TRANSMISSION CHANNELS OF CRUDE OIL PRICE SHOCKS ON KENYA'S ECONOMY

GACHARA PETER MAINA

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF ECONOMIC THEORY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ECONOMICS (POLICY AND MANAGEMENT) OF KENYATTA UNIVERSITY.

NOVEMBER, 2015

DECLARATION

This research project is my original work and has not been presented in any other university for any other award.

Signature…… Date……

Gachara Peter Maina

B.ED (Arts) (Ergerton University)

K102/26316/2013

This project has been submitted to the department of Economic Theory with our approval as the university supervisors.

Signature…… Date……

Kennedy Nyabuto Ocharo (PhD)

Lecturer, Department of Economic Theory

Kenyatta University

Signature…… Date……

Julius Korir (PhD)

Lecturer, Department of Economic Theory

Kenyatta University

DEDICATION

To my dear wife Naomi and our lovely kids: Nelly & Edwin.

ACKNOWLEDGEMENTS

I sincerely thank Dr. Kennedy Nyabuto Ocharo and Dr. Julius Korir for their invaluable assistance and insights in the writing of this research project. My gratitude also go to other lecturers in the School of Economics for their constructive criticism which enhanced this project.

The School of Economics Kenyatta University has provided an excellent environment for my research. I spent many enjoyable hours with department members and fellow students in the Masters class. It is this rich environment that aided my ideas to come to fruition.

To my mother Esther, who sacrificed so much to see her children get the best education, no words can explain how grateful I am. Finally to my wonderful wife Naomi, thank you for standing by me throughout the journey, for encouraging me and for giving me the strength to reach higher.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
BP	British Petroleum
CPI	Consumer price Index
ERC	Energy Regulatory Commission
GDP	Gross Domestic Product
GNP	Gross National Product
IMF	International Monetary Fund
NOCK	National Oil Company of Kenya
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
S.D	Standard Deviation
SVAR	Structural Vector Autoregressive
USD	United States' Dollars
VAR	Vector Autoregressive

OPERATIONAL DEFINITION OF TERMS

*Gross domestic product***:** the value of all goods and services produced in a country over a period of one year regardless of whether they were produced by foreigners or residents.

*Gross national product***:** value of all goods and services produced by citizens of a country within or without the country's borders.

*Cointegration***:** Existence of long run relationship between variables.

Money supply: total quantity of money in circulation in a given country's economy at a given time.

*Real exchange rates***:** Relative price of domestic currency with respect to foreign currency while considering the differentials among countries.

ABSTRACT

Achieving a high and stable economic growth is one of the main objectives of any state but oil price fluctuations and its impact on inflation, exchange rate and on other macroeconomic variables may cause difficulties in attaining this goal. This study investigated empirically the channels through which oil price shocks affect economic activity in Kenya. Following existing literature, the study focused on five macroeconomic variables: real exchange rate, inflation, money supply, real GDP growth and international price of crude oil. Existing quarterly data from the first quarter of 1991 to the last quarter of 2014 were used in the analysis on the basis of the Structural VAR approach. Granger causality tests found no causality between crude oil prices and any of the four macroeconomic variables. The study found that there exist a bi-directional causality between real exchange rate and inflation in Kenya. There also exists a unidirectional causality from inflation to real GDP and from real GDP to real exchange rate. The study found that crude oil price shocks have a significant effect on Kenya's macroeconomic performance. Following an oil price shock, the Kenyan shilling depreciates with the shock contributing 2.16 percent of real exchange rate volatility in the first four quarters. This contribution however rises gradually to 2.34 percent over a three-year horizon. Oil price shocks explain a relatively small portion of less than one percent of forecast error variance in the domestic price level both in the short run and long run. Money supply exhibits an immediate and sustained negative reaction to the shock which peaks in the sixth quarter after the shock but does not die out even in the longer horizon. Finally, the study found that oil price shocks have a negative and significant effect on real GDP growth with the impact being persistent over the longer horizon. Results suggest a moderate, negative response of real GDP growth in the first three quarters. The contribution of oil shocks to variations on GDP growth gradually rises from zero in the first quarter with the largest impact of the shock being felt in the 8^{th} quarter after the shock after which domestic output growth starts to recover. Over the 12-quarter period, an oil price shock contributes 3.46 percent of variations in Kenya's real GDP. Finally, the study identified real exchange rate and money supply as the most important sources of disturbances in Kenya following an oil price shock. Given the findings of the study, the government's main focus should be to stabilize the exchange rate and implementation of policies that encourage development and use of alternative sources of energy.

CHAPTER ONE

INTRODUCTION

1.1 Background

One of the most significant technological advancements made during the industrial revolution in the 19th century was the invention of the internal combustion engine (Painter, 1986). To operate, the engine uses petroleum, coal or natural gas. Internal combustion engines are used intensively in agriculture, transportation and manufacturing industries. As the world economies rely more on oil powered means, an upward pressure is put on the global oil demand. The disparity between oil supply and demand has had different effects on economies depending on whether it is a net oil-exporting or net oil-importing (Feussi, 2012).

The far reaching use of oil in various sectors has propelled oil to become a significant input in the aggregate output of any given economy (Suleiman, 2013). This raises a very fundamental question: *through what channels do oil price shocks impact on economic activity in Kenya?* Having an idea on what could be magnitude of the impact of oil price shock on various macroeconomic variables would be very helpful in economic forecasting. While the main motivation behind this study was the series of oil discoveries made in Kenya between 2010 and 2014 and their policy implications once oil production is actualized, variable response to changes in world oil price formed the core interest of the study.

1.1.1 Oil Demand and Supply

Alyousef (2012) in a study of determinants of crude oil price between 1997 and 2011 identified four causes of rise in the price of crude oil: fast growing demand due to high global economic growth, declining supply from non-Oil Producing and Exporting Countries (OPEC), cartel behaviour of oil producers and speculative behaviour of financial market participants. The study however submitted that demand and supply factors are the most fundamental in determining oil price behaviour and constitute the two main channels through which oil price fluctuations influence the economy of a country

On the demand side channel, oil price changes mainly affect consumption and investment (Hamilton, 1996). An increase in the price of oil pushes up the general level of prices. Higher prices are associated with lower purchasing power of money and lower real disposable incomes and hence reduced aggregate demand (Riman, Akpan and Offiong, 2013).

As countries develop, industrialization and higher living standards increase their demand for oil (Dunlap, Swan and Fowler, 2009). Available evidence show that oil consumption has been on the rise across the world. In 1990 world daily consumption was estimated at 66.653 thousand barrels (British Petroleum, 2014). This figure rose by 31.102% to 87,439 thousand barrels in 2010. In 2014, global oil consumption grew by 1.4 million barrels per day (or 1.4%) as compared to global oil production growth of 0.55million barrels per day (or 0.65%) (British Petroleum, 2014).

On the supply side, oil is a basic input to the production process. This implies that a rise in oil price results to an increase in firms' costs of production and consequently, lower output. Supply

of crude oil is divided into two main categories, OPEC and non-OPEC suppliers. OPEC is an intergovernmental body comprising 12 member countries that account for the greater proportion of oil production in the world. It was formed in 1970 with the primary aim of making uniform petroleum policies for its member countries, ensuring coordinated actions by members for stability of price and ensuring an efficient, economic and regular supply of petroleum to consuming nations. Although non-OPEC members produce a bigger proportion of world's oil, pricing power is mainly with OPEC members because they control 71.3% of oil reserves as per 2013 statistics (British Petroleum, 2014).

1.1.2 Kenya Oil Situation

Since early 2010, Kenya has made a series of commercial oil discoveries. These discoveries elicited overwhelming interest in oil exploration activities in Kenya and the wider East African region. These discoveries are an important milestone in Kenya's long oil and gas exploration history which began in the 1950s (National Oil Corporation of Kenya, 2012). Tullow Oil, the main oil exploration company in Kenya, projects to start producing oil by 2020 at the rate of 100,000 barrels per day against the 2013 average crude oil imports of 72,000 barrels per day (World Bank, 2014). An optimistic view is that the country might soon emerge as net oil exporter once full production activities kick into gear. These prospects have significant policy implications to Kenya which call for extensive research.

