OIL IMPORT VOLATILITY AND ITS EFFECT ON ECONOMIC GROWTH IN KENYA

BY:

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DECLARATION

This research paper is my original work and has not been submitted for a degree or examination in any other university.

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DEDICATION

To my father Lawrence Mureithi, my sister Michelle and my late mother Lydia Mureithi.

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ABSTRACT

The main objective of this study is to establish the causes of oil import volatility and its effect on economic growth in Kenya. The study used quarterly data from KNBS, CBK, and OPEC to determine the long-run and short-run causes of oil import volatility, and to study the effects of the volatility on GDP growth. The variables of interest are GDP growth rate, exchange rate, OPEC oil production, quantity of money (M2), traffic volume, total manufacturing index, international oil prices, and domestic energy (electricity) production. The analysis is based on the Johansen-Juselius approach to co-integration test and vector error correction.

Results indicate that exchange rate was has a statistically significant effect on oil import volatility in the short-run. In the long-run, oil import volatility is determined by several macroeconomic variables. Specifically, exchange rate, traffic volume, total manufacturing index, and GDP growth rate have positive and statistically significant effects on oil import volatility. OPEC oil production has a negative relationship with oil import volatility.

Oil import volatility has a negative and significant effect on GDP growth in both the short-run and the long-run. However, an increase in oil import leads to increased economic growth and vice versa. Other important determinants of GDP growth include exchange rate, quantity of money in circulation, domestic energy production, and interest rate. Given these findings, the government should focus on stabilizing the exchange rate and increase domestic energy production to reduce oil import volatility.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey Fuller
ARDL	Autoregressive Distributive lag
ASEAN	Association of Southeast Asian Nations
ERC	Energy Regulatory Commission
GoK	Government of Kenya
KIPRRA	Kenya Institute of Public Policy Research
KNBS	Kenya National Bureau of Statistics
NOCK	National Oil Corporation of Kenya
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PFMOLS	Panel Fully Modified Ordinary Least Squares
UAE	United Arab Emirates
VECM	Vector Error Correction Model
VAR	Vector Autoregressive

DEFINITION OF TERMS

Oil import volatility: refers to the degree to which the value of oil imports increase or decrease over a period in Kenya

Factor productivity: refers to the share of output that is not attributed to the amount of inputs used in production. Thus, its level is determined by the level of efficiency and intensity with which the inputs are utilized in production

Oil production volatility: refers to the degree to which the volume of crude oil produced in OPEC and non-OPEC countries increase or decrease over time

Manufacturing index: the index used by the Kenya National Bureau of Statistics to track changes in the value of output in Kenya's manufacturing sector

Traffic volume: the number of vehicles that are in use for transportation at a particular time in Kenya

CHAPTER ONE

INTRODUCTION

1.1 Background

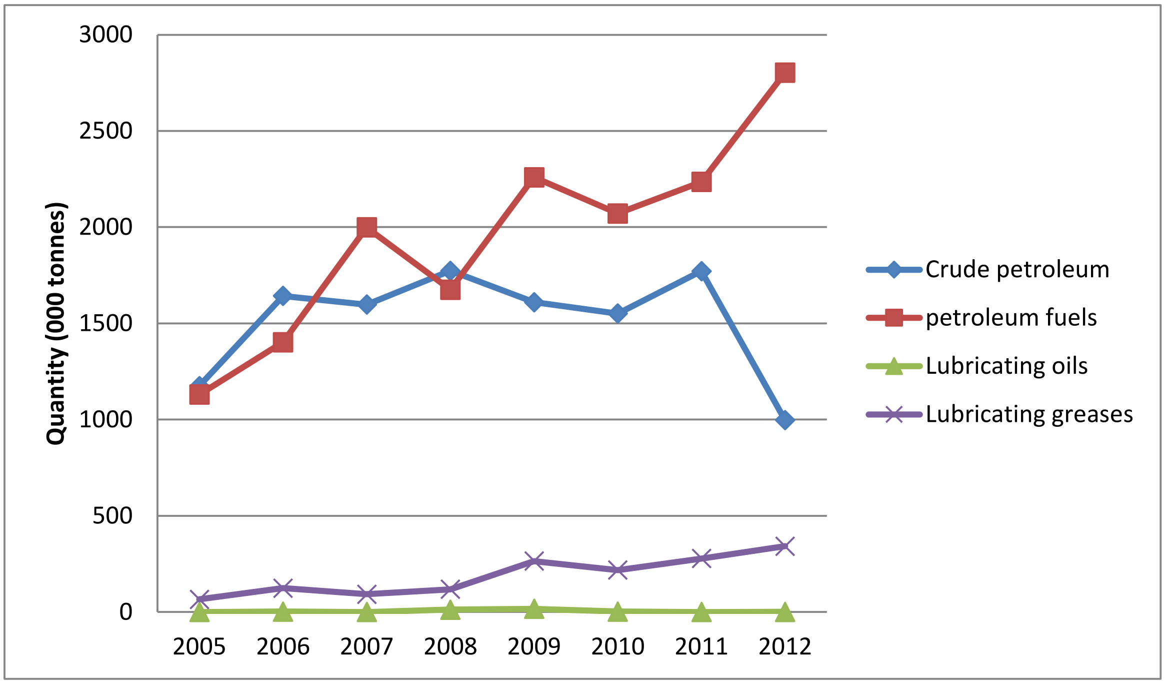
In Kenya, petroleum has been a major source of energy. It accounts for over 80 percent of the country's commercial energy requirements (Macheo & Omiti, 2002). Due to the changes in the international oil prices, the expenditure on petroleum imports has been fluctuating widely at times taking a big share of Kenya's total foreign earnings. The quantity and value of imports of petroleum products from the year 2005-2012 in Kenya is shown in Table 1 below.

Table 1: Quantity and Value of Imports of Petroleum Products in Kenya, 2005-2012

Quantity ('000 Tons)					Value (KSh Million)			
Year	Crude Petroleum	Petroleum Fuels	Lubricating oils	Lubricating Greases	Crude Petroleum	Petroleum Fuels	Lubricating oils	Lubricating Greases
2005	1,774.0	1,130.9	0.4	66.8	51,528.6	42,494	39.6	66.8
2006	1,643.2	1,402.7	2.6	124.4	55,015.6	55,807.2	73.1	124.4
2007	1,598.7	1,999.9	0.0	93.2	49,240.8	70,204.8	10.8	93.2
2008	1,773.3	1,675.4	12.4	118.6	81,452.9	110,663.7	614.1	118.6
2009	1,610.1	2,259	17.0	265.0	54,495.4	96,621.3	588.2	8,487.6
2010	1,551.5	2,071.9	3.0	218.2	72,598	119,462.5	123.4	8,596.1
2011	1,772.1	2,235.6	0.0	278.0	124,042	196,648.9	0.3	17,058.4
2012	997.0	2,803.4	0.07	342.0	68,086	237,699.5	5.8	21,130.3
Total	12,719.9	15,578.8	35.5	1,506	556,459	929,601.9	1,455	55,675.4

Source: Economic Survey 2009, 2013

Figure 1 Volatility trend of oil import demand



Source: Author's own illustration from Economic Survey data

Figure 1 shows a significant drop in the import of crude oil and a substantial increase in refined petroleum fuels imports from 2011. These changes are mainly explained by the refinery problems that the country has been grappling with since 2010. Specifically, the oil refinery at Mombasa has not been able to produce refined fuel products in a profitable manner since 2010 due to poor management, technical inefficiencies, and financial constraints (ERC, 2013). As a result, the government has been forced to reduce the volume of crude oil imports, while increasing the amount of refined petroleum fuels imports.

Various key sectors of Kenya's economy rely on petroleum. The petroleum consumption trends in Kenya indicate that the transport industry consumes 70 percent of the petroleum products used in the country. The transport sector in Kenya relies on petroleum products for its operations as commercial vehicles use diesel to transport essential goods. Some personal vehicles also use diesel while others rely on petrol. In agriculture, diesel is demanded to run mills, tractors, combine harvesters, and other machinery. In industry, generators that run on diesel are used as alternative sources of energy. During drought periods, diesel is used for electricity generation to complement hydropower. Kenya imported a total of 2452.3 tons of oil in the 2000 drought period (GoK, 2003). Therefore, the demand for oil imports influences economic growth and any volatility in imports is likely to affect the process adversely.

In 2002, the government set up a 100MW of emergency diesel fired plant and another 46MW of permanent and semi-permanent plant. The total demand for oil in Kenya rose by 2.2% from 3131.5 thousand tons in 2006 to 3218.3 thousand tons in 2007 (KNBS, 2009). As per the last economic statistics, the demand for oil imports has increased to 3638.0 tons in 2012 (KNBS, 2013). In 2011, Kenya imported 33,000 barrels per day of crude oil from the UAE. It also imported 51,000 barrels per day of refined oil products (KNBS, 2010).

There have been various efforts made by the government on oil exploration over the last decade. From these efforts, three discoveries have been made; two for crude oil in Blocks 10BB of Ngamia 1 well and 13T of Twiga South 1 well all located in Turkana County. These exploration blocks have significantly increased from 37 as at 1st December, 2006 to 53 in March 2013 (GoK, 2013). Upon such discovery, it usually takes five years on average to commence production of oil with all other factors and conditions remaining constant due to the capital intensiveness of the pre–requisite infrastructural network. Because of these factors, the recent discoveries have had no effect on the import bill at the moment. Other recent oil and natural gas discoveries in Africa as of 2012 are shown in Table 2 below.

Table 2: Quantity of recent crude oil reserves in Africa

Region	Oil Production ('000 bbl/d)	Crude oil Reserves (billion bbl)	Dry Natural Gas Production (Bcf)	Natural Gas Reserves (Tcf)	Crude oil Refinery Capacity ('000 bbl/d)
East Africa	122	7.5	165	11.3	265
Southern Africa	181	0.0	45	2.8	485
West Africa	2,667	38.0	1,161	184.8	604
Central Africa	2,912	17.1	318	23.2	121
North Africa	4,151	65.0	5,434	293.2	1,743
Total Africa	10,033	127.6	7,124	515.4	3,218

Source: U.S Energy Information Administration and Oil & Gas Journal, 2013

1.1.1 Oil Reserves in Africa

According to the data above, the African continent has quite a sizable amount of oil deposits. 46.6 percent of Africa's total exports in 2010 were petroleum and petroleum products, (African Economic Outlook, 2010). The deposits may not be as large as those in the Middle East, but they are certainly accessible and largely unexploited. Despite this fact, Kenya has been unable to import from her neighbors in order to smooth her oil imports. This is largely due to the fact that African countries have highly inconsistent oil supply. This may be attributed to issues such as political instabilities for example in Libya and existence of guerilla groups in countries like Nigeria who control the oil fields and use the revenue to arm themselves and not to further develop the resource. The economic paradox known as the resource curse has also affected oil-drilling activities as oil exports are known to cause other exports and industries to become uncompetitive due to inflation of their currency. Once these industries die off, the country begins to depend on importation of all other sector needs. Another issue that has negatively affected oil exploration and exportation by African countries is the poor state of its institutions. Most institutions in African countries are riddled with corrupt individuals who are only interested in promoting personal interests at the expense of the country's future well being. This therefore prevents full emergence of oil exportation sectors in most African countries; thus, the need for continual importation.

1.1.2 Structural Reforms in the Oil Sector

The government has implemented various structural reforms in the petroleum industry with a view to improve the operational efficiency of the sector. The reforms are meant to eliminate distortions and to induce competition so that energy prices can move in consonance with the market fundamentals. Since the 1980s, various sessional papers, regulations, and Acts of Parliament have played a major role in reconstructing energy policy in Kenya. An example of this is the Companies Act (Cap 489) which saw the establishment of the National Oil Corporation of Kenya Limited (NOCK) in 1981. Its main mandate was to source and supply at least 30 percent of Kenya's crude oil requirements then sell to marketing companies who would then refine and sell to the end user. The Petroleum Exploration and Production Act of 1984 gave the NOCK oversight on oil exploration activities in Kenya. These activities have recently bore fruit with the discovery of oil deposits in Turkana. Another example is Sessional Paper No.1 of 1986, which monitors and enforces pricing of petroleum through the Department of Price and Monopoly Control. In 1989, the Restrictive Trade Practices, Monopoly, and Price Control Act was enacted to encourage competition in the industry which would see reduced prices and better service quality in the oil sector.

