchange Rates	Independent Variable	Secondary data from publications and websites of CBK, ERC.	Interval	Quantitative	Exchange rate volatility	Inferential Statistics
Supply-chain inefficiencies	Independent Variable	Questionnaire & Interviews with KPRL, KPC and Oil Marketing Company officials and managers	Interval & Nominal	Qualitative & Quantitative	Pipeline & Refinery inefficiencies Product Supply trends Supply-demand analysis	Descriptive & Inferential statistics
Oil Industry Regulation	Independent Variable	Questionnaire & Interviews with KRA and ERC officials	Interval & Nominal	Qualitative & Quantitative	Volatility of taxes Oil profit margins variations Allowed oil loss limits variation	Descriptive & Inferential statistics
Political shocks	Independent Variable	Questionnaires & Interviews with all stakeholders	Interval & Nominal	Qualitative	Perceptions and price trends following	Descriptive & Inferential statistics

Variable Name	Type of Variable	Data Collection method	Type of Scale	Type of analysis	Indicator	Level of analysis
					political shocks and inflationary pressures	

APPENDIX IX: PRICES OF REGULATED PETROLEUM PRODUCTS

MONTH/YEAR	PRODUCT			
	PMS	RMS	IK	AGO
Dec'10 - Jan'10	94.03	94.39	75.83	87.45
Jan - Feb'11	95.67	97.17	77.51	88.71
Feb - Mar'11	98.08	98.11	72.79	91.72
Mar - Apr'11	102.44	100.9	83.97	94.53
Apr - May'11	111.17	108.16	88.73	105.44
May - Jun'11	115.35	111.48	92.61	108.02
Jun - Jul'11	114.93	112.17	85.71	106.3
Jul - Aug'11	115.39	115.29	86.16	106.12
Aug - Sep'11	117.22	116.71	88.96	108.97
Sep - Oct'11	117.75	116.68	88.29	108.17
Oct - Nov'11	120.50	116.73	89.95	110.94
Nov - Dec'11	124.13	123.88	94.87	114.30
Dec'11 - Jan'12	119.06	121.85	90.94	110.98
Jan - Feb'12	111.95	115.4	87.11	107.90
Feb - Mar'12	111.32	115.4	83.74	105.29
Mar - Apr'12	111.69	115.4	84.13	105.12
Apr - May'12	118.50	122.16	86.28	108.8
May - Jun'12	121.13	121.23	87.00	108.44

Source: Petroleum Insight, Petroleum Institute of East Africa, 2012

APPENDIX X: STABILITY OF PUMP PRICES IN KENYA

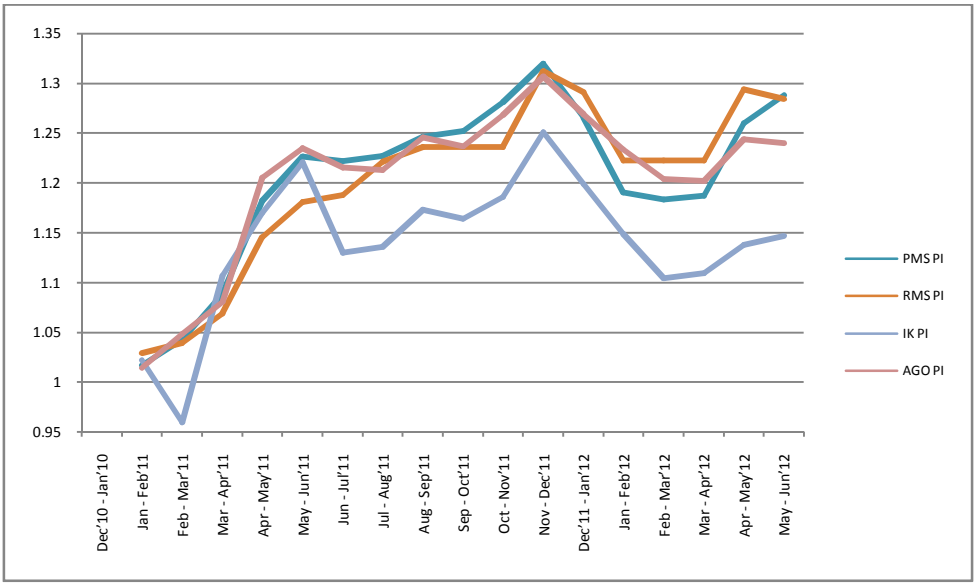

Figure 1.1: Consumer Price Indices for Oil Products December 2010 to June 2012

Source: **Petroleum Insight, Petroleum Institute of East Africa, 201**

APPENDIX XI: SUMMARY OF INFERENTIAL ANALYSIS

Objective	Variable	Statistical tests	Interpretation
To examine the effect of world prices of oil on the volatility of prices of petroleum products in Kenya	WOP	Granger causality tests between World Price fluctuations and volatility of oil prices	Nature and value of Standard deviation (t statistic)
To investigate the effect of exchange rate fluctuations on the volatility of prices of petroleum products in Kenya	EXR	Cause effect on Exchange Rate fluctuations and volatility of oil prices	Nature and value regression coefficient (t statistic)
To determine the effect of supply-chain inefficiencies on the prices of petroleum products in Kenya	SCH	Regression on costs of supply-chain inefficiencies using Granger causality tests	Nature and value regression coefficient (t statistic)
To establish the effect of regulatory costs (taxes, oil losses and profit margins) on the volatility of prices of oil products in Kenya	REG	Regression analysis on regulatory costs using Granger causality tests	Nature and value regression coefficient (t statistic)

Objective	Variable	Statistical tests	Interpretation
To determine the effect of political shocks on the prices of petroleum products in Kenya.	POL	Regression analysis on political shocks using Granger causality tests.	Nature and value regression coefficient (t statistic)