Since the early 1990s, the Kenyan economy has undergone major structural reforms in view of improving macroeconomic performance. These reforms have had a bearing on the oil sector in two main ways. First, there was deregulation of downstream petroleum market operation in 1994

which included liberalization of distribution and pricing of petroleum products. Two government bodies have since been formed in this respect: The National Oil Corporation of Kenya (NOCK) was formed with a view to breaking the cartel type of behavior of oil firms in Kenya while the Energy Regulatory Commission was formed in 2006 with the aim of controlling retail petroleum prices. It was argued that oil companies collude in their quick adjustment of retail petroleum prices upwards when international prices are rising but are slow in lowering prices when oil prices are declining (Mucheru, 2013).

1.1.3 International Oil Prices and Macroeconomic Performance

Theoretically, the immediate effect of positive oil price shocks is a resultant increase in the cost of production for oil importing countries. This is likely to decrease output, and its magnitude depends on the shape of the aggregate demand curve (Mordi and Adebiyi, 2010). Empirical evidence provides that rising oil prices reduce output and increase inflation (Hamilton, 1996). Oil price changes also affect trade and exchange rates. According to Mordi and Adebiyi (2010), oil consumption is difficult to decrease in the short-run for oil importing countries. When oil prices rise, the inelastic demand curve for oil means that the total spending on oil imports increase. This puts pressure on the exchange rate and depreciates the local currency. This depreciation, in turn, may further affect economic performance. Even if depreciation increases the aggregate demand for oil-importing countries, prices may increase due to the exchange rate pass-through and lower output may occur due to higher input costs (Berument, Cylan and Dogan, 2009).

A study by Hamilton (1983) observed that most economic recessions since the World War II in the US were preceded by a sharp rise in the price of oil pointing to a negative response of economic activity. Similar conclusions were also reached by Mork (1989), Hooker (1996) and Cologni and Manera (2008) in their studies that sought to explain the oil pass-through into cost of production, inflation and investor confidence. Another stream of evidence suggests the existence of a non-linear, asymmetric relationship in the oil price-economic growth nexus but consent that this link has been weakening with time (Hamilton, 2003; Killian, 2008 and Atil, Lahiani and Nguyen, 2014).

Fig 1.1 illustrates the relationship between crude oil prices and the Kenya's GDP for the period of study.

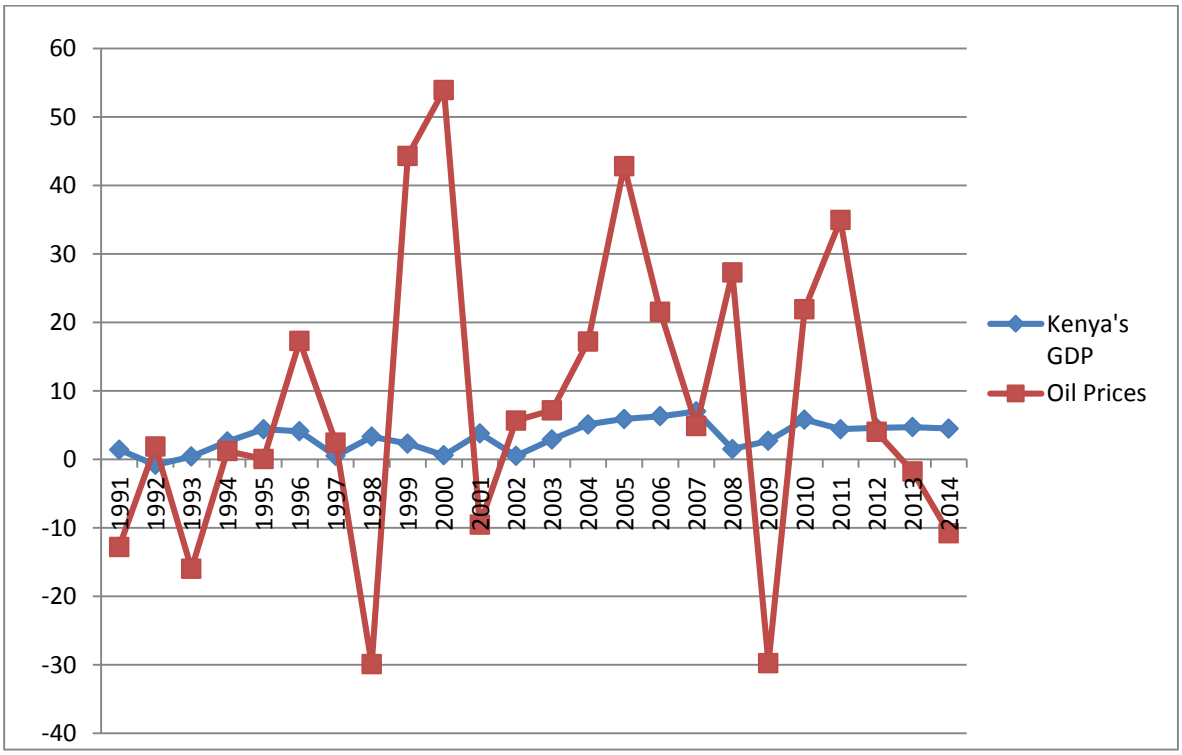


Figure1.1 Annual percentage change in crude oil price and Kenya's real GDP

Source: World Bank (2014)

From this graph there appears to exist a relationship between crude oil price and Kenya's GDP at some points in time. Similar patterns can be observed for the periods between 1991-1992, 2001-2002, 2007-2008 and 2008-2009 where sharp rises in oil prices seem to have been experienced along with declining economic performance. It is also clear from the graph that despite the consistent trend of rising oil prices between 2001 and 2005, Kenya's economy assumed an expansion path from 2002 through to 2007 when growth was interrupted by eruption of civil unrest.

The relationship between oil price and Kenya's economic performance however, cannot easily be discerned by a mere look at the graph. This begs one particular question for this study: what is the quantity measure of response of each of the macroeconomic variables to oil price changes?

1.2 Statement of the Problem

According to U.S. Energy Information Administration (2014), petroleum fuels are the most important source of energy in Kenya at 21 percent and are mainly used in the transport, commercial and industrial sectors. Although the country has recently discovered unspecified quantities of oil whose commercial value is yet to be ascertained, Kenya continues to rely entirely on imported petroleum products. In 2014, Kenya's oil import bill stood at Ksh. 333 billions and it is estimated that by 2030, petroleum consumption will have risen from the 2014 estimate of 4.2 million metric tons to 14.45 metric tons (World Bank, 2014). This situation makes the country very vulnerable to international oil prices.

A large body of literature exists focusing on the economic properties of oil, its impact on the aggregate world economy and specifically on both net oil importing and net oil exporting economies. Several authors have called into relevance the question of oil price shocks as a significant source of economic fluctuations (Mork, 1989; Cunado and de Gracia, 2003; Jimenez-Rodriguez and Sanchez, 2005 and Hamilton, 2005). On the other hand, studies on the crude oil price and macroeconomic performance for developing countries have reported varied results.

Although available studies on the oil price-growth nexus for Kenya are mainly descriptive in nature, their conclusions consent that oil demand in Kenya usually mimic economic activity, increasing during periods of expansion and contracting following internal or external shocks (Aligula, Wasike and Mutua, 2007; Kiptui, 2009; Gatuhi and Macharia, 2013; Njangiru, 2013). A study however, that identifies the various channels through which oil price shocks affect economic activity and further provides a quantitive measure of the response of each macroeconomic variable to the shock would be an important tool in developing policies that mitigate the effects of such shocks.

Owing to the fact that oil use is on the rise across all sectors of the Kenyan economy, while taking into account the likely scenario of Kenya's changing fortunes in oil production and considering the relative volatility in oil price dynamics, this study sought to analyze the effects of oil price fluctuations while tracing the possible channels of transmission of such shocks to the Kenyan economy.

1.3 Research Questions

This study sought to answer the following questions:

i. What is the effect of world crude oil price changes on Kenya's exchange rate?

ii. What is the effect of world crude oil price changes on inflation in Kenya?

iii. What is the effect of world crude oil price changes on money supply in Kenya?

iv. What is the effect of world crude oil price changes on real Gross Domestic Product in Kenya?

1.4 Research Objectives

The main objective of this study was to examine the channels through which world crude oil price shocks transmit into the Kenyan economy. The specific objectives were:

i. To estimate the effect of world crude oil price changes on Kenya's exchange rate.

ii. To estimate the effect of world crude oil price changes on inflation in Kenya.

iii. To estimate the effect of world crude oil price changes on money supply in Kenya

iv. To estimate the effect of world crude oil price changes on real Gross Domestic Product growth in Kenya.