Major liberalization came in 1994 where oil marketers were allowed to determine their distribution and pricing strategies. This was aimed at enhancing operational efficiencies and offer better prices to the market by introducing competitiveness in the oil market. This attracted new investments and entry of independent marketers in the industry. Recent reforms have incorporated more environmental and health issues as protection and conservation of the environment has become forefront when advocating for energy sector reforms. This was highly propagated in Sessional Paper No. 4 in 2004. In 2006, the Energy Regulatory Commission (ERC) was established under the Energy Act with its main functions being regulation of electrical energy, petroleum and related products, renewable energy, protection of investor and consumer interests, maintaining energy data, ensuring principles of fair competition are upheld in the energy sector and preparation of indicative national energy plans. In 2009, the Restrictive Trade Practices, Monopolies and Price Control Act was replaced by the Competition Act 2009 which then became the Competition Authority in 2011.

Most recently, the proposed Energy Bill 2013 seeks to establish the National Energy Regulatory Commission whose main mandate will be regulation, exploration, importation, exportation, refining, transportation, storage, and sale of petroleum and petroleum products amongst other functions. The Energy Bill also proposes establishment of the Energy Efficiency and Conservation Agency whose concern will be creating and promoting awareness of efficient energy uses and environmental conservation. It will work hand in hand with the Kenya Bureau of Standards to maintain energy efficient but cost effective technologies.

The energy sector is in this light viewed as one of the key enablers towards the realization of Vision 2030. It contributes to a considerable share of the GDP of about 9.4%. Out of this contribution to GDP, petroleum contributes 8.4% (GoK, 2012**).** The country therefore needs to stabilize petroleum energy supply in order to achieve a steady economic growth.

KIPRRA (2010) asserts that even though other sources of energy exist in Kenya, petroleum and electricity are the most dominant fuels in the commercial sector. Petroleum fuels account for about 28.7% of the total final energy consumption. Demand for petroleum fuel and especially diesel has been on the increase in Kenya with the quantity consumed rising annually from 2324.08 thousand tons in 1990 to 3638.0 thousand tons in 2012 (GoK, 2013). This therefore points to the importance of stabilizing supplies. To do so, we need to understand the factors that determine the volatility of oil imports in Kenya.

1.2 Problem Statement

Petroleum is a major input in production activities in Kenya. The demand for oil imports in Kenya has been fluctuating though the general trend is an increase over time. This has led to fluctuations in expenditure on oil imports and a general increase in the annual oil import bill as shown in Table 1.1. Moreover, the escalating international oil prices, high demand for oil, and the fluctuating Kenyan currency against the major international currencies such as the U.S dollar have worsened the oil import bill for Kenya. This in turn has led to adverse balance of payments.

The oil crisis of the 1970s that was as a result of increase in the price of crude oil brought about an economic crisis in Kenya. The oil crisis was triggered by the Yom- Kippur War (Arab-Israel conflict) and since then the global price of crude oil has generally been on an increasing trend.

Oil is an essential factor in the aggregate production function of Kenya. Thus, any factor that influences oil and oil products has far-reaching consequences on the economic growth and development of the country. In this light, this study sought to determine the factors that influence the volatility of oil imports in Kenya with a view to finding ways of stabilizing the trend. The study answered the question: what factors determine the volatility of oil imports in the country? Oil import volatility is the degree to which the value of Kenya's oil imports increase or decline over a period. The oil market is considered volatile if the value of oil imports changes significantly (by a large margin) within a short time. By contrast, a relatively stable oil import bill is associated with low volatility.

1.3 Research Questions

The study was guided by the following research questions

a) What are the factors that determine the volatility of oil imports in Kenya?

b) What are the effects of oil imports volatility on economic growth in Kenya?

c) How can oil imports volatility in Kenya be stabilized?

1.4 Objectives of the Study

The overall objective of the study was to investigate empirically the factors that determine the volatility of oil imports, and the resultant effect of the volatility on economic growth in Kenya.

Specific Objectives

a) To examine the factors that determine the volatility of oil imports in Kenya

b) To examine the effect of oil imports volatility on economic growth in Kenya

c) To explore how oil imports volatility could be stabilized in Kenya

1.5 Significance of the Study

The study provided useful information concerning the volatility of oil imports in Kenya, the factors that affect it, and how this affects economic growth. Petroleum is a major input in the manufacturing process in Kenya with the transport sector consuming two thirds of the total petroleum supplies. In agriculture, diesel is used to operate tractors, mills, and combined harvesters among other farm machinery. The service sector is not an exception since institutions such as banks use diesel fuelled generators to keep their operations running in case of electricity failure. The industrial sector is also not left behind as diesel is used to power machinery in the industries. According to Senga, Manundu, and Manundu (1980), the transport sector consumes 70 percent of the petroleum products used in the country. This has continued to be the case and petroleum products have continued to be the most important sources of commercial energy in Sub-Saharan Africa accounting for 72 percent of requirements with gas, coal and electricity meeting the rest of the demand (Schloss, 1992). Therefore, demand for petroleum is very critical since it is used in all sectors of the economy and therefore affects the entire economy. This implies that the demand for petroleum needs to be properly managed as it can lead to an economic crisis problem of cost-push inflation. However, this can only be properly managed if the factors that affect demand and volatility of oil imports are known. Therefore, this study explored the factors that influence the volatility of oil imports and how they affect economic growth to facilitate proper management of its demand.

In recent times, there has been an escalation of oil prices in Kenya and this has led to the Energy Regulatory Commission coming in to review oil prices on a monthly basis. Therefore, prices are a very important focus point when dealing with oil and thus policies to address these issues can only be made with knowledge of how factors such as this influence the volatility of oil imports thus the need for this study.

The findings of this study are also expected to assist oil firms to know the factors influencing volatility of oil imports and their resultant effects thus aiding them to forecast sales and enable inventory management. The study also adds to the existing literature and acts as a basis for scholars who will conduct related research in the future. The government is expected to benefit from the results of the study by using them to formulate and effectively enforce the fiscal and monetary policies that will help curb cost-push inflation caused by hiking crude oil prices. It will also be able to estimate the change in the level of revenue obtained from fuel levy fund that is likely to accrue from any change in any of the factors. These expositions therefore justified the importance of this study.

1.6 Organization of the Study

Chapter 1 has provided the background of the study. In addition, it has covered the research problem, the research objectives, and research questions. Chapter 2 will provide the theoretical and empirical literature review. Chapter 3 will cover the methodology that was used in the study. Chapter 4 presents the results of the study, whereas chapter 5 provides a brief discussion of the results, policy recommendations, and conclusions.

CHAPTER TWO

LITERATURE REVIEW

In studying the relationship between oil and economic growth, it is in order to classify oil in the right product category. Oil can be viewed as a consumer good, particularly, when individuals purchase petroleum products such as kerosene and gasoline for domestic use. However, oil is also an industrial good when it is used as an input or source of energy in the production process. This study will consider oil as an industrial good.

2.1 Theoretical Literature Review

According to Solow's growth model, an increase in savings will result into an increase in output. However, the output will increase at a reduced rate as savings increase. Ultimately, the economy will reach a steady state when the savings is just enough to replace the stock of capital in the next production period (Romer, 2012). This implies that economic growth through capital formation will decline as the economy approaches the long-run equilibrium. Thus, the government must focus on increasing the total factor productivity in order to maintain rapid economic growth (Prabhakar, 2010). An increase in total factor productivity results from using innovative production technologies or improved organization of the production process. This includes using machinery, improved transportation systems, and efficient sources of energy (Prabhakar, 2010). In this respect, crude oil is one the factors that influence the total factor productivity. Improved access to reliable and cheap oil supply will improve total factor productivity, thereby increasing the national output (GDP). One of the factors that explain the increase is that cheap oil will reduce the cost of production, thereby enabling producers to increase their production capacities.

According to Solow's growth model, any changes in total factor productivity will result into fluctuations in economic growth. For instance, insufficient supply of oil will reduce total factor productivity, thereby causing a recession or a general decline in GDP growth rate. By contrast, an increase in oil supply is likely to lead to economic boom. Apart from oil, other factors that are likely to affect total factor productivity include exchange rate, government expenditure, quantity of money, and interest rates (Prabhakar, 2010).

Determinants of Oil Import Volatility

According to Oriakhai and Osaze (2013), several factors affect the oil import demand in a country. These include international oil prices, domestic energy production, exchange rate fluctuations, political risks in the oil producing countries, GDP growth, and interest rates among others (Oriakhi & Osaze, 2013). The price of crude oil is an important determinant of oil imports' demand. Conceptually, an increase in international oil prices is expected to cause a decline in consumption of oil imports. However, several studies indicate that oil imports demand is price inelastic particularly in the short-run (Alun, Muhleisen, and Pant 2011; Suleiman 2013; Yazdani and Faaltofighi 2013). One of the factors that explain this finding is the lack of substitutes for oil in the short-run. Thus, oil imports are hardly affected by significant increases in their prices in the short-run. Producers are likely to maintain their level of production and shift the high cost of oil to consumers through an increase in prices of finished goods and services. In this context, high oil prices lead to high inflation, which in turn reduces economic growth (Yazdani & Faaltofighi, 2013). In the long-run, producers are likely to reduce their production capacities in response to the low demand triggered by shifting the high cost of oil to consumers. As a result, the level of oil imports will reduce.

Domestic energy production is considered to have a substitution effect on oil imports (Berument & Ceylan, 2008). As net oil importing countries such as Kenya focus on producing alternative energy such as hydroelectric power, wind energy, and solar energy, their reliance on oil imports is expected to reduce. The substitution effect is likely to occur if using the domestic sources of energy is cheaper than importing oil. Domestic energy sources not only enhance reliability, but also improve terms of trade by reducing the value of imports.

In theory, economic growth is expected to have a positive relationship with oil import demand (Romer, 2012). Specifically, an increase in economic growth (GDP) increases oil imports and vice versa. However, industrial production is considered as the best indicator when studying the relationship between oil imports demand and economic growth. This choice is motivated by the fact that manufacturing and transportation sectors account for the largest share of oil consumption, especially, in developing countries such as Kenya where access to alternative sources of energy is limited (Zhao & Wu, 2009).

International crude oil prices are often denominated in US dollars. This means that changes in the oil importer's currency against the US dollar is likely to affect the oil import bill in the importing country. In theory, a depreciation of the Kenya shillings against the US dollar is expected to increase the cost of importing oil in Kenya, ceteris paribus. However, Krugman (1987) asserts that in the event of currency depreciation in the importing country, the exporter is likely to reduce the prices of his goods and services to make his products affordable/ competitive in the importing country. This is likely to happen if the exporter is facing a highly elastic demand curve due to high competition (Krugman, 1987). However, Krugman's argument hardly holds in the oil market. For instance, OPEC (one of the largest oil exporters) is viewed as a cartel with the power to determine oil supply and prices. In this respect, exporters of oil generally face an inelastic demand curve in the import market. As a result, they can pass the high costs associated with currency depreciation to consumers in the oil importing countries (Jabara, 2009). This suggests that a significant depreciation of Kenya's currency will lead to domestic oil price volatility, which in turn causes oil import volatility.

2.2 Empirical Literature Review

2.2.1 Determinants of Oil Import Volatility

In their study of the factors that determine volatility in oil production, Metcalf and Wolfram (2010) found that political stability is one of the major determinants of oil production volatility in OPEC countries. Countries with very democratic political systems had less volatility in oil production than their counterparts with autocratic political systems. Fluctuations in oil production were found to affect global oil prices, thereby causing price volatility in countries that import oil. In addition, the level of oil consumption and the size of the economy determined oil import volatility (Metcalf & Wolfram, 2010). These results were based on data collected from OPEC and OECD countries. The dataset included oil production levels, oil import volumes, GDP, and the composite democracy index for the period 1970-2007. The two-stage least squares econometric technique was used for data analysis. However, the researchers failed to consider the possible causes of oil import volatility in the context of developing countries such as Kenya that heavily rely on oil as their main source of energy.

Using panel data for the period 1996 to 2010, Alun, Muhleisen, and Pant (2011), studied the causes of sharp oil price movements and its effects on oil imports in OECD countries. The data set consisted of nominal oil prices, demand for oil in each country, inflation expectations, exchange rate, political risk, and oil supply from non-OPEC countries. The data was analyzed using co-integration tests and error correction model. In the short run, the variables that had statistically significant effects on oil prices were political risk and oil supply. In the long-run, oil prices were determined by demand for oil, political risks, and exchange rate (Alun, Muhleisen, & Pant, 2011). A significant increase in oil prices led to volatility in oil imports in the OECD countries. This study supports the findings of Metcalf and Wolfram (2010) which showed that political risks in the oil producing countries lead to oil import volatility in the importing countries.

Zhao and Wu (2009) used quarterly data for the period 1995 to 2006 to analyze the determinants of oil imports in China. The data set included crude oil price, domestic energy production, industrial output, and the total traffic volume in the transport sector. To determine the long-run relationship between these variables and oil import volatility, the researchers used Johansen co-integration tests and the vector error correction model (VECM) to analyze the data. Zhao and Wu (2009) found that international oil price has no statistically significant long-run effect on oil import, suggesting that China is large enough to influence international oil prices. Industrial output and traffic volume had positive significant relationship with oil import. By contrast, domestic energy production had a negative relationship with oil imports. Although this study highlights the causes of oil import volatility, it does not link the volatility to economic growth.

In their study of the impact of oil consumption in India and China, Niklaus and Inchauspe (2013) used data for the period 1991 to 2012. Their data set included international oil prices, oil consumption in chain and India, as well as, oil production volume in OPEC and non-OPEC countries. Using VAR and VECM, the researchers found a long-run significant relationship between oil consumption in China and India and international oil prices. Specifically, an increase in importation of crude oil in China and India increased global demand for oil, thereby raising international oil prices (Niklaus & Inchauspe, 2009). As a result, the high international oil prices led to oil imports volatility in importing countries such as Kenya. These findings support the argument by Zhao and Wu (2009) that China's oil consumption is large enough to affect international oil prices.

Suleiman (2013) studied the causes of oil consumption/import volatility and its effects on economic growth in North America, Europe, Africa, and the Middle East for the period 1970-2010. His data set, which was analyzed using structural time series, models included oil consumption and real GDP for each region, as well as, real international oil prices. The main finding of the study is that oil consumption and import volatility is mainly caused by international oil prices in all regions (Suleiman, 2013). In North America, GDP per capita is also a significant determinant of oil consumption and importation. The main shortcoming of this study is that it considers the determinants of oil imports volatility in regions rather than individual countries.

Marbuah (2013) used the ARDL approach to co-integration and data for the period 1980 to 2012 to examine the oil import behavior in Ghana. His data set consisted of international oil prices, real income, exchange rate, domestic oil production, and population growth. Oil imports in Ghana were found to be price-inelastic implying that the country's oil consumption increase regardless of price increases (Marbuah, 2013). Economic activity (industrial production), exchange rate, and domestic oil production led to oil imports volatility in the short and long-run. These findings are consistent with that of Zhao and Wu (2009) who showed that industrial production is an important determinant of oil imports volatility in China. However, Marbuah (2013) failed to link the oil imports volatility to GDP growth.

2.2.2 Effects of Oil Import Volatility

Using data for the period 2006 to 2011, Kotut, Menjo, and Jepkwony (2012) showed that fluctuations in oil prices cause oil imports volatility, which in turn negatively affects economic growth in Kenya. The researchers used Johansen co-integration tests and VECM to analyze the data. The variables included GDP, oil prices, exchange rate, and inflation rate. The volatility of oil imports resulting from price fluctuations limits access to oil, which is a key factor of production. This causes a negative effect on economic growth.

Rodriguez and Sanchez (2004) analyzed the effect of oil imports volatility resulting from oil price fluctuations on economic growth in the G-7 countries, Norway, and the Euro-zone countries. The data set for the study included GDP, oil imports, oil production, exchange rate, and oil price for the countries for the period 1990 to 2003. Using VAR, VECM, and Granger causality tests, the researchers showed that oil imports volatility resulting from significant increases in oil prices results into a decline in GDP growth in all countries except Japan in the long-run. According to Rodriguez and Sanchez (2004), oil exporting countries such as Canada, a reduction in oil prices led to a decline in GDP growth. The results are consistent with that of Kotut, Menjo, and Jepkwony (2012) who linked oil imports volatility to negative economic growth.

Yazdani and Faaltofighi (2012) analyzed the causal relationships between oil imports volatility and economic growth in five oil-importing countries namely, Turkey, South Korea, Malaysia, India, and Pakistan. Their data set included oil import and GDP growth rate for each country for the period 1980 to 2007. The econometric technique used in this study was the panel fully modified ordinary least squares (PFMOLS) and the panel error correction model. Yazdani and Faaltofighi (2012) found a unidirectional causal relationship running from GDP to oil imports, implying that variations in oil imports is a direct response to fluctuations in GDP growth. Although this study sheds light on the relationship between oil import volatility and economic growth, it does not highlight the causes of the volatility.

Acheampong (2013) studied the long-run relationship between oil imports and economic growth in Ghana using the autoregressive distributive lag (ARDL) approach to co-integration test. The researcher used annual data for oil price, GDP per capita, exchange rate, and money supply for the period 1967 to 2011. Acheampong (2013) found that oil import volatility resulting from oil price fluctuations had a significant negative relationship with GDP growth in the short-run and long-run. The negative relationship was attributed to the increased expenditure of tax revenue to subsidize fuel rather than to fund other development activities (Acheampong, 2013).

Tin (2010) used the ARDL approach to co-integration test and causality test to analyze the long-run relationship between oil imports volatility resulting from oil price fluctuations on economic growth and terms of trade in the ASEAN countries. The researcher used annual GDP, oil imports bill, and terms of trade for each country, as well as, the international oil prices for the period

1990-2009. The findings indicated that oil price and import volatility had a long-run negative effect on economic growth only in the Philippines (Tin, 2010). Acheampong (2013) also found similar results in Ghana. In Singapore, oil price volatility had long-run negative effects on economic growth and terms of trade.

Jayaraman and Lau (2011) used panel fully modified ordinary least squares (PFMOLS), panel co-integration, and Granger causality tests to study the relationships between oil price shock, oil imports volatility, foreign exchange reserve, and economic growth in five Pacific Island Countries (PICs). The countries included Fiji, Samoa, Solomon Islands, Tonga, and Vanuatu. The study covered the period 1982 to 2007 (Jayaraman & Lau, 2011). Jayaraman and Lau (2011) found that oil price shocks and the resulting volatility in oil imports had negative effects on economic growth in all the five countries. However, foreign exchange reserve had a positive significant relationship with economic growth. This suggests that foreign exchange reserves facilitated importation of oil, which in turn led to economic growth.

2.3 Overview of the Literature

The reviewed literature shows that most of the previous studies considered oil price as the main source of oil imports volatility. Little attention has been given to other potential sources of oil import volatility such as domestic energy production and foreign exchange fluctuations. Most of the studies have been done in developed countries, especially, the OECD. In Africa, most of the studies on causes of oil import volatility and its effects on economic growth have been done in South Africa, Ghana, Nigeria, and the countries that belong to the MENA region. Co-integration analysis using the ARDL and Johansen maximum likelihood approach, as well as, Granger causality tests has been widely used in the literature to analyze the long-run and short-run relationships between oil imports volatility and economic growth. This study sought to contribute to the existing literature by first determining the causes of oil imports volatility in Kenya. It then determined the effects of the volatility on economic growth in the country.

CHAPTER THREE

METHODOLOGY

3.1 Model Specification

The first objective of this study was to determine the factors that cause oil imports volatility. The second objective was to analyze the effect of oil imports volatility on economic growth. Drawing from theoretical and empirical evidence, the study assumed that oil imports volatility is a function of international oil price volatility, exchange rate, OPEC oil production, domestic energy production, and economic activity proxied by manufacturing and traffic volume. Similarly, economic growth, measured by GDP is a function of among other factors oil import volatility, exchange rate, money supply, and interest rate. The equation of oil imports volatility can be defined as:

$$OIV = f(IOP, EX, OPOP, DEP, TMI, TV, Y) \quad (1)$$

Equation 1 illustrates the relationship between oil imports volatility and its determinants where:

OIV is oil import volatility

IOP is international crude oil prices

EX is exchange rate

$OPOP$ is OPEC oil production

DEP is domestic energy production

TMI is total manufacturing index

TV is traffic volume

Y is GDP growth

The equation for the relationship between economic growth, oil imports volatility and other determinants of economic growth can be defined as:

$$Y_t = f(OIV, EX, QM, Ir, DEP) \qquad (2)$$

Where:

Y_t is GDP growth rate

OIV is oil import volatility

EX is exchange rate

QM is quantity of money (M2)

Ir is lending interest rate

DEP is domestic energy production

Log transformation was used to linearize the relationships between the dependent and the independent variables to ease estimation. The transformed equation of oil imports volatility can be defined as:

$$LnOIV = \alpha + LnIOP + LnEX + LnOPOP + LnDEP + LnTMI + LnTV + LnY + \varepsilon \qquad (3)$$

The transformed equation for the relationship between economic growth, oil imports volatility and other determinants of economic growth can be defined as:

$$LnY_t = \delta + LnOIV + LnEX + LnQM + LnIr + LnDEP + \epsilon \qquad (4)$$

Where

ε and ϵ are error terms

α and δ are intercepts

Estimation Method

Regressions based on the ordinary least squares (OLS) method assume that all the time series are stationary. Spurious regression is likely to arise if this assumption is violated. Generally, most macroeconomic aggregates such as GDP, exchange rate, and imports are non-stationary in time series data (Granger, 2003). In this respect, it is necessary to test for unit roots to determine the order of integration of the macroeconomic variables used in the estimation model. If the variables are non-stationary, it calls for testing for co-integration. If at least one co-integrating relationship is found, the short-run and long-run relationships between the variables can be best modeled using the error correction model.

Co-integration exists when a linear combination of two I(1) series become stationary or I(0). The three main methods of testing for co-integration are the Johansen-Juselius test, the Engle-Granger test, and the autoregressive distributive lag (ARDL) bound test. The Engle-Granger test is not relevant for this study since it cannot reveal more than one co-integrating relationships. Both Johansen maximum likelihood test and the ADRL overcome this limitation. However, this study used the Johansen-Juselius test rather than the ADRL due to its simplicity to analyze the short-run and long-run relationships between oil import volatility and economic growth.

Co-integration test based on Johansen-Juselius test begins with estimation of a vector autoregressive (VAR) model of order p (Hendry & Juselius, 2005). The number of co-integrating vectors are then determined using the trace and maximum eigenvalue tests. In the presence of at least one co-integrating vector, a vector error correction model (VECM) is constructed to capture the shot-run and long-run relationships between the dependent and independent variables.

In past oil studies, (Niklaus and Inchauspe, 2013; Zhao and Wu, 2009; and Rodriguez and Sanchez, 2004) if the variables are non-stationary the regression models such as equation 3 and 4 are not estimated. Instead, the Johansen-Juselius co-integration test and the vector error correction model (VECM) are preferred to regression analysis. This helps in determining the short-run and long-run relationships between oil import volatility and its determinants. This study follows the same principle.

3.2 Description of the Variables

The description of the dependent and independent variables for the study are presented in table 3.

Table 3: Summary of the variables

Variable	Description
$LnOIV$	Quarterly change in crude oil import bill in Kenya shillings
$LnEX$	Kenya shillings exchange rate against the US dollar in Ksh/Dollar
$LnIOP$	The average quarterly international price of crude oil per barrel in US dollar
$LnOPOP$	The quarterly aggregate volume of crude oil produced by OPEC measured in barrels
$LnDEP$	The quarterly amount of electricity produced in Kenya measured in megawatts
$LnTMI$	KNBS index of tracking changes in the value of output in Kenya's manufacturing sector measured in scalar quantity
$LnTV$	The number of newly registered vehicles per quarter in Kenya
LnY	The quarterly change in Kenya's real gross domestic product
$LnQM$	M2 is the broad money supply, which includes M1 and M0
$LnIr$	Is the real lending interest rate measured as a percentage

Source: Author's summary based on descriptions from KNBS, CBK, and OPEC databases

3.3 Estimation Issues

3.3.1 Test for Stationarity

Testing for stationarity was done to determine the order of integration of the variables. The Augmented Dickey-Fuller (ADF) test was used to test for stationarity. The ADF test is based on the model:

$$\Delta y_t = \alpha + \delta T + \rho y_{t-1} + \sum_{i=1}^{n} \beta_i \Delta y_{t-1} + \varepsilon_t \qquad (5)$$

Where

Δ is the difference operator

y_t is the variables in their levels

T is a time trend

$\alpha, \delta, and\ \beta$ are parameters

ε_t is a white noise error term

The ADF tests the null hypothesis of a unit root against the alternative of no unit root

3.3.2 Testing for Co-integration

The Johansen-Juselius co-integration test is based on $VAR_{(p)}$ of the form:

$$Y_t = v + A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + \varepsilon_t \qquad (6)$$

Where

$Y_t = y_{1t}, y_{2t} \cdots y_{nt}$ is a vector of the dependent and independent variables in equations 3 and 4

v and $A's$ are matrices of the model's parameters

ε_t is assumed to be a white noise error term

P is the optimal lag length of the model

The optimal lag length p was determined using different information criteria. These included the Akaike information criterion (AIC), Schwartz-Bayesian information criterion (SBIC), Hannan-

Quinn information criteria (HQIC), the final predictive error criteria (FPE), and the sequential modified likelihood ratio test (LR).