1.5 Significance of the Study

Currently, Kenya produces zero oil output and thus depends entirely on oil imports for her uses. This situation, compounded by the relatively small size of the economy implies that Kenya is a price taker in the world oil market. This makes the country vulnerable to oil price shocks. This study is an attempt to better understand the magnitude and direction of impact of oil price shocks on economic activity in Kenya. The findings of the study will equip policy makers with the

necessary tools for developing policy responses that mitigate the adverse effects of oil price shocks.

1.6 Scope of the Study

The study covered the period starting from the first quarter of 1991 to the last quarter of 2014 which gives a total of 92 observations. The rationale for excluding the period before the 1990s was to use more standard and reliable data and to estimate GDP growths that are more closely related to the current ones. Kenya imports crude oil mainly from Dubai and India with Dubai oil imports forming 88.6 percent of 2013 total crude oil imports (World Bank, 2014). Use of Dubai oil spot prices with the exclusion of other oil import prices was a limitation of the study.

1.7 Organization of the Study

Chapter one presents an introduction to the study. Chapter Two reviews related theoretical and empirical literature while chapter three explains the methodology that was adopted in order to meet the study objectives. Chapter Four presents the results of the estimated models. Finally, chapter five presents a summary and conclusions of the study and the policy implications of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the theoretical and empirical literature on studies carried out on the relationship between oil prices and macroeconomic variables.

2.2 Theoretical Review

This sub-section introduces and describes the theories which explain the relationship between oil price and macroeconomic performance. It also reviews the transmission channels through which oil price impacts on economic activity.

2.2.1 Theory of Production and Growth

This theory was developed by Stern (2003) as a response to the failure of standard economic growth theories to give primary energy inputs an explicit role in the production process. The author observed that the mainstream theory of economic growth pays little or no attention to the role of energy or other natural resources in enabling economic growth. Land, labour and capital are regarded as the primary factors of production by mainstream economists while primary energy inputs such as oil, essential in the process, are thought of as intermediate inputs. The theory stems on the premise that gaining an understanding on the role of energy in economic growth cannot be achieved without first understanding the role of energy in production.

The theory borrows from the efficiency law of thermodynamics that holds that a minimum quantity of energy is required to transform inputs into outputs. All economic processes require

energy although some service activities may not require the direct processing of materials. Every other production process involves transformation or movement in some way. There must be limits to the substitution of energy for other factors of production.

2.2.2 The Neoclassical Growth Model.

This model was advanced by the Nobel Prize winning economist Robert Solow and Trevor Swan in 1956 within the framework of neoclassical economics. The model seeks to explain long-run economic growth using capital and labour as the two key inputs to the production process along with the requisite technological progress, A. The model assumes a Cobb-Douglas production function;

$$Y_t = A_t K_t^{\propto} L_t^{1-\propto}$$

Where Y_t is the aggregate output, K_t is the physical capital, L_t are the labour inputs, A_t is the augmenting technology and $0 \leq \alpha \leq 1$ is the elasticity of output with respect to physical capital.

The model is anchored on three basic assumptions; positive and diminishing marginal returns of factor inputs; constant returns to scale for both capital and labour and: the production function satisfies the inada conditions. The main criticism to the Solow-Swan growth model is the assumption that population growth rate is constant in the short run but yields an exponential behaviour over time. This assumption is seen to be unsustainable and unrealistic in the long run. This model takes labour and capital stock as the main inputs to the production process, giving little attention to the role of energy in the production process.

2.2.3 The Mundell-Fleming-Dornbusch Model

This model was developed by Rudiger Dornbusch in 1976 as a variant of the Mundell-Fleming model. This was at a time when the world was transiting from fixed to flexible exchange rates. The thrust of the model was the concept of exchange rate overshooting in a framework of understanding international monetary policy. The model holds that exchange rate volatility is needed to equilibrate the economy in response to monetary shocks because goods prices adjust so slowly (Rogoff, 2002).

The model is founded on two basic equations. The first equation is on the uncovered interest parity condition that holds that the home interest rate on bonds, i must be equal to the foreign interest rate i^* plus the expected rate of depreciation of exchange rate, $E_t(e_{t+1} - e_t)$.

$$i_{t+1} = i_t^* + E_t(e_{t+1} - e_t) \quad (2.1)$$

Where e is the logarithm of the exchange rate and E_t is the market expectation based on time t information. This equation is a variant of the equation, $i = i^*$ in the Mundell-Fleming model.

The second equation is the money demand equation:

$$M_t = P_t + \delta Y_t - \beta i_{t+1} \quad (2.2)$$

Where M is the money supply, P is the domestic price level and Y is the domestic output, all expressed in logarithms. Equation (2.2) posits that: demand for money is proportional to the price level; an increase in output raises transactions demand for money and that higher interest rates raise the opportunity cost of holding money.

The usefulness of the Mundell-Fleming-Dornbusch Model however, goes beyond predicting the exchange rate overshooting phenomenon. Rogoff (2002) observes that the model is a generalized framework for thinking about macroeconomic policy. When output is endogenous, the model does not necessarily predict overshooting. If a new variable say, consumption is introduced in the money demand equation, the balance tilts away from overshooting and the model can be used for a more generalized macroeconomic analysis (Rogoff, 2002). This property makes it possible for this study to adopt the model in its theoretical orientation by introducing the oil price variable into the model.

2.2.4 Oil Price Transmission Channels

Oil price fluctuations have negative repercussions on the aggregate economy as abundantly shown in literature. A rise in the price of oil results to a rise in the general price level and a reduction in output (Dornbursh, Fisher and Startz, 2001). Oil price increase leads to higher commodity prices hence lower demand for commodities which translate to a decrease in aggregate demand. The macroeconomic effects of oil price shocks are transmitted through demand and supply side channels. Figure 2.1 illustrates these channels.

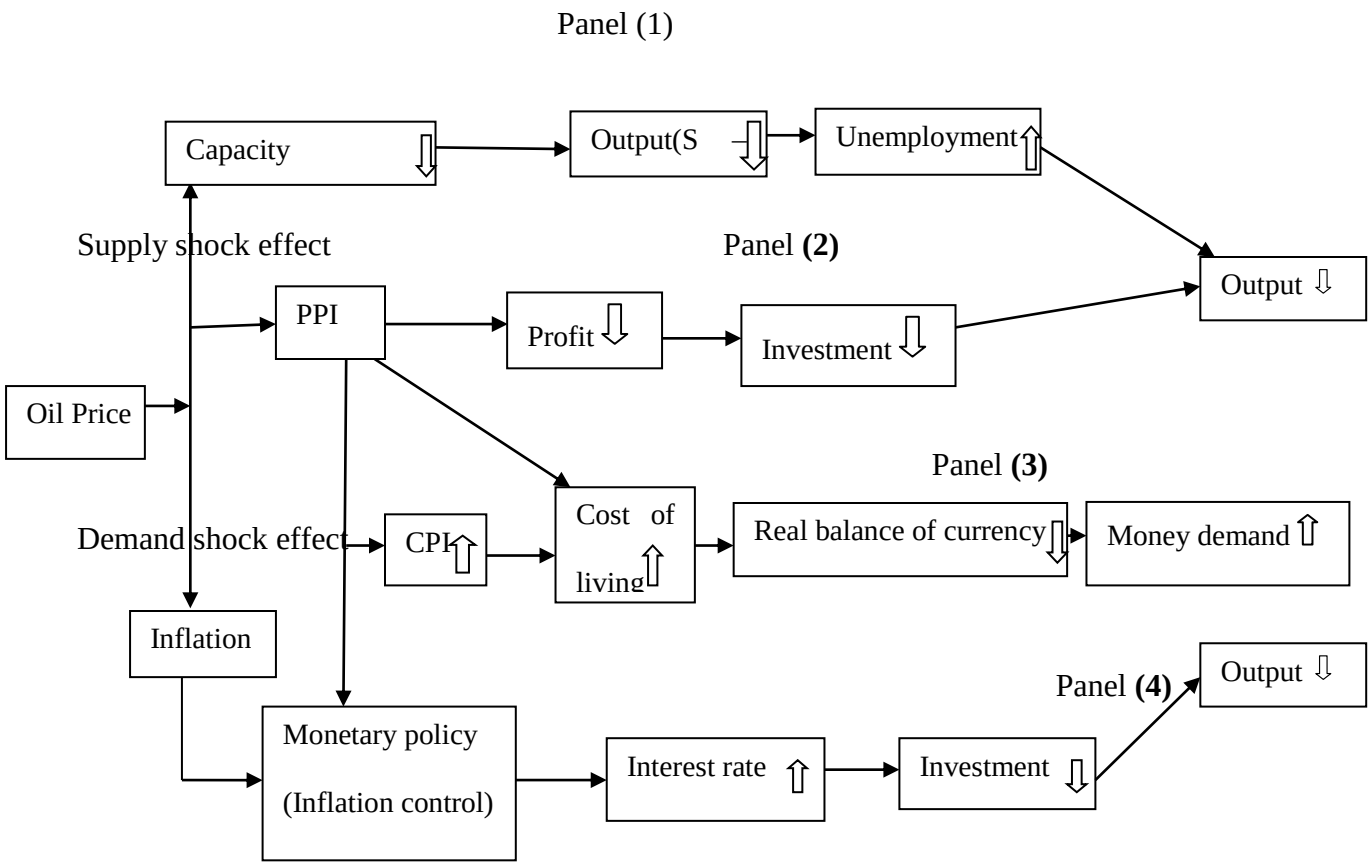


Fig 2.1 Oil transmission channels

Source: Adapted from Tang, Wu and Zhang (2010).