3.3.3 Co-integrating Vectors

The VAR model in equation 6 can be transformed into a vector error correction model of the form:

$$\Delta Y_t = v + \Pi Y_{t-1} + \sum_{i=1}^{p} \Gamma_i \, \Delta Y_{t-i} + \varepsilon_t \qquad (7)$$

The co-integrating vectors in the model are identified by determining the rank (r) of matrix Π. When $r = o$ there is no co-integration. However, if $0 < r < n$ where n is the number of variables in the model, there is at least one co-integrating vector (Hendry & Juselius, 2005). The rank of matrix Π was estimated using the trace and maximum eigenvalue tests.

The maximum eigenvalue test was based on the model:

$$LR_{max}(r_0) = -Tln\left(1 - \hat{\lambda}_{r_0+1}\right) \qquad (8)$$

Where λ is the largest eigenvalue of the Πmatrix. The maximum eigenvalue tests the following hypothesis:

$$H_0(r_0): r = r_0$$

$$H_1(r_0): r \quad = r_0 + 1$$

The trace test is based on the model:

$$LR_{trace} = -T \sum_{i=r_0+1}^{n} ln\left(1 - \hat{\lambda}_i\right)$$

The trace statistic tests the hypotheses:

$$H_0(r): r = r_0$$

$$H_1(r_0): r > r_0$$

3.3.4 Vector Error Correction (VEC)

Reproducing equation 11, the VEC is defined by:

$$\Delta Y_t = v + \Pi Y_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \qquad (9)$$

Where:

ΔY_t is a vector of the dependent and independent variables in equations 3 and 4 in their first difference

Π is the error correction term. It can be rewritten as $\Pi = \alpha\beta'$ where α is a vector of the parameters that indicate the speed with which the dependent variables (OIV and Y_t) adjust to the long-run equilibrium after a change in one of the dependent variables. β' is a vector of the long-run coefficients of the model.

Γ_i is the matrix that contains the short-run coefficients of the model

ε_t is a white noise error term

3.4 Diagnostic Tests

3.4.1 Stability Test

Stability test helped in determining if the appropriate number of co-integrating equations were estimated and if they were stationary. The VECM is stable if all the eigenvalues of the companion matrix fall within the unit circle. This can be seen by plotting the real and imaginary components of the eigenvalues.

3.4.2 Serial Correlation Test

Testing for serial correlation in the residuals of the VECM helped in determining if the appropriate lag length of the VAR and VECM was specified (Hendry & Juselius, 2005). A low lag length often leads to serial correlation. Thus, serial correlation was tested using the Lagrange-multiplier test.

3.5 The Data

Quarterly data from the Kenya National Bureau of Statistics (KNBS), the Central Bank of Kenya (CBK) and OPEC's website for the period 1995 to 2013 was used in this study. The sample period was selected because of the changes that occurred in the domestic and global economy, which are likely to have influenced oil imports volatility and its subsequent effect on economic growth. These include the 2008/2009 global financial crisis, which resulted into high international crude oil prices, low economic growth (0.6%) in 2001 in Kenya, and high inflation rate of 13% in 2012.

GDP growth rate, number of newly registered vehicles, oil import, total manufacturing index, and domestic energy production data was obtained from the Kenya National Bureau of Statistics (KNBS). Data for exchange rate, lending interest rate, and quantity of money was obtained from the Central Bank of Kenya (CBK). International oil prices and OPEC oil production data was obtained from OPEC's website, www.opec.org.

CHAPTER FOUR

ESTIMATION RESULTS

4.1 Descriptive Statistics

The descriptive statistics of the variables in their natural logs are presented in table 4. There were a total of 76 observations for each variable. All variables except quantity of money (LnQM) have a standard deviation of less than one. This suggests that their volatility over the sample period was relatively low. Domestic energy production (LnDEP), traffic volume (LnTV), and interest rate (LnIr) were positively skewed, whereas the remaining variables were negatively skewed. Oil import seems to be leptokurtic due to its high positive kurtosis. Other variables have positive, but low kurtosis, which suggests that their distribution is relatively flat.

Table 4: Descriptive statistics

Variable	Mean	Std. deviation	Variance	Skewness	Kurtosis	Minimum value	Maximum value
LnOIV	8.9365	0.7656	0.5862	-1.3022	5.9248	5.6328	9.9215
LnIOP	3.6046	0.7654	0.5859	-0.0070	1.6761	2.1506	4.7670
LnEX	4.2807	0.1509	0.0228	-0.9156	3.4059	3.7876	4.5523
LnOPOP	10.2482	0.0961	0.0092	-0.1760	1.5995	10.0941	10.3867
LnDEP	7.1888	0.2156	0.0465	0.5808	2.2020	6.8483	7.6911
LnTMI	5.3929	0.4698	0.2207	-0.8500	1.9449	4.5570	5.9441
LnTV	9.5561	0.8374	0.7012	0.5193	1.6778	8.4353	11.1390
LnY	1.1247	0.6278	0.3942	-0.9295	3.4652	-0.7550	1.9741
LnQM	12.3878	1.9087	3.6432	-0.7361	1.9348	9.0041	14.4821
LnIr	2.8981	0.2849	0.0812	0.3491	1.8067	2.4874	3.4167

Source: Author's own computation

4.2 Diagnostic Tests

4.2.1 Normality Test

The results of the joint skeweness/ kurtosis test for normality is presented in table 5. The null hypothesis of normal distribution was rejected at 1% level of significance for all variables except LnDEP, where the hypothesis was rejected at 5% level of significance. This means that all the series were not normally distributed.

Table 5: Normality test

			Joint test	
Variable	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
LnOIV	0.000	0.001	20.44	0.0000
LnIOP	0.978	0.000	28.66	0.0000
LnEX	0.002	0.295	9.30	0.0095
LnOPOP	0.501	0.000	42.29	0.0000
LnDEP	0.035	0.045	7.58	0.0225
LnTMI	0.003	0.001	16.25	0.0003
LnTV	0.056	0.000	30.89	0.0000
LnY	0.002	0.257	9.61	0.0082
LnQM	0.009	0.000	15.33	0.0005
LnIr	0.189	0.000	18.07	0.0001

Source: Author’s own computation

4.2.2 Correlation

Figure 2 indicates the correlation between the variables. Oil import volatility had a positive and statistically significant correlation with most variables except the total manufacturing index (LnTMI) and interest rate (Lnir) whose coefficients are negative. The figure also shows the expected positive and statistically significant relationship between GDP growth (LnY) and oil import.

Figure 3: Correlation matrix

	LnOIV	LnIOP	LnEX	LnOPOP	LnDEP	LnTMI	LnTV	LnY	LnQM	LnIr
LnOIV	1.00									
LnIOP	0.70	1.00								
LnEX	0.47	0.60	1.00							
LnOPOP	0.75	0.84	0.58	1.00						
LnDEP	0.62	0.90	0.63	0.83	1.00					
LnTMI	-0.39	-0.58	-0.49	-0.40	-0.63	1.00				
LnTV	0.61	0.88	0.57	0.76	0.92	-0.82	1.00			
LnY	0.29	0.40	0.09	0.49	0.46	-0.13	0.37	1.00		
LnQM	0.82	0.86	0.76	0.84	0.78	-0.39	0.71	0.32	1.00	
LnIr	-0.70	-0.68	-0.56	-0.72	-0.53	0.14	-0.49	-0.39	-0.83	1.00

Source: Author's own computation

4.2.3 Test for Stationarity

Unit root tests were conducted using the ADF test and the results are presented in table 6. The null hypothesis of a unit root was accepted for all variables in both the model with an intercept only and the model with an intercept and a time trend. This means that all the series were non-stationary in their levels. However, all the variables become stationary after the first difference, implying that they were I(1). The implication of this finding is that OLS estimation will lead to spurious regression if the variables are used in their levels. Moreover, co-integration is likely to exist in the time series. If the variables are differenced to make them stationary, the information about their long-run relationships might be lost. Therefore, the study used the Johansen-Juselius test to test for co-integration, whose presence signifies existence of long-run relationships.

4.2.4 Trends in the variables

It is important to analyze how the various variables have trended over time to give an indication of the direction and magnitude of their relationship.

Figure 2.1 shows that real interest rate has a downward trend. The real interest rate reduced steadily from 1996 to 2005. However, it has increased sharply from the third quarter of 2011 to the fourth quarter of 2012. The increase is attributed to the high inflation (over 10%) that was experienced from mid 2011 to 2012.

Figure 2.2 shows that Kenya’s quarterly GDP has been changing in a cyclical pattern. This change is likely to have been caused by fluctuations in macroeconomic variables such as inflation rate, interest rates and exchange rate. In addition, oil import volatility is likely to have contributed to the cyclical change in GDP through its effect on the level of economic activities.

Figure 2.3 shows an upward trend in Kenya Shilling exchange rate against the US dollar. This means that the shilling has generally been weakening against the dollar, thereby increasing the cost of imports. In this respect, depreciation of the exchange rate is likely to have contributed to import volatility.

According to figure 2.4, oil production measured in barrels has an upward trend. This means that OPEC countries have been increasing the amount of crude oil that they produce on a quarterly basis. Nonetheless, figure 2.4 shows that the production has been characterized by significant fluctuations that are likely to have affected international oil prices, thereby causing oil import volatility in Kenya.

Figure 2.5 shows that international oil price has an upward trend. The decline between 2007 and 2009 is attributed to the recent global financial crisis that reduced economic activities in various parts of the world. As a result, OPEC reduced oil prices to increase the sales of crude oil.

According to figure 2.6, domestic energy production proxied by electricity generation has been increasing in Kenya. This increase is expected to reduce the country's dependence on imported oil. In this context, domestic energy production is expected to reduce oil import volatility.

Figure 2.7 indicates an upward trend in M2. The outlier between 2008 and 2009 is attributed to the Economic Stimulus Programme that led to increased money supply to boost economic growth after the 2007/2008 post-election violence.

Figure 2.8 indicates an upward trend in Kenya's traffic volume. This means that the number of newly registered vehicles have been increasing in Kenya. The resulting increase in petroleum consumption is expected to influence oil import volatility.

Figure 2.9 indicates that crude oil imports in Kenya have been changing in a cyclical pattern. This implies that oil imports have been very volatile over the sample period. The volatility is likely to affect the level of economic activity and economic growth.

Table 6: ADF tests

Variables in levels		
	Model with intercept only	Model with intercept and trend
	p-value for z(t)	p-value for z(t)
LnOIV	0.2168	0.0598
LnIOP	0.7992	0.2668
LnEX	0.0122	0.0619
LnOPOP	0.7066	0.9023
LnDEP	0.9872	0.9113
LnTMI	0.9469	0.8778
LnTV	0.8713	0.7663
LnY	0.0187	0.0378
LnQM	0.5328	0.9056
LnIr	0.6743	0.9771
Variables in first difference		
LnOIV	0.0000	0.0000
LnIOP	0.0000	0.0000
LnEX	0.0000	0.0000
LnOPOP	0.0014	0.0014
LnDEP	0.0000	0.0000
LnTMI	0.0007	0.0043
LnTV	0.0000	0.0000
LnY	0.0000	0.0000
LnQM	0.0000	0.0000
LnIr	0.0000	0.0000

Source: Author’s own computation

4.3 Johansen-Juselius Co-integration Analysis

The estimation strategy was to first estimate the determinants of oil import volatility as shown in equation 1. The second step was to determine the effect of oil import volatility on economic growth. Therefore, two separate co-integration tests were done. In the first test, only the variables in equation 1 (oil import volatility and its determinants) were included in the VAR model in equation 6. In the second test, only the variables in equation 2 (effect of oil import volatility on economic growth) were included in equation 6.

4.3. 1 The First Co-integration Test

Oil Import volatility and its determinants

In the first co-integration test, the variables included in equation 6 were oil import volatility, international oil prices, exchange rate, oil production, domestic energy production, traffic volume, and GDP. The appropriate lag length for equation 7 was determined to be 2 lags based on the FPE and HQIC information criteria.

Co-integrating Vectors

The results of the trace statistic and the maximum eigenvalue tests are presented in table 7. The results indicate the presence of one co-integrating vector at the 5% level of significance. This means that there is a long-run relationship between oil import volatility and its determinants. Thus, it was necessary to estimate this relationship using a VECM.

Table 7: Co-integrating vectors

Maximum rank	LL	Eigenvalue	Trace statistic	5% critical value
0	723.7634		173.3338	156.00
1	751.4326	0.5266	117.9953*	124.24
2	769.4157	0.3849	82.0291	94.15
3	786.2755	0.3660	48.3095	68.52
4	795.5658	0.2221	29.7288	47.21
5	803.1348	0.1850	14.5909	29.68
6	807.3423	0.1075	6.1759	15.41
7	810.4015	0.0794	0.0576	3.76
8	810.4302	0.0008		

Source: Author's own computation

The VECM

Since the series were difference stationary, the VECM (equation 7) was estimated with the assumption that the VAR had a linear trend, whereas the co-integrating equations had only an intercept. The results of the VECM are presented in table 8.1, 8.2 and 8.3.

Table 8.1: Model statistics

Equation	R-sq	Chi2	p>chi2
LnY	0.2943	21.6821	0.3580
LnOIV	0.4529	43.0426	0.0020
LnEX	0.2899	21.2341	0.3835
LnQM	0.3020	22.4964	0.3142
LnIr	0.5143	55.0612	0.0000
LnDEP	0.5433	61.8657	0.0000

Source: Author's own computation

Table 8.2 presents the short-run coefficients of the model and the adjustment parameter. The adjustment parameter is negative and statistically significant, which is consistent with economic theory. Exchange rate (LnEX) is the only variable that had a negative and statistically significant effect on oil import volatility in the short-run.

Table 8.2: Short-run coefficients

	Coefficients	Std. Error	Z	$p > \|z\|$
Adjustment parameter	-0.0746	0.0327	-2.28	0.022
LnOIV	-0.0865	0.1230	-0.70	0.482
LnIOP	-0.0798	0.3172	-0.25	0.801
LnEX	-3.2034	1.0537	-3.04	0.002
LnOPOP	2.5259	3.4217	0.74	0.460
LnDEP	0.7980	1.5469	0.52	0.606
LnTMI	-0.3762	0.6431	-0.58	0.559
LnTV	-0.1172	0.3911	-0.30	0.765
LnY	0.0347	0.1151	0.30	0.763
Constant	0.0798	0.0541	1.48	0.140

Source: Author's own computation

The long-run coefficients of the model (equation 9) are presented in table 8.3. Johansen and Juselius (1995) assert that the first co-integrating vector is the most important when analyzing the long-run relationships between variables. Since there was only one co-integrating vector, the results were normalized on oil import volatility (LnOIV). International oil prices (LnIOP) and OPEC oil production volume (LnOPOP) had negative and statistically significant relationships with oil import volatility. Total manufacturing index (LnTMI), traffic volume (LnTV), and GDP growth (LnY) had positive and statistically significant effect on oil import volatility. However, domestic energy production had a negative but statistically insignificant relationship with oil import volatility in the long-run.

Table 8.3: Long run-coefficients

Co-integrating equation/ vector		Chi2		p>chi2
LnOIV		63.82198		0.0000
Identification: beta is exactly identified Johansen normalization restriction imposed				
Beta	Coefficient	Std. error	z	P > |z|
LnOIV	1			
LnIOP	-2.4146	0.6140	-3.93	0.000
LnEX	4.7679	1.8537	2.57	0.010
LnOPOP	-7.4023	4.1501	-1.78	0.074
LnDEP	-3.1167	3.7929	-0.82	0.411
LnTMI	2.5482	1.1294	2.26	0.024
LnTV	3.1729	1.2616	2.52	0.012
LnY	2.4374	0.3757	6.49	0.000
Constant	31.3614			

Source: Author's own computation

4.3.2 The Second Co-integration Test

Effect of Oil Import Volatility on Economic Growth

In the second co-integration test, the variables included in equation 6 were GDP growth, oil import volatility, exchange rate, quantity of money in circulation, interest rate, and domestic energy production. The appropriate lag length for equation 7 was determined to be 4 lags based on the LR information criteria.

Co-integrating Vectors

Table 9 presents the results of the co-integration tests. The test identified one co-integrating vector at the 5% level of significance. This suggested that there was a long-run relationship between GDP growth and oil import volatility, exchange rate, quantity of money in circulation, interest rate and domestic energy production. Thus, it was necessary to estimate the long-run relationship using the VECM (equation 9).

Table 9: Co-integrating vectors

Maximum rank	LL	Eigenvalue	Trace statistic	5% critical value
0	320.2785	.	97.6906	94.15
1	336.4691	0.3506	65.3095*	68.52
2	349.7396	0.2980	38.7683	47.21
3	360.2990	0.2532	16.8672	29.68
4	366.2990	0.1389	5.6496	15.41
5	369.1168	0.0724	0.0139	3.76
6	369.1238	0.0002		

Source: Author's own computation

The VECM

The VECM was estimated with the assumption that the VAR had a linear trend, whereas the co-integrating equations had only an intercept. Table 12.1 summarizes the model statistics for each equation.

The short-run coefficients of the VEC model (equation 9) and the adjustment parameter are presented in table 10.1. The adjustment parameter is negative and statistically significant as expected. In the short-run, oil import had a positive and statistically significant relationship with GDP growth. Similarly, domestic energy production had a positive and statistically significant relationship with GDP growth in the short-run. However, other control variables did not have any effect on GDP growth in the short-run.

Table 10.1: Short-run coefficients

	Coefficient	Std. Error	z	□ > |□|
Adjustment parameter	-0.2900	0.1351	-2.15	0.032
LnY	0.2320	0.1569	1.48	0.139
LnOIV	0.4273	0.2002	2.13	0.033
LnEX	0.5400	1.6849	0.32	0.749
LnQM	-0.4045	0.2726	-1.48	0.138
LnIr	0.5392	1.3204	0.41	0.683
LnDEP	5.9838	1.9441	3.08	0.002
Constant	-0.0238	0.0692	-0.34	0.731

Source: Author’s own computation

The long-run coefficients of equation 9 (VECM) are presented in table 10.2. The results were normalized on GDP growth (LnY). Oil import maintained its positive effect on GDP growth in the long-run. In addition, its statistical significance improved to 1% significance level in the long-run. However, the relationship between GDP growth and domestic energy production became negative but statistically significant. Exchange rate and interest rate had positive and statistically significant relationships with GDP growth. However, the effect of quantity of money (LnQM) was negative but statistically significant in the long-run.

Table 10.2: Long run-coefficients

Co-integrating equation/ vector		Chi2		p>chi2
LnY		63.33416		0.0000
Identification: beta is exactly identified Johansen normalization restriction imposed				
Beta	Coefficient	Std. error	z	$p > \|z\|$
LnY	1	.	.	.
LnOIV	1.1023	0.1899	5.80	0.000
LnEX	3.8955	0.7642	5.10	0.000
LnQM	-0.3721	0.1358	-2.74	0.006
LnIr	1.0809	0.4313	2.51	0.012
LnDEP	-1.3281	0.5144	-2.58	0.010
Constant	-16.6639			

Source: Author's own computation

4.4 Post Estimation Tests

4.4.1 Serial Correlation Test

The presence of serial correlation in the residuals of the VECM was tested using the Lagranger-multiplier test. Table 11.1 shows the results of the test in the VECM with the variables in equation 3. The results show that the null hypothesis of no serial correlation was accepted at all significance levels. Table 11.2 shows the results of the test in the VECM with the variables in equation 4. The results show no serial correlation in the residuals of the VECM. These results indicate that the correct lag length was selected for the VAR.

Table 11.1: Lagrange-multiplier test

Lag	Chi2	Df	Prob>chi2
1	55.8181	64	0.75707
2	56.3334	64	0.74124

Source: Author's own computation

Table 11.2: Lagrange-multiplier test

Lag	Chi2	Df	Prob>chi2
1	34.5594	36	0.53711
2	36.1732	36	0.46056
3	38.6118	36	0.35239
4	42.0045	36	0.22682

Source: Author's own computation

4.4.2 Stability Test

The stability of the VECM was tested by calculating and plotting the eigenvalues of the companion matrix. The results are reported in table 12.1 and 12.2, as well as, figure 3.1 and 3.2 in the appendix. Table 12.1 shows the eigenvalues and the moduli of the model with the variables in equation 3. There were 7 unit eigenvalues and moduli since the model had 8 variables and 1 co-integrating vector. Clearly, the remaining moduli are less than 1. This is confirmed by figure 3.1, which shows that all the remaining eigenvalues are within the unit circle. Table 12.2 presents the eigenvalues and the moduli of the model with the variables in equation 4. In this case, there were 5 unit eigenvalues and moduli. Table 12.2 shows that the remaining moduli are less than one, whereas figure 3.2 shows that the remaining eigenvalues are within the unit circle. This means that the model was stable and; thus, there was no misspecification error.

Table 12.1: Stability test

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
1	1
1	1
1	1
1	1
.7287227 + .1438789*i*	.742791
.7287227 - .1438789*i*	.742791
.4132695 + .503368*i*	.651284
.4132695 - .503368*i*	.651284
-.196999 + .222977*i*	.297535
-.196999 - .222977*i*	.297535
.2330253	.233025
.06855825 + .20443*i*	.21562
.06855825 - .20443*i*	.21562

The VECM specification imposes 7 unit moduli

Table 12.2: Stability test

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
1	1
1	1
.508268 + .5669491*i*	.761425
.508268 - .5669491*i*	.761425
.5571438 + .5189419*i*	.761387
.5571438 - .5189419*i*	.761387
.7337006	.733701
-.4569875 + .5483684*i*	.713825
-.4569875 - .5483684*i*	.713825
.5825391 + .3188465*i*	.66409
.5825391 - .3188465*i*	.66409
-.5898853	.589885
-.1984034 + .4934767*i*	.531868
-.1984034 - .4934767*i*	.531868
.1532343 + .4616987*i*	.486463
.1532343 - .4616987*i*	.486463
-.3463443 + .2968307*i*	.456139
-.3463443 - .2968307*i*	.456139
-.2349072 + .3452628*i*	.417598
-.2349072 - .3452628*i*	.417598
.1151968	.115197

The VECM specification imposes 5 unit moduli

Source: Author’s own computation

CHAPTER FIVE

DISCUSSION

5.1 Determinants of Oil Import Volatility

In the model used to estimate the determinants of oil import volatility, the adjustment parameter was -0.0746. The negative sign and statistical significance of this parameter means that oil import volatility, measured by changes in the value of crude oil imports reverts to its long-run equilibrium following a destabilizing shock in the short-run. Specifically, any deviation from the equilibrium will be corrected at a rate of 7.46% per quarter. This is a relatively slow rate and suggests that the country is vulnerable to oil shocks (Marbuah, 2013).

The negative and statistically significant relationship between exchange rate and oil import volatility is consistent with a priori expectation and economic theory. A depreciation of Kenya's currency against the US dollar makes oil imports to be more expensive and vice versa. Thus, a depreciation of the exchange rate is likely to reduce the volume of oil imports in the short-run. This result is consistent with the findings of Alun, Muhleisen, and Pant (2011) and Marbuah (2013) who found that exchange rate determined oil import volatility in OECD countries and Ghana respectively.