2.2.4.1 Supply Side Channel

According to Tang *et al*., (2010), crude oil is one of the most fundamental raw materials for industrial production. As panel (1) indicates, oil price shocks can increase the marginal cost of production hence cutting down firm's capacity utilization. This results to a reduction of output and unemployment persists.

Verleger (1994) observes that oil price volatility shrinks investment activities. A permanent increase in volatility might lead to a situation where future production capacity will always be a little lower. Hamilton (1996) concurs and asserts that concerns on oil price variability and oil

price disruptions could cause postponement of investment decisions. This scenario is captured by panel (2). There may also be a possibility of a structural shift and a period of adjustment when oil prices rise. As oil becomes relatively more expensive to other intermediate goods, energy intensive industries contract their production whereas less energy dependent sectors expand. Such periods of adjustment are associated with high costs, higher unemployment and resource underutilization (West African Monetary Agency, 2008).

2.2.4.2 Demand Side Channel

As we have already seen, a rise in oil prices leads to increase in commodity prices at which firms sell their products in the market. Higher prices of commodities translate to reduced purchasing power of money and increased cost of living (Jimenez-Rodriguez and Sanchez, 2005). This is represented by panel (3). Furthermore, the transfer of income and resources from oil importing to oil exporting countries is more likely to reduce aggregate global demand as demand in the former is likely to decline more than it will rise in the latter (Hunt, Judge and Ninomiya, 2003). The resulting lower purchasing power for oil importing countries lead to reduced demand.

2.2.4.3 Economic Policy Responses

Inflationary pressures resulting from oil price increases may stimulate tightening of monetary policies (Hunt *et al*., 2001). This may necessitate the Central Bank (CB) to employ monetary policy tools to minimize the adverse effects of such a shock. This scenario is depicted by panel (4). The CB has its target interest rates that can influence demand and inflation directions in the economy. However, the response of a monetary authority to oil shocks may affect its credibility if the monetary policy reaction is inconsistent with the announced policy objectives. As a result,

inflation management process is disrupted (Hunt *et al*., 2001). According to Ferderer (1996), money supply plays an important role on the negative correlation between oil prices and economic growth. Through the real money balances channel, increase in oil prices cause inflation which in turn reduces the quantity of real balances in the economy. Ferderer (1996) further adds that a highly restrictive monetary policy intended to maintain inflation at very low levels would invariably reduce output due to the trade-off between inflation and output.

2.3 Empirical Literature

A large number of studies focusing on the relationship between oil price fluctuations and economic activity have been carried out using different estimation techniques. Some of these works focus on the economic properties of oil and its impact on aggregate world economy while others focus specifically on economies of different types, say net exporters or net oil importers. The structure of literature review is consistent with two main blocks of papers: those that estimate oil price pass through into particular macroeconomic variables such as real GDP, inflation, money supply, industrial production, real stock returns, unemployment and exchange rates; and those studies that focus entirely on the relationship between oil price shocks and economic activity in Kenya. The choice of which articles to review was mainly influenced by the authors judgment on the detail of oil price transmission mechanism since it is this mechanism that is used to justify choice of variables to include in the investigation (Zaytsev, 2010).

In a pioneering study on the oil price-economic growth nexus, Hamilton (1983) demonstrated a strong correlation between oil price changes and GNP growth in US data for the period between 1948 and 1981. The study included two output variables (real output and unemployment),

implicit price deflator for non-farm business income, oil import prices and a money growth estimate, M1. The study estimated bivariate correlations between oil price changes and GDP growth. Estimations of the partial effects of oil price changes were then done within a reduced-form regression model that includes five-quarter distributed lags for each of the variables. This study was conducted at a period in which all the large oil price movements were upward and thus left the question of whether the correlation persist in periods of price decline. The price variable used by Hamilton (1983) was also somewhat distorted by price controls of the 1970s in US.

Mork (1989) extended Hamilton(1983) results using a six-variable quarterly vector autoregressive model. The objective was to investigate whether Hamilton's results continued to hold when the sample was extended to include the subsequent oil market collapse in 1985-1986 and the oil price variable was corrected to include effects of price controls. The period of study thus covered was between 1948 and 1988. In this study, particular attention was given to the possibility of asymmetric responses to oil price increase and decrease by specifying real price increase and decrease as separate variables. The two variables were defined as follows:

$$Op_t^{+} = \begin{cases} \Delta Op_t , & \text{if } \Delta Op_t \geq 0 \\ 0 , & \text{otherwise} \end{cases}$$

$$Op_t^{-} = \begin{cases} \Delta Op_t , & \text{if } \Delta Op_t \leq 0 \\ 0 , & \text{otherwise} \end{cases}$$

Where ΔOp_t is the rate of change of oil price in period t.

This study strongly confirmed a large negative effect of oil price increases on real GNP growth. On the other hand, the coefficients for price declines were much smaller and of varying signs

providing convincing evidence that effects of oil price declines were different from those of oil price increase.

Mork, Olsen and Mysen (1994) further extended Mork (1989) findings by including six other industrialized countries namely, Japan, Germany, France, Canada, United Kingdom and Norway. The approach used was similar to that of Hamilton (1983) but the period of study was extended to between the third quarter of 1967 and the last quarter of 1992. The study found that dependence on oil as an input to the production process varied considerably according to the degree in which each of the countries is dependent on foreign oil. The study also found that a negative correlation between oil price increase and GDP was present and significant for all the other countries except for the UK.

Sadorsky (1999) investigated the relationship between oil price and other macroeconomic variables using an unrestricted VAR framework. The choice variables in the study were industrial production, interest rates, oil price, real stock returns and inflation. Monthly data from 1947 to 1996 was used. The study found that the response of real stock returns to oil price changes is asymmetric; positive oil price shocks explain more forecast error of variance in interest rates, real stock returns and industrial production than negative shocks during the full sample period. During the post 1986 period, both positive and negative oil price shocks explain almost the same fraction of forecast error variance of real stock returns while in the pre-1986 period, positive oil price shocks contribute more to the forecast error variance in real stock returns than negative oil price shocks.

Jimenez-Rodriguez and Sanchez (2005) empirically assessed the impact of oil price shocks on real GDP growth of some of the main industrialized countries: Norway, Canada, France, Italy, United Kingdom, Japan, Germany and the United States. A multivariate VAR analysis was carried out using both linear and non-linear models for the period between 1981 and 2001. The study found non-linear effects of oil price on real economic activity and that the effect of oil price rise on output decline is higher than the effect of oil price fall on output increase.

Rautava (2004) sought to establish the role of oil price and the real exchange rate fluctuations on Russian fiscal policy and economic performance. The VECM framework was applied in this study. The results obtained indicate that the Russian oil exporting economy is influenced significantly by fluctuations of oil price and real exchange rates through both long run equilibrium conditions and short-run effects. The author reports that a 10% permanent increase in the international price of oil is associated with a 2.2% growth in the level of Russian real GDP.

Korhonen and Mehrotra (2009) estimated the effects of oil price shocks on real exchange rates and output in four large energy producing countries; Iran, Kazakhstan, Venezuela and Russia. The study estimated a structural VAR model using standard long-run restrictions for the four variables; real GDP, real exchange rate, inflation and oil price. The estimation samples were based on data availability as follows: Russia 1995Q2-2007Q1; Kazakhstan 1995Q2-2006Q4; Iran 1991Q2-2006Q4; Venezuela 1997Q2-2008Q1. The theoretical explanation of the empirical model was provided by a dynamic open economy Mundell-Fleming-Dornbusch model, augmented with an oil price variable. The study found that supply shocks explain 45% to 90% of

movements in output for the four economies. However, oil shocks do not account for a large share of movements in exchange rates and only plays a minor role in the movements of real GDP. This study borrowed heavily from the theoretical orientation employed by Korhonen and Mehrotra (2009).

Gounder and Bartleet (2009) investigated the impact of oil price shock on economic growth of New Zealand (a net oil importer) using the vector autoregressive methodology based on quarterly data. This study analyzed the direct and indirect impacts of short run oil price shocks on economic growth for the period between 1989 and 2006. Utilizing the Wald and Likelihood ratio tests of granger causality, their results indicate that linear price change, the asymmetric price increase and the net oil price variables were significant for the system as a whole, whereas the asymmetric price decrease was not. Following the causality analysis of the oil price-growth nexus, the generalized impulse responses and error variance decompositions reaffirm the direct link between the net oil price shock and growth as well as the indirect linkages.

Aliyu (2009) sought to assess the effects of oil price shock and real exchange rate volatility on the level of real economic activity in Nigeria (a net oil exporter) using a sample of observations from 1986Q1 to 2007Q4. Granger causality tests and multivariate VAR analysis were carried out using linear and non-linear oil specifications. Results of the long-run analysis show that a 10 percent increase in world crude oil price cause the real GDP to increase by 7.72 percent while a 10 percent appreciation in the level of exchange rate only increases real GDP by 0.35 percent. Results from the short run VECM show that the coefficient is statistically significant. This

implies that long run equilibrium conditions influences the short run dynamics for the Nigerian economy.

Zaytsev (2010) investigated the impact of oil price changes on the macroeconomic performance of Ukraine, a net oil importer, using a Structural VAR/VECM approach for the period between 1996 and 2006. The focus was on six macroeconomic variables: nominal foreign exchange rate, CPI, real GDP, interest rate, monetary aggregate M1 and average world price of oil. The study found that oil price increases tend to deteriorate real economic activity in the short-run as opposed to the long run. The reaction goes through indirect effect, namely the downward demand effect which is characterized by contraction of aggregate demand in response to adverse oil supply shock. The study however acknowledges its failure to empirically observe the direct effect of oil price shock which theoretically, should have forerun both cost and downward demand effects, resulting in increased inflation.

In a more recent study, Pushkarev (2013) analyzed the relationship between oil price, real GDP, inflation and oil exports in Kazakhstan. The analysis was based on quarterly data from the year 2000Q1 to 2010Q4 using time series Vector Error Correction model. In addition, the Johansen cointegration test was used to examine the sensitivity of economic growth to changes in oil prices in the long-term. The study found that an oil price shock has no significant impact on real economic growth of Kazakhstan. However, price of oil increase was found to have a significant positive effect on GDP in the short-term.

Only a handful of studies have been conducted on the oil price-growth nexus in Kenya. Aligula, Wasike and Mutua (2007) examined the effects of oil price volatility on Kenyan economy using ordinary least squares. They posited that when Kenya's economic performance is declining, the negative effects of oil price increases are higher as in the 1990s. When growth is robust the negative effects of oil price increase are subdued as in the 1960s and 1970s. This study however, does not give a quantitive measure of response of other macro-economic variables to oil price shocks.

Kiptui (2009) investigated oil price pass-through into inflation in Kenya. The study adopted a Phillips Curve approach with monthly data for world oil prices and exchange rates between the year 2002 and 2008. The study found that oil prices have significant effects on inflation with a pass-through of 0.05 in the short run and 0.1 in the long run. This study did not consider the response of economic growth to oil price shocks. In addition, the period of study can be seen to be too limiting hence inappropriate for forecasting.

Kotut, Menjor and Jepkwony (2012) employed the VAR framework to study the economic impact of petroleum oil price fluctuations in Kenya. Real GDP, CPI, real exchange rate and oil prices were chosen as the variables of analysis for the period between 2007 and 2011. The study found that oil price fluctuations have a negative significant impact on the economic performance in Kenya. This study however did not include aggregate money supply and hence its findings cannot appropriately inform monetary policy. The study period of approximately five years is also seen to be limiting.

Njangiru (2013) sought to establish the relationship between oil price volatility and economic growth in Kenya. The study employed regression analysis on quarterly data from the year 2005 to 2012. The study found that there is a unidirectional causal relationship between oil prices and economic growth. Oil price volatility is found to impact on GDP growth through other variables in the economy. However the study submits that this study period was too limiting with only 32 observations thus is subject to an error margin. Further, this study's results cannot be generalized to show the effect of oil price shocks on other macroeconomic variables such as inflation and exchange rates that the present study sought to address.

Gatuhi and Macharia (2013) studied the influence of oil prices on stock market performance in Kenya. The study employed monthly data of oil prices, interest rates, oil consumption, exchange rates and stock market indices in a linear regression model. Using domestic diesel oil price as a proxy for oil prices, the study found that oil prices positively and significantly influence the performances of Nairobi stock exchange. This study's main focus however, was not on the oil price-macroeconomic performance nexus.

2.4 Overview of literature

Drawing a single conclusion in an attempt to summarize the impact of crude oil price shocks on various macroeconomic variables would clearly be inaccurate. Although there exist a general consensus from the studies that oil price shocks impact on macroeconomic variables, the nature and magnitude of the impact seems to vary from one economy to another. Studies on developing countries have reported varying reports where this variance is mostly influenced by the direction of the impacts; whether net oil importing or exporting (Akram, 2011). The VAR framework is

the most dominant method of estimating this relationship across literature but the choice of variables vary from one study to another.

The current study contributes to the existing literature on oil price-macroeconomic performance nexus by conducting a five-variable Structural Vector Autoregressive analysis of the relationship for the case of Kenya. The study particularly examined the short run and the long run relationship between oil price and each of the four choice variables for the Kenyan economy. The key novelty of the study was the broad based attempt to identify the particular channels through which oil price shocks affect economic activity in Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter analyses the methodology used in examining the transmission channels of oil price shocks on economic activity in Kenya. The chapter begins with the research design of the study followed by the theoretical framework. The model specification, parameter identifying restrictions, study area, description and measurement of variables, data type and source, research instruments, data collection and data analysis follow in that order.

3.2 Research design

The main objective of the study was to investigate the channels through which oil price shocks transmit to economic activity in Kenya. A non-experimental research time-series design was adopted. Quarterly secondary data was used for the period ranging from the first quarter of 1991 to the last quarter of 2014. The choice variables for the study were: world crude oil price, real exchange rate, inflation, money supply and real GDP growth. The structural VAR methodology framework was utilized in the estimation process where Impulse Response functions and forecast error variance decomposition were analyzed.

3.3 Theoretical Framework

The current study was based on the theoretical framework of the Mundell-Fleming-Dornbusch model of a dynamic, open economy. The model is augmented with an oil price variable as in Korhonen and Mehrotra (2009). Oil price enters the model through the aggregate supply

function. Standard restrictions were then imposed on the system of variables such that only oil price shocks are allowed to impact oil prices themselves.

The four variables: aggregate demand d_t , aggregate supply s_t, oil price o_t and money supply m_t were all assumed to follow a stochastic process;

$$d_t = d_{t-1} + \epsilon_t^d \quad (3.1)$$

$$s_t = s_{t-1} + \epsilon_t^s \quad (3.2)$$

$$o_t = o_{t-1} + \epsilon_t^o \quad (3.3)$$

$$m_t = m_{t-1} + \epsilon_t^m \quad (3.4)$$

Where, ϵ_t^d, ϵ_t^s , ϵ_t^o , and ϵ_t^m are the structural shocks on aggregate demand , aggregate supply, oil price, and money supply.

Supply of output is determined by its own random walk process and the oil price:

$$Y_t^s = s_t + \gamma o_t \quad (3.5)$$

Where γ, is the energy elasticity of output.