The negative and statistically insignificant effect of international oil price on oil import volatility is consistent with the findings of Zhao and Wu (2009) and Marbuah (2013) who found that international oil prices had no effect on oil import volatility in China and Ghana respectively. However, the finding is inconsistent with Suleiman (2013) who showed that international oil price was a significant determinant of oil import volatility in North America and Europe. A possible explanation of the negative and statistically insignificant relationship is that Kenya lacks adequate alternative energy sources. Thus, prices changes in the short run are not likely to affect its level of oil imports. Overall, only exchange rate has a statistically significant effect on oil imports volatility in the short-run. The remaining variables with the exception of domestic energy production affect oil import volatility in the long-run.

In the long-run, international oil prices have a negative and statistically significant relationship with oil import volatility. This finding is consistent with a priori expectation and the findings of Alun, Muhleisen, and Pant (2011) and Nnadikwe (2008). One of the explanations of the finding is that high international oil prices are likely to make production using oil very expensive in the long-run. As a result, the government of Kenya is likely to exploit alternative energy sources such as geothermal power to reduce the cost of production, thereby reducing oil imports.

The positive and statistically significant relationship between the exchange rate and oil import volatility is inconsistent with a priori expectation. Indeed, Schryder and Peersman (2012) showed that an appreciation of the US dollar led to a significant decline in oil imports in OECD and non-OECD countries that do not use the dollar for local transactions. Additionally, Trehan (1986) found that an appreciation of the US dollar led to a decline in oil prices, thereby increasing the demand for oil in the US. However, the positive relationship is not surprising for Kenya because a depreciation of the exchange rate improves foreign exchange earnings from agricultural exports. The resulting increase in production and foreign exchange reserves is likely to increase oil imports in the long run.

OPEC oil production has a negative and statistically significant relationship with oil import volatility in the long-run. This finding confirms those of Metcalf and Wolfram (2010) and Alun, Muhleisen, and Pant (2011). The finding can be attributed to the fact that increased oil production by the OPEC countries often reduces international oil prices. This is likely to cause a reduction in the value of oil imports in Kenya ceteris paribus.

Domestic energy production, proxied by locally produced electricity, had a negative relationship with oil import volatility. This conforms to a priori expectation and the findings of Zhao and Wu (2009) who found a similar result in China. One of the explanations of the negative relationship is that increased domestic energy production is expected to reduce Kenya's reliance on imported oil. The insignificance of the relationship is not surprising since Kenya's installed electricity generation capacity cannot meet the existing energy demand. Thus, only a significantly large increase in electricity generation capacity is likely to have a substitution effect in the energy market.

The positive and statistically significant relationship between the manufacturing index and oil import volatility is consistent with economic theory. An increase in the manufacturing index is an indication of increased production in the economy. Generally, increased production is expected to increase the demand for oil, which is the main source of energy in Kenya. Eksi, Izgi, and Senturk (2011) also found that an increase in economic activity, proxied by the industrial production index, led to an increase in oil import volatility in France.

As expected, the traffic volume proxied by the number of newly registered vehicles had a positive and statistically significant effect on oil import volatility. The finding underscores the heavy reliance on petroleum products in Kenya's transport sector. Zhao and Wu (2009) also found that an increase in traffic volume was an important determinant of oil import volatility in China.

The positive and statistically significant relationship between GDP growth and oil import volatility is to be expected. Apart from the manufacturing and transport sectors, other sectors of the economy also depend on oil, which is often used to generate electricity, especially during the dry seasons. Metcalf and Wolfram (2010) and Suleiman (2013) also found that economic growth was a determinant of oil import volatility in the OECDs and North America respectively.

5.2 Effects of Oil Import Volatility on Economic Growth

In equation 4, oil import volatility was the most important variable since the rest were used as control variables. The negative and statistically significant adjustment parameter means that GDP growth reverts to its long-run equilibrium after a destabilizing shock attributed to oil import volatility and other variables in the short-run. The GDP adjusts rapidly at the rate of 29% per quarter to its long-run equilibrium. In line with a priori expectation, oil import volatility has a short run positive and statistically significant relationship with GDP growth. This means that a significant decrease in oil importation due to factors such as high prices is likely to cause a decline in economic growth, ceteris paribus. The finding supports those of Kotut, Menjo, and Jepkwony (2012) and Rodriguez and Sanchez (2004) who found similar results in Kenya and G-7 countries respectively.

Apart from oil import volatility, domestic energy production had positive and statistically significant relationship with GDP growth as was expected. This finding suggests that producers in Kenya consider domestic energy production, measured by electricity generation, and oil imports as supplement rather than substitute energy sources in the short-run.

In the long-run, all variables included in the model had a statistically significant relationship with GDP growth. The coefficient of the oil import volatility maintained its positive sign. Additionally, it became statistically significant at 1% rather than the 5% significance level as was the case in the short-run. This suggests that the effect of oil import volatility is stronger in the long-run than in the short-run. Aktas and Yilmaz (2008) and Lim, Seul-Yu, and Yoo (2013) also found that oil import/ consumption was a significant determinant of economic growth in Turkey and the Philippines respectively.

Unlike the short run, domestic energy (electricity) production had a negative relationship with economic growth. This suggests that producers consider electricity and oil to be substitutes in the long-run. The negative relationship could be explained by the high cost of generating and purchasing electricity in Kenya. For instance, cement and steel producers cite high electricity costs as one of their major challenges, whereas Tata Chemicals Magadi closed its factory in 2014 due to unsustainable electricity costs. In this respect, producers are likely to substitute electricity with oil in the long-run to reduce costs. Companies that are not able to find cheaper energy sources are likely to scale down their operations, thereby reducing economic growth.

The exchange rate has a positive relationship with GDP growth in the long-run. This finding supports those of Rapetti, Skott, and Razmi (2011) and Rodrik (2008). The relationship could be explained by the fact that a depreciation of the exchange rate is likely to spur economic growth through improved export earnings. The negative relationship between the quantity of money and GDP is consistent with economic theory. Specifically, increased supply of money is likely to discourage economic growth in the long-run by causing high inflation. The positive relationship between interest rate and GDP growth is inconsistent with a priori expectation. However, it supports the findings of Fry (1995) and Galbis (1995). A possible explanation of the relationship is that high interest rates could lead to low inflation. In addition, banks are likely to offer high deposit interest rates to access funds for issuing loans when the CBR rate is high. The resulting increase in savings coupled with low inflation is likely to spur economic growth in the long-run.

5.3 Conclusions

The objective of this study was to determine the long-run and short-run causes of oil import volatility, as well as, the effect of the volatility on economic growth. The result shows that the oil market in Kenya is vulnerable to shocks that affect the supply of crude oil since it corrects to its long-run equilibrium at a very slow pace (7.47% per quarter). Exchange rate was the only variable that had a significant effect on oil import volatility in the short-run. However, oil import volatility was explained by several variables in the long-run. Specifically, exchange rate, traffic volume, total manufacturing index, and GDP growth had positive and statistically significant effect on oil import volatility. On the other hand, OPEC oil production had a negative relationship with oil import volatility. However, domestic energy production did not have a statistically significant effect on oil import volatility in the long-run.

The study also showed that oil import volatility had a significant effect on GDP growth in both the short-run and the long-run. However, the effect seemed to be stronger in the long-run rather than the short-run. Generally, an increase in oil import led to increased economic growth and vice versa. Other important determinants of GDP growth included exchange rate, quantity of money, domestic energy production, and interest rate.

5.4 Policy Recommendations

Given the results discussed in the foregoing paragraphs, the following recommendations should be considered to stabilize oil import volatility. First, the government should focus on stabilizing the exchange rate. A stable exchange rate will prevent significant fluctuation of the oil import bill attributed to unexpected changes in the exchange rate.

Second, the government should increase domestic energy production in order to reduce its reliance on imported oil. This should involve increased production of cheap and reliable energy such as solar, wind, coal, and geothermal energy. In addition, the recently discovered oil wells should be exploited to meet the country’s oil demand. Generally, increased domestic energy production is likely to reduce oil imports, thereby promoting economic growth through a stable supply of cheap energy.

Third, oil production in the OPEC countries has a significant effect on oil import volatility in Kenya. Thus, the country should diversify its oil import sources to prevent significant volatilities that might arise due to OPEC’s production decisions. For instance, diversifying oil import sources can help to prevent oil price shocks that often occur when OPEC reduces its output level.

Finally, the government should counter the negative effect of international oil prices by negotiating bilateral trade agreements with major oil producing countries. This will enable the country to access reliable supply of oil at favorable prices.

This study can be extended in future by analyzing the determinants of oil import volatility using a different methodology or econometric framework. Future studies can also include more variables to shed more light on the factors that determine oil import volatility in Kenya.

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APPENDIX

Figure 2.1: Interest rate trend

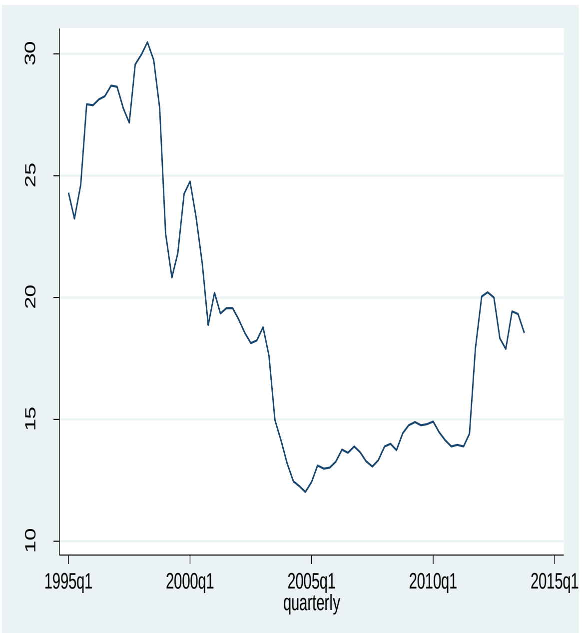


Figure 2.2: GDP trend

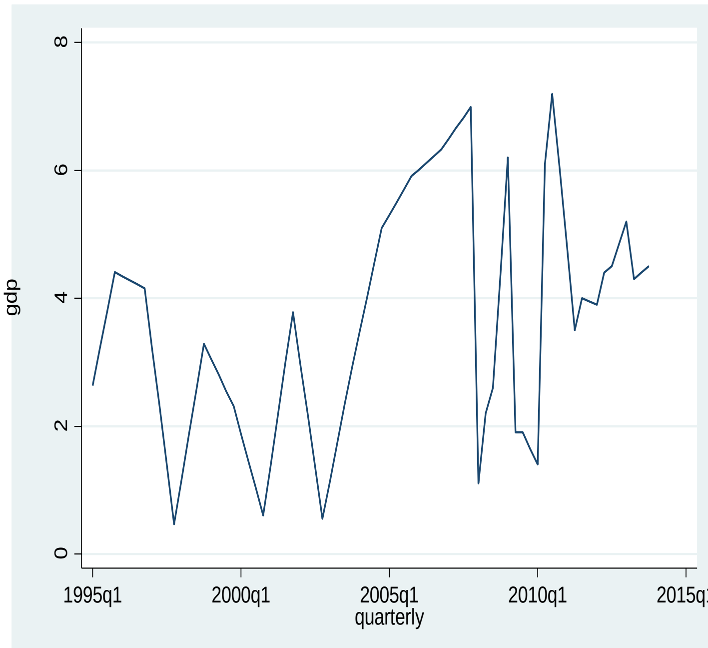


Figure 2.3: Exchange rate trend

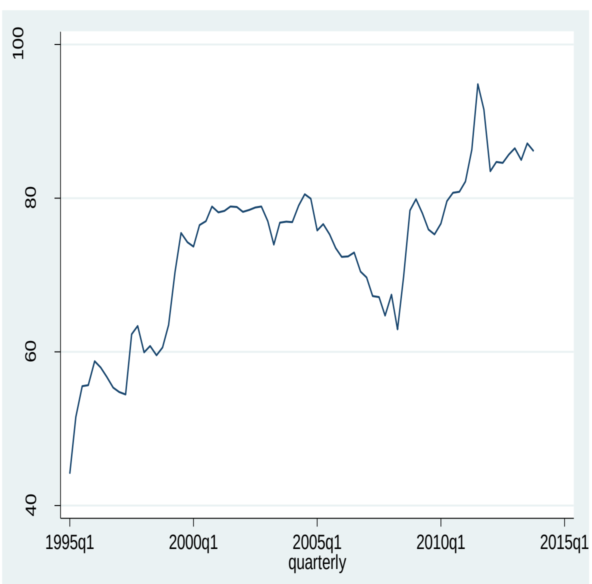


Figure 2.4: Oil production trend

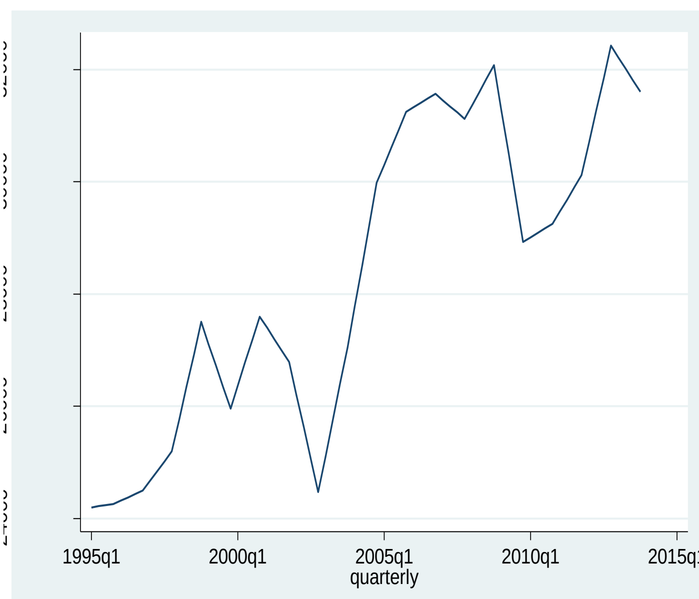


Figure 2.5: Oil price trend

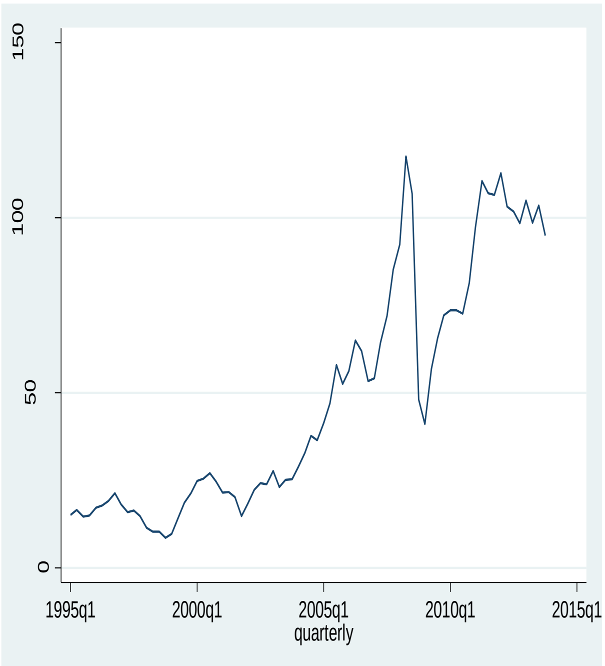


Figure 2.6: Domestic energy production

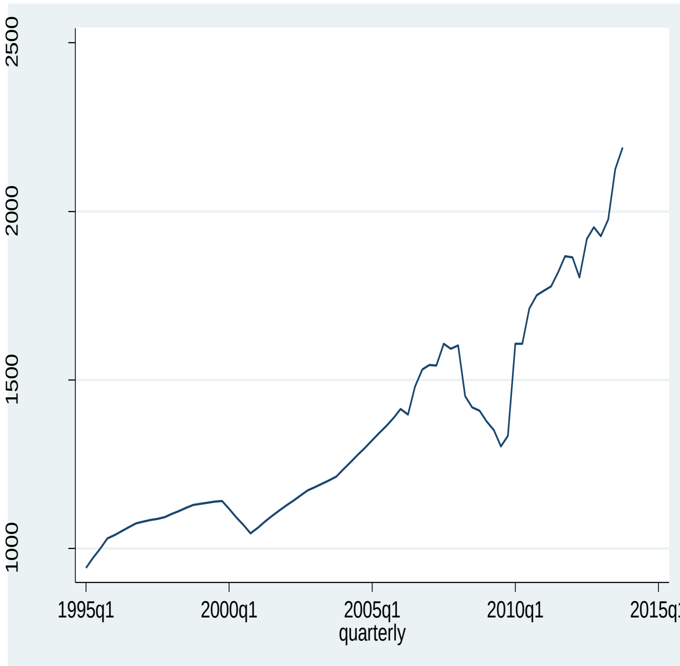


Figure 2.7: M2 trend

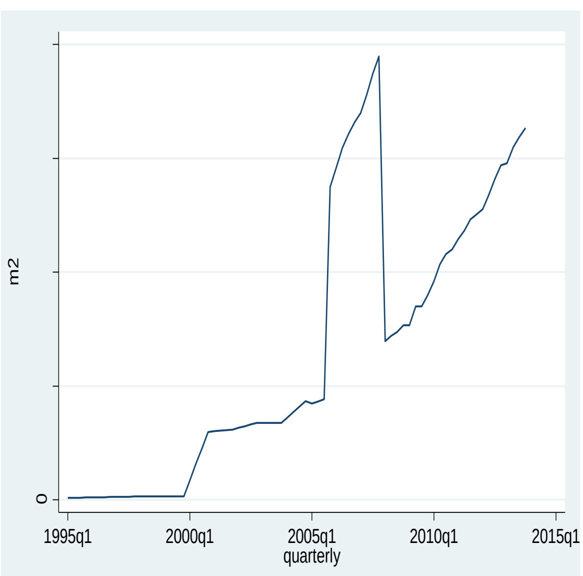


Figure 2.8: Traffic Volume trend

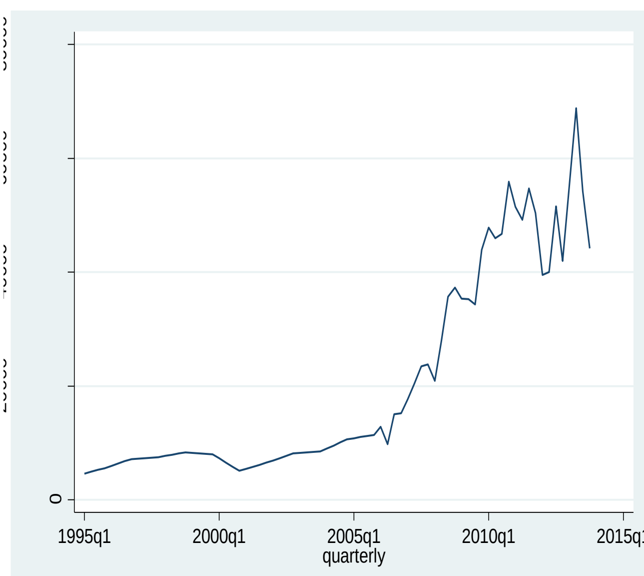


Figure 2.9: Crude oil import trend

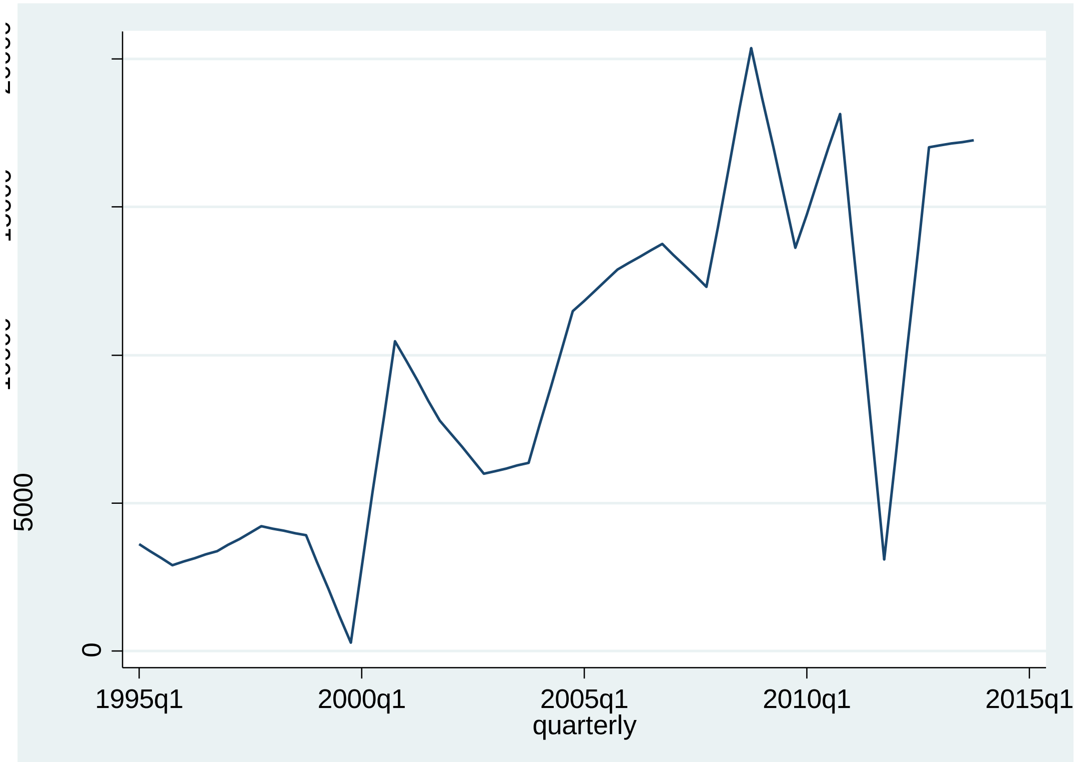


Figure 4.1: Stability test

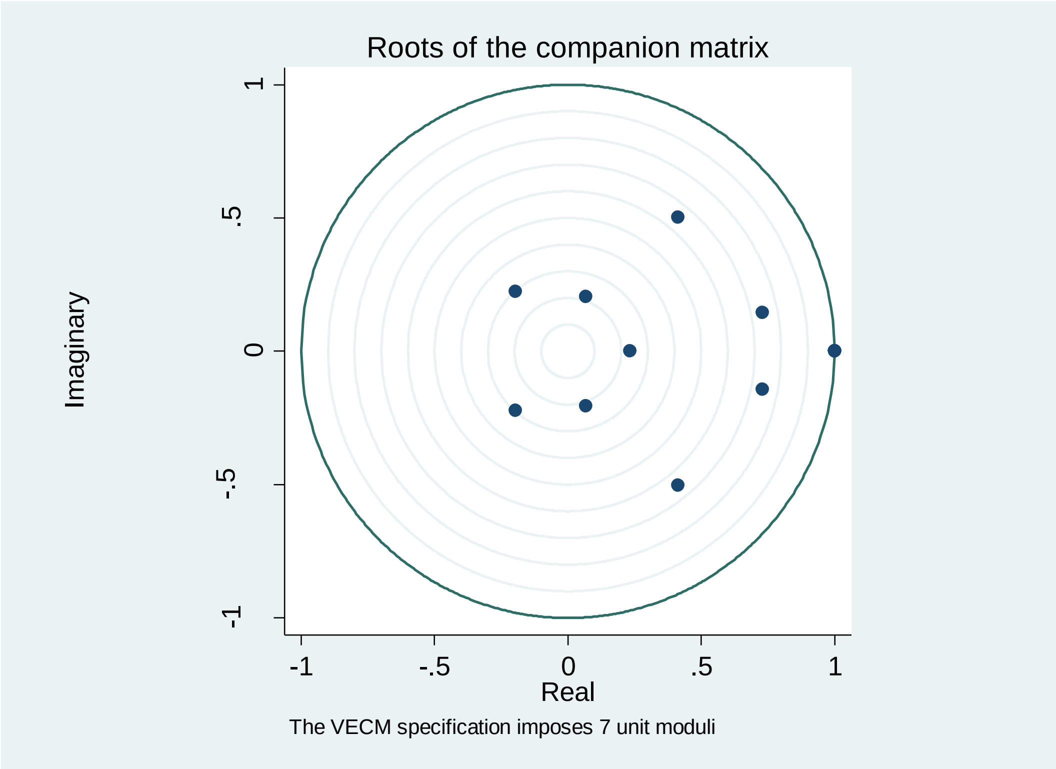
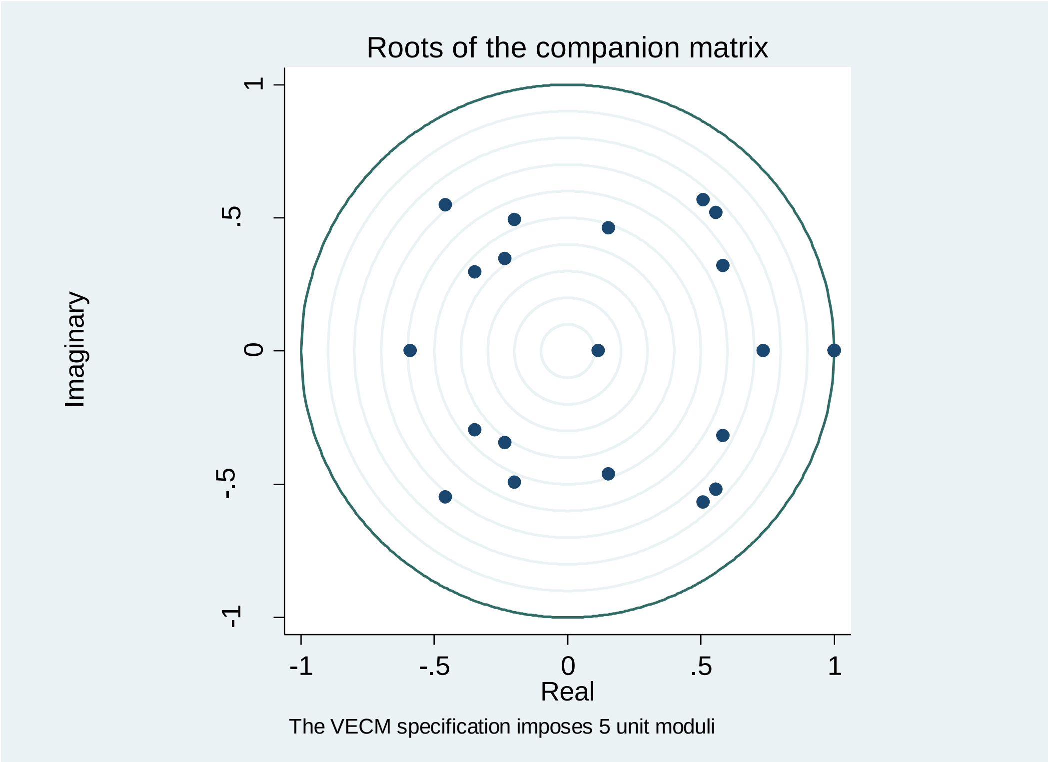