Demand for output is determined by its own random walk process and the real exchange rate, e_t .

$$Y_t^d = d_t + \emptyset e_t \quad (3.6)$$

Equation (3.6) can be considered as an open IS equation where domestic output is increasing in the real exchange rate. Equilibrium in the goods market holds that $Y_t^s = Y_t^d = Y$. Further, assuming a standard LM relation where the transactions demand for money is increasing in output and decreasing in the rate of interest:

$$M_t = P_t + \delta Y_t - \beta i_t \quad (3.7)$$

Assuming an interest rate parity condition:

$$i_t = E(e_t) \quad (3.8)$$

From equations (3.3) and (3.4), we have:

$$\Delta O_t = \epsilon_t^o \quad (3.9)$$

$$\Delta M_t = \epsilon_t^m \quad (3.10)$$

Equations (3.5) and (3.9) yield:

$$\Delta Y_t = \epsilon_t^s + \gamma \epsilon_t^o \quad (3.11)$$

Substituting (3.11) into (3.6) and solving for Δe_t gives:

$$\Delta e_t = {}^{1}/_{\emptyset}(\gamma \epsilon_t^o + \epsilon_t^s - \epsilon_t^d) \quad (3.12)$$

Rearranging (3.7) and substituting $i_t = E(e_t)$, an expression for price level is obtained:

$$P_t = M_t - \delta Y_t + \beta E(e_t) \quad (3.13)$$

Finally, deducing an expression for change in price level by substituting (3.10), (3.11) and (3.12) into (3.13) yields:

$$\Delta P_t = \epsilon_t^m + (\beta/\emptyset - \delta) \epsilon_t^s - (\beta/\emptyset) \epsilon_t^d + (\beta\gamma/\emptyset - \delta\gamma) \epsilon_t^o \quad (3.14)$$

Equations (3.9), (3.11), (3.12) and (3.13) clearly show that the relationships between structural shocks among variables can be expressed in a triangular order: oil price shocks solely determine oil price in the long run while output is affected by both long run oil price shocks and supply shocks. Real exchange rate is determined by demand, supply and oil price shocks while price level is determined by all the four structural shocks in the long run. The theoretical model can now be fitted to the data using Structural Vector Autoregressions with long run restrictions.

3.4 The Empirical Model

To estimate the effect of oil price shocks on each of the macroeconomic variables, the study employed the Structural Vector Autoregressive (SVAR) modeling approach. The main advantage of SVAR over other classes of VAR is that it has a better empirical fit and allows for identification of structural shocks in accordance to theory (Khan and Ahmed, 2014). Chuku *et*

al., (2011) observed that SVAR also makes it possible to assess the net effect of a change in one variable on other variables in the system.

The model specification for the study was given as:

$rGDP_t = f\ (OP_t, rGDP_{t-1}\ EXR_t, M2_t, CPI_t)$ (3.15)

Where rGDP is the real Gross Domestic Product growth, OP is the oil price, EXR is the real exchange rate, M2 is the aggregate money supply and CPI is the consumer price Index (a proxy for inflation).

A corresponding structural VAR (p) model as provided by Breitung *et al.*, (2004) is given as:

$AX_t = A_1X_{t-1} + A_2X_{t-2} + \ldots\ldots + A_pX_{t-p} + B\epsilon_t$ (3.16)

Where $X_t = (OP_t, GDP, CPI, EXR, M2)$ is a (5 x 1) vector of endogenous variables, A is a (5 x1) invertible matrix of structural coefficients, p is the number of lagged terms, A_i's are (k x k) matrices which capture dynamic interactions between the variables in the model, B is a (k x k) matrix of structural coefficients that represent structural shocks and ϵ_t is a (5 x 1) vector of structural error terms.

For the purpose of policy analysis, the model representation (3.16) must be identified (Khan and Ahmed, 2014). A problem of economic interpretation arises because such a model is not directly observable and thus cannot be directly estimated in order to derive the true values of A, A_i's and ϵ_t. A reduced form model is thus obtained by pre-multiplying equation (3.16) with the inverse matrix A to obtain:

$X_t = A_1^*\ X_{t-1} + A_2^*\ X_{t-2} + \ldots\ldots + A_t^*\ X_{t-p} + \ \mu$ (3.17)

Where $A^* = A^{-1}A_i$

The relation between the reduced form residuals and the structural residuals is as follows:

$A\mu_t = B\epsilon_t$ or $\mu_t = A^{-1}B$ (3.18)

The vector μ_t denotes the reduced form VAR residuals uncorrelated with the variables in X_t and normally independently distributed with the variance-covariance matrix, $\Omega = E(\mu_t \mu_t^1)$.

The structural coefficients in (3.16) can now be recovered from the reduced form VAR equation (3.17) using the relation (3.18).

3.4.1 Parameter Identifying Restrictions

The next step involved identifying the structural form parameters. This involves placing restrictions on the parameter matrices. An exact number of identifying restrictions is imposed on either parameters A or B to ensure parsimony of the model and to avoid invalid restrictions (Khan and Ahmed, 2014). The underlying assumption on parameter restriction is that the variance-covariance matrix Ω is a diagonal matrix and is normalized to an identity matrix I_k (Alom, 2011).

Using a recursive (Cholesky) identification scheme, matrix A is assumed to be an identity matrix while B is a lower triangular matrix. According to Breitung *et al*., (2004) when either of the matrices A or B is assumed to be an identity matrix, the exact number of restrictions for a k-variable model is k(k-1)/2. The current study has 5 variables and thus 10 just-idenfying restrictions are imposed on the system of variables.

To generate the required 10 restrictions, economic theory comes into play. Kenya relies entirely on oil imports regardless of economic conditions and therefore in line with Tang *et al.*, (2010), Alom (2011) and Khan and Ahmed (2014), oil price is exogenous but the other four variables are

endogenous in the model. The study variables were therefore ordered as follows: real oil price, , real exchange rate, inflation, money supply and real GDP .

Following Khan and Ahmed (2014), the long run impact matrix has the following triangular form:

$$\begin{bmatrix} op \\ exr \\ cpi \\ m2 \\ rgdp \end{bmatrix} \begin{bmatrix} b11 & 0 & 0 & 0 & 0 \\ b21 & b22 & 0 & 0 & 0 \\ b31 & b32 & b33 & 0 & 0 \\ b41 & b42 & b43 & b44 & 0 \\ b51 & b52 & b53 & b54 & b55 \end{bmatrix} = \begin{bmatrix} \varepsilon^{op} \\ \varepsilon^{exr} \\ \varepsilon^{cpi} \\ \varepsilon^{m2} \\ \varepsilon^{rgdp} \end{bmatrix} \quad (3.19)$$

From the above matrix, the zeros in second matrix represent the parameter identifying restrictions. No other shock is allowed to impact on oil price shock except oil price shocks themselves. Exchange rate is assumed to be directly influenced by oil price shocks. Price levels are assumed to react to structural shocks of exchange rates and oil price movements. Money supply is placed after inflation with the assumption that it is contemporaneously affected by the price level, exchange rates and oil prices shocks. Finally real GDP is assumed to be affected by structural shocks of oil price, inflation, exchange rate and money supply.

3.5 Study area

The study used Kenya as a case study to investigate the transmission channels of oil price shocks on economic activity.

3.6 Description and Measurement of Variables

The Table 3.1 describes the variables used in the analysis and their measurement criteria.

Table 3.1: Description and measurement of variables

Variable	Definition	Measurement
Real oil price	This is the price of oil after adjusting for inflation effects.	The average quarterly measure of the dollar value of the Dubai spot price (in US$) per barrel of oil.
Real GDP	It is the measure of total economic output adjusted for price changes.	Quarterly measure of Kenya's economic growth deflated using the GDP deflator.
Inflation	General increase in prices and a fall in the purchasing power of money.	The quarterly measure of Kenya's consumer price Indices was used as a proxy for inflation.
Real Exchange Rate	The weighted average of a country's currency relative to another major currency adjusted for effects of inflation.	Quarterly average of the Kenya Shillings per US dollar adjusted for inflation.
Money Supply	Total supply of money in circulation in a given country's economy at a given time.	Quarterly monetary aggregate M2.

3.7 Data type and source

The study used secondary data from the first quarter of 1991 to the last quarter of 2014 which is a total of 96 observations. Real oil price data was obtained from the World Bank Development Indicators (2015). Data on real GDP, consumer price indices, real exchange rates and money supply M2, was obtained from the Kenya National Bureau of Statistics and Central Bank of Kenya's websites.

3.8 Research Instruments

A data collection sheet was prepared to show the specific values of each of the macroeconomic variables at a given quarter for the entire period of study. Numbering of the observations was

such that January to March 1991 formed the first quarter while October to December 2014 made the 92nd quarter. This is presented in Appendix One, Table A1 on page 59.

3.9 Data Analysis

The study intended to achieve four specific objectives as laid out in chapter one. The objectives were effectively achieved through analysis of the SVAR where impulse response functions and variance decomposition were interpreted. Following Jiménez-Rodríguez and Sánchez (2004), a battery of tests was conducted.

The first stage of the estimation and modeling procedure was to identify the order of integration of the data series. The Augmented Dickey-Fuller (ADF) test and the alternative Phillips and Perron, (PP) tests were undertaken. A mixture of both I(1) and I(0) was found where the oil price series was found to be I(0) while the time series for the other four variables were I(1). The structural VAR model was then estimated in levels in line with Farzanegan and Makwardt (2009), Tang *et al*,.(2010) and Alom (2011).

The next stage involved short run and long run assessment of oil price shocks on economic growth. This included Granger causality-type tests, impulse response functions and the error variance decompositions of the VAR model (Stock and Watson, 2001). The VAR model is very sensitive to the number of lags selected. An appropriate selection of the order of the VAR, *p*, was made based on five selection criteria, sequential modified LR test statistic, Final Prediction Error (FPE), the Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBC) and the Hannan-Quinn Information Criterion (HQ).

Once the order of the VAR had been determined, the **Wald Test** of Granger causality was performed. This primarily helps to determine whether a change in oil price directly Granger cause macroeconomic variables in Kenya. Such a relationship would be implied by the rejection of the null hypothesis that all *p* lags of the oil price coefficient are jointly equal to zero in the GDP growth equation of the VAR (Gounder and Bartleet, 2009).

Indirect linkages may provide important transmission mechanisms for oil price shocks. The **Likelihood Ratio Test** was utilized to deduce whether or not an indirect relationship between oil price changes and the rest of the system exists. This helped to capture the indirect transmission channels that are not addressed by the Wald test. Pair wise tests among variables provide important insights on whether or not oil price changes have an impact on inflation, exchange rates and money supply for Kenya. If such an impact is found to exist then its magnitude can be quantified using the impulse response function and forecast error variance decomposition mechanism (Gounder and Bartleet, 2009).

CHAPTER FOUR

MODEL ESTIMATION AND ANALYSIS OF RESULTS

4.1 Introduction

This chapter presents the findings of the study. Section 4.2 presents the stationarity results of the time series data; Section 4.3 reports the optimal lag order selection results from the various information criteria; Section 4.4 presents results on causality between variables; Section 4.5 covers results of diagnostic tests. Section 4.6 presents the outputs of the SVAR estimates. Section 4.7 presents the results for the objectives of the study with each subsection devoted to each of the four objectives of the study.

4.2 Stationarity Test Results

In line with the algorithm outlined in the previous chapter, the first step was to assess the stationarity properties of the data. The conventional augmented Dicky-Fuller (ADF) and the Phillips-Perron (PP) tests of unit root were employed. Table 4.1 shows a summary of the unit root tests using the two procedures at 5 % level of significance.

Table 4.1: Unit Root Test Results

Variable	ADF Statistic	Critical value	Result	PP Statistic	Critical Value	Result
	At Level					
Oil Price	-9.0619	-2.5839	Stationary	-9.0429	-3.5039	Stationary
Real Exchange rate	-1.0219	-3.5144	Not Stationary	-2.4126	-3.5039	Not stationary
Consumer Price Index	-2.1709	-3.5103	Not stationary	3.5929	-3.5039	Stationary
Money Supply, M2	-2.1511	-3.5103	Not Stationary	-1.8250	-3.5039	Not stationary
Real GDP growth	-1.8316	-3.5144	Not Stationary	-2.4403	-3.5039	Not stationary
	At First log difference					
Real Exchange rate	-5.8329	-3.5112	Stationary	-3.9430	-3.5047	Stationary
Consumer Price Index	-4.3778	-3.5103	Stationary	-9.9263	-3.5047	Stationary
Money Supply, M2	-5.4297	-3.5074	Stationary	-3.5186	-3.5047	Stationary
Real GDP growth	-3.5261	-3.5056	Stationary	-3.5641	-3.5039	Stationary

The results imply that each of the series is I(1) except the oil price series which is stationary at level. Following Jimenez-Rodriguez and Sanchez (2005), the first log differences on each of the series for REXR, CPI, M2 and RGDP are obtained to achieve stationarity. Although the ADF and the PP tests give contradicting results for CPI series at level, the decision rule is not to reject the null hypothesis of unit root and further proceed to log differencing. The oil price variable is therefore estimated at level while the other variables are estimated in first log differences. Following and Korhonen and Mehrotra (2009) and Khan (2012), the study does not investigate cointegration analysis between the variables since an SVAR model with long-run restrictions allows for estimation of long-run relationship between variables.

4.3: Optimal lag order selection

Prior to estimation of the SVAR model, the potential number of lags to be included was determined. Table 4.2 reports the lag order selection statistics based on the LR, FPE, AIC, SIC and HQ lag selection criteria.

Table 4.2: Lag order selection results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	74.39224	NA	1.29e-07	-1.672102	-1.526389	-1.613563
1	365.1749	539.5244	2.14e-10	-8.076503	-7.202223	-7.725266
2	579.9767	372.6682	2.22e-12	-12.65004	-11.04719	-12.00611
3	657.1336	124.5666	6.44e-13	-13.90683	-11.57542*	-12.97020*
4	682.7258	38.23416	6.55e-13	-13.92110	-10.86113	-12.69178
5	717.7536	48.11047	5.42e-13	-14.16274	-10.37419	-12.64071
6	745.2311	34.42957	5.54e-13	-14.22244	-9.705324	-12.40771
7	796.7398	58.33516*	3.29e-13*	-14.86120*	-9.615521	-12.75378
8	811.9028	15.34573	4.92e-13	-14.62416	-8.649919	-12.22405

* 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

Table 4.2 indicate that the three criteria: LR, FPE and AIC suggest that seven lags should be included in the estimation of SVAR while SC and HQ indicate three lags. On the basis of the majority, a parsimonious lag structure of seven was selected**.**

4.4: Results for Causality Analysis

Pairwise Wald tests of Granger non-causality were conducted to demonstrate the short run impact of oil price shocks on Kenya's economy. A summary of the results from the tests are reported in Table 4.3 with the entries in F-test statistics using seven lags.

Table 4.3: Granger Causality Test Results

Null Hypothesis:	Observations	F-Statistic	Prob.
Real GDP does not Granger Cause CPI		1.62039	0.1440
CPI does not Granger Cause Real GDP	92	8.31883	2.E-07
M2 does not Granger Cause CPI		0.69029	0.6799
CPI does not Granger Cause M2	92	0.52929	0.8095
Oil P does not Granger Cause CPI		1.50044	0.1814
CPI does not Granger Cause Oil P	92	0.36535	0.9194
REXR does not Granger Cause CPI		2.66138	0.0168
CPI does not Granger Cause REXR	92	14.5736	2.E-11
M2 does not Granger Cause Real GDP		0.97647	0.4553
Real GDP does not Granger Cause M2	92	0.84301	0.5557
Oil P does not Granger Cause Real GDP		1.09771	0.3743
Real GDP does not Granger Cause Oil P	92	1.07991	0.3855
REXR does not Granger Cause Real GDP		6.08710	1.E-05
Real GDP does not Granger Cause REXR	92	16.3267	2.E-12
Oil P does not Granger Cause M2		0.62120	0.7367
M2 does not Granger Cause Oil P	92	0.44018	0.8735
REXR does not Granger Cause M2		0.34853	0.9284
M2 does not Granger Cause REXR	92	1.34087	0.2444
REXR does not Granger Cause Oil P		1.09087	0.3786
Oil P does not Granger Cause REXR	92	2.01002	0.0659

Where: OIL P is the Oil Price; REXR is the Real Exchange Rate; CPI is the Consumer Price Index; M2 is the money supply and GDP stands for real GDP growth rate.

The results suggest that the null hypothesis of no causality between oil prices and any of the macroeconomic variables cannot be rejected for any of the Wald tests. This implies that world crude oil price shocks do not directly Granger-cause exchange rate, inflation, money supply or economic growth in Kenya. This result is akin to the findings of Jimenez-Rodriguez and Sanchez (2005) and Cunado and De-Gracia (2003) on such pairwise measures. There is bi-directional causality between CPI and real exchange rate. The results indicate that there is unidirectional causality from CPI to real GDP growth in Kenya and from real GDP growth to real exchange rate. The results also show that crude oil price is not affected by Kenya's real GDP growth which is consistent with the fact that Kenya is a price taker of oil in the world market.

4.5: SVAR Estimation Output

The SVAR was estimated using the specified lag order of seven. Ten just-identifying restrictions were imposed on the model given the structural factorization given by equation 3.19 on page 29. Table 4.4 reports the contemporaneous coefficient estimates which are outputs of the SVAR model.

Table 4.4: Contemporaneous Structural VAR Coefficients

	Coefficient	Std. Error	z-Statistic	Prob.
B_{11}	-3.21E-05	7.41E-05	-0.433830	0.6644
B_{21}	-2.99E-05	6.60E-05	-0.452888	0.6506
B_{22}	0.148297	0.096530	1.536277	0.1245
B_{31}	-0.003670	0.002764	-1.327863	0.1842
B_{32}	-9.147333	4.092211	-2.235304	0.0254
B_{33}	-0.432530	4.535647	-0.095362	0.9240
B_{41}	-0.042044	0.028488	-1.475831	0.1400
B_{42}	-88.85061	42.96298	-2.068074	0.0386
B_{43}	93.06818	46.28022	2.010971	0.0443
B_{44}	-0.533682	1.106683	-0.482235	0.6296
B_{51}	2.491206	0.191067	13.03840	0.0000
B_{52}	0.001702	0.000131	13.03840	0.0000
B_{53}	0.001514	0.000116	13.03840	0.0000
B_{54}	0.063327	0.004857	13.03840	0.0000
B_{55}	0.646133	0.049556	13.03840	0.0000

Likelihood Ratio (LR) test for just-identifying restrictions: $\chi 2 = 2.069$ [0.1069]

The coefficients on Table 4.4 provide a baseline intuition of the basic relationships that exist among the variables (Khan, 2012). They indicate the immediate responses of exchange rate, domestic price level, money balances and domestic output to world crude oil price shocks.

Jimenez-Rodriguez and Sanchez (2005) observed that rather than concluding that an economy is not affected by oil price shocks, it may be true that the Wald tests failed to account for the system-wide effect on each of the variables. The study thus next considered the Likelihood Ratio (LR) test. The LR test value of $\chi 2 = 2.069$ indicate that the restrictions imposed on the contemporaneous relations between variables are valid. At a probability of 10.69, the null hypothesis that oil price coefficients are jointly zero in the SVAR equations is rejected.

4.6: Diagnostic Tests

The diagnostic test results for the residuals of the SVAR model are presented in Tables A2, A3 and A4 in Appendix 2.

4.6.1: Residual Normality Test

This test indicates whether a given series is normally distributed which is an underlying assumption in the SVAR estimation process. A Jarque-Bera test was conducted (see Appendix 2, Table A2 on page 62). The test compares the third and the fourth moments (skewness and kurtosis) to those from a normal distribution. The results show that at a joint 10 degrees of freedom, the residuals were multivariate normal with a probability of 19.27 percent at a Jarque-Bera critical value of 38.62. The test was conducted at 5% level of significance. The decision rule thus was not to reject the null hypothesis that the residuals are multivariate normal.

4.6.2: Serial Correlation Lagrange Multiplier (LM) Test

The LM test was used to test for higher order ARMA errors with a null hypothesis of no serial correlation at lag order h (see Appendix 2 Table A3 on page 63). The test reported an estimated Chi-square of $\chi^2 = 117.05$ at 25 degrees of freedom. The decision rule thus was not to reject the null hypothesis of no serial correlation..

4.6.3: Stability

In line with literature, the stability of the results was confirmed by changing the Cholesky ordering of the variables. The ordering of the domestic macroeconomic variables was adjusted while maintaining oil price as the first variable. The rationale of not changing the position of oil price was to maintain the exogeinity of oil prices to the Kenyan economy in the estimation process. The contemporaneous coefficients results obtained after the reordering were almost similar to the initial results while a new set of results were produced when the exogeinity status of crude oil price was violated. This implies that the estimates are robust to the ordering of the domestic variables in the SVAR model.

4.7: Impulse Response Functions and Forecast Error Variance Decomposition

The estimates obtained from the SVAR as presented in Appendix 3, Table A5 and the contemporaneous SVAR coefficients presented by Table 4.4 are not quite informative. This is because the variables are measured in different units and the system is presented in reduced form. In order to meet the four objectives of the study, it was important to perform innovation accounting through Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD). With IRF, the focus was to quantify through a plot, the impact of a

positive standard deviation shock in the error term of the oil price variable on other macroeconomic variables included in the model.

Forecast error variance decomposition on the other hand shows how much variation in the dependent variable is due to variations of the included variables in the model (Chuku *et al*., 2010). It also provides insights on the transmission channels through which a given shock is transmitted from the first variable in the Cholesky ordering of variables to the last variable (Khan, 2010).

In the study, a unit standard deviation shock was applied to the oil price variable up to a limit of a three-year (12-quarter) horizon. Since the main interest of the study was to identify the channels of transmission of the shock, the responses of the independent variables were traced out. In the model, it was assumed that oil prices do not react to disturbances from other macroeconomic variables. This section looks at the Impulse Response Functions and Variance Decomposition analysis of each of the variables in respect of their Cholesky ordering in the model. Sections 4.7.1, 4.7.2, 4.7.3 and 4.7.4 provide more detailed answers to the four research questions of the study.

4.7.1: Effect of Crude Oil Price Shock on Real Exchange Rate

The first objective of the study was to estimate the effect of crude oil price shock on Kenya's real exchange rate. Figure 4.1 presents the impulse response of real exchange rate to a unit standard deviation of crude oil price shock.

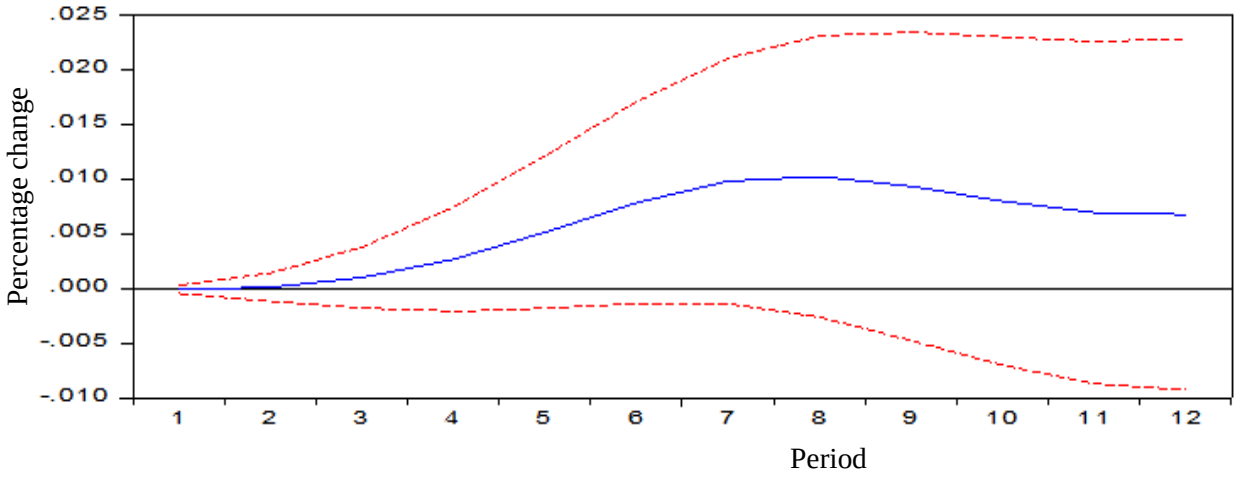


Figure 4.1: Impulse response of Real Exchange Rate to a one S. D oil price Shock

Following a crude oil price shock, the Kenyan shilling starts to depreciate reaching its peak level in the seventh quarter. It then slowly and gradually appreciates after the eighth quarter. This mean-reverting behaviour of exchange rate overshooting is consistent with the implications of the Dornbusch exchange rate overshooting model (Rogoff, 2001).

Variance decomposition of crude oil price analysis suggest that the contribution of oil price shock to real exchange rate volatility stands at 2.166 percent in the first six quarters. This contribution rises gradually to 2.34 percent over a three year period (see Appendix 4 Table A7). The result can be explained by the Central Bank's act of buying or selling foreign exchange in an attempt to stem excessive volatility in the exchange rate. This result is consistent with the findings of Jimenez-Rodriguez and Sanchez (2005) that a rise in oil prices leads to depreciation of the exchange rate in the G7 countries.

4.7.2: Effect of Crude Oil Price Shock on Consumer Price