Figure 4.2: Stability test



DATA

Year	Intr. rate	GDP	Exch. rate	Oil Prod.	Oil Price	Manf. Index	Elect. Prod.	Traffic vol.	Oil Imports	M2
1995 Mar	24.3	2.6	44.2	24199.6	15.1	254.6	942.3	4607	3601.9	8136.3
1995 June	23.2	3.2	51.5	24219.7	16.6	257.7	971.3	4923	3367.3	8633.9
1995 Sep	24.6	3.8	55.5	24239.9	14.7	260.8	1000.3	5240	3132.7	9131.5
1995 Dec	27.9	4.4	55.7	24260.0	15.0	263.9	1029.3	5556	2898.1	9629.2
1996 Mar	27.9	4.3	58.8	24319.9	17.2	266.1	1040.4	5959	3017.6	10201.5
1996 June	28.1	4.3	58.0	24379.8	17.9	268.4	1051.6	6361	3137.1	10773.7
1996 Sep	28.3	4.2	56.8	24439.7	19.1	270.6	1062.8	6764	3256.5	11346.0
1996 Dec	28.7	4.2	55.4	24499.6	21.3	272.9	1074.0	7166	3376.0	11918.3
1997 Mar	28.7	3.2	54.8	24673.9	18.2	274.2	1078.8	7243	3583.6	12411.3
1997 June	27.8	2.3	54.5	24848.2	15.9	275.5	1083.6	7320	3791.1	12904.4
1997 Sep	27.2	1.4	62.3	25022.5	16.4	276.8	1088.4	7397	3998.7	13397.5
1997 Dec	29.6	0.5	63.4	25196.8	14.9	278.1	1093.3	7474	4206.3	13890.5
1998 Mar	30.0	1.2	60.0	25773.6	11.5	279.4	1102.2	7690	4131.4	13974.3
1998 June	30.5	1.9	60.8	26350.5	10.3	280.8	1111.1	7906	4056.6	14058.0
1998 Sep	29.7	2.6	59.5	26927.3	10.3	282.1	1120.1	8121	3981.7	14141.8
1998 Dec	27.8	3.3	60.6	27504.2	8.6	283.4	1129.0	8337	3906.9	14225.5
1999 Mar	22.6	3.0	63.5	27117.1	9.7	283.1	1132.1	8257	3000.0	14363.1
1999 June	20.8	2.8	70.4	26730.0	14.3	282.8	1135.3	8177	2093.1	14500.6

Year	Intr. rate	GDP	Exch. rate	Oil Prod.	Oil Price	Manf . Index	Elect. Prod.	Traffic vol.	Oil Imports	M2
1999 Sep	21.8	2.6	75.5	26342.8	18.7	282.5	1138.4	8096	1186.3	14638.1
1999 Dec	24.3	2.3	74.3	25955.7	21.4	282.2	1141.5	8016	279.4	14775.7
2000 Mar	24.8	1.9	73.7	26367.0	24.9	282.0	1117.3	7277	2828.8	85549.8
2000 June	23.3	1.5	76.5	26778.2	25.5	281.8	1093.1	6538	5378.1	156323.8
2000 Sep	21.4	1.0	77.1	27189.5	27.1	281.6	1068.9	5798	7927.5	227097.9
2000 Dec	18.9	0.6	78.9	27600.8	24.7	281.4	1044.8	5059	10476.8	297872.0
2001 Mar	20.2	1.4	78.2	27399.1	21.5	281.8	1061.8	5421	9806.3	300587.8
2001 June	19.3	2.2	78.4	27197.5	21.7	282.3	1078.9	5783	9135.8	303303.5
2001 Sep	19.6	3.0	78.9	26995.8	20.2	282.7	1096.0	6144	8465.3	306019.3
2001 Dec	19.6	3.8	78.9	26794.1	14.8	283.1	1113.0	6506	7794.8	308735.0
2002 Mar	19.1	3.0	78.3	26213.1	18.3	284.0	1127.6	6920	7342.3	316112.3
2002 June	18.5	2.2	78.5	25632.0	22.3	284.9	1142.2	7333	6889.9	323489.5
2002 Sep	18.1	1.4	78.8	25051.0	24.2	285.7	1156.8	7747	6437.4	330866.8
2002 Dec	18.2	0.6	78.9	24469.9	23.9	286.6	1171.5	8160	5985.0	338244.0
2003 Mar	18.8	1.1	77.0	25114.5	27.7	287.6	1181.8	8240	6077.2	338272.3
2003 June	17.6	1.7	73.9	25759.1	23.2	288.6	1192.2	8320	6169.4	338300.5
2003 Sep	15.0	2.3	76.8	26403.6	25.2	289.6	1202.5	8399	6261.6	338328.8
2003 Dec	14.1	2.9	77.0	27048.2	25.3	290.6	1212.9	8479	6353.9	338357.0
2004 Mar	13.2	3.5	76.9	27781.8	28.9	295.5	1234.3	9015	7637.5	361909.5
2004 June	12.5	4.0	79.1	28515.3	32.8	300.3	1255.8	9550	8921.1	385462.0

Year	Intr. rate	GDP	Exch. rate	Oil Prod.	Oil Price	Manf . Index	Elect. Prod.	Traffic vol.	Oil Imports	M2
2004 Sep	12.3	4.6	80.5	29248.9	37.8	305.2	1277.2	10086	10204.8	409014.5
2004 Dec	12.0	5.1	80.0	29982.4	36.5	310.0	1298.6	10621	11488.4	432567.0
2005 Mar	12.4	5.3	75.8	30298.4	41.4	316.0	1320.7	10819	11836.8	422568.0
2005 June	13.1	5.5	76.6	30614.4	47.0	322.1	1342.7	11017	12185.3	430193.0
2005 Sep	13.0	5.7	75.3	30930.4	58.0	328.1	1364.7	11215	12533.7	441776.0
2005 Dec	13.0	5.9	73.5	31246.4	52.6	334.1	1386.8	11413	12882.2	1373730.0
2006 Mar	13.3	6.0	72.4	31326.2	56.3	339.0	1414.3	12850	13100.1	1458060.0
2006 June	13.8	6.1	72.4	31406.0	65.0	343.8	1397.8	9730	13318.0	1547296.0
2006 Sep	13.6	6.2	73.0	31485.8	62.0	348.7	1479.3	15062	13536.0	1606655.0
2006 Dec	13.9	6.3	70.5	31565.6	53.4	353.5	1530.8	15175	13753.9	1658878.0
2007 Mar	13.7	6.5	69.7	31455.1	54.2	360.5	1544.5	17704	13393.0	1700107.0
2007 June	13.3	6.7	67.3	31344.5	64.4	367.5	1543.3	20376	13032.1	1777285.0
2007 Sep	13.1	6.8	67.2	31234.0	72.1	374.5	1607.1	23484	12671.1	1872767.0
2007 Dec	13.3	7.0	64.7	31123.4	85.3	381.5	1593.0	23760	12310.2	1947568.0
2008 Mar	13.9	1.1	67.5	31361.4	92.4	310.0	1603.0	20865	14323.5	697142.0
2008 June	14.0	2.2	63.0	31599.4	117.6	238.4	1451.2	27976	16336.7	719309.0
2008 Sep	13.7	2.6	69.8	31837.4	106.8	166.9	1419.5	35665	18350.0	736464.0
2008 Dec	14.4	4.4	78.4	32075.4	48.1	95.3	1408.1	37325	20363.2	766471.0
2009 Mar	14.8	6.2	79.9	31288.3	41.0	96.5	1376.9	35324	18678.4	766482.0
2009 June	14.9	1.9	78.1	30501.2	56.8	97.7	1350.0	35249	16993.5	849100.0

Year	Intr. rate	GDP	Exch. rate	Oil Prod.	Oil Price	Manf. Index	Elect. Prod.	Traffic vol.	Oil Imports	M2
2009 Sep	14.8	1.9	75.9	29714.2	65.6	98.8	1302.4	34353	15308.7	849209.0
2009 Dec	14.8	1.7	75.3	28927.1	72.2	100.0	1334.9	43900	13623.9	898099.0
2010 Mar	14.9	1.4	76.7	29007.7	73.7	101.7	1607.6	47838	14755.3	959005.0
2010 June	14.5	6.1	79.6	29088.3	73.6	103.5	1607.6	45950	15886.7	1033704.0
2010 Sep	14.2	7.2	80.7	29168.8	72.6	105.2	1712.2	46763	17018.1	1078452.0
2010 Dec	13.9	6.0	80.8	29249.4	81.4	106.9	1751.9	55898	18149.5	1100299.0
2011 Mar	14.0	4.8	82.2	29467.3	97.3	107.7	1764.1	51492	14387.4	1145003.0
2011 June	13.9	3.5	86.3	29685.3	110.6	108.5	1777.8	49221	10625.3	1183864.0
2011 Sep	14.4	4.0	94.9	29903.2	107.0	109.2	1819.0	54727	6863.2	1232807.0
2011 Dec	17.9	4.0	91.5	30121.2	106.6	110.0	1866.2	50401	3101.0	1253958.0
2012 Mar	20.1	3.9	83.5	30697.0	112.8	109.9	1863.1	39489	6581.2	1276403.0
2012 June	20.2	4.4	84.8	31272.9	103.3	109.8	1804.8	40000	10061.3	1339072.0
2012 Sep	20.0	4.5	84.6	31848.8	101.8	109.6	1918.3	51550	13541.4	1409368.0
2012 Dec	18.3	4.8	85.7	32424.7	98.4	109.5	1953.4	42005	17021.5	1469037.0
2013 Mar	17.9	5.2	86.5	32219.5	105.0	109.6	1926.8	54986	17081.4	1477677.0
2013 June	19.4	4.3	85.0	32014.2	98.6	109.8	1976.5	68800	17141.4	1547882.0
2013 Sep	19.3	4.4	87.2	31809.0	103.5	109.9	2124.8	54196	17201.3	1593396.0
2013 Dec	18.5	4.5	86.2	31603.8	95.0	110.0	2188.8	44196	17261.3	1632845.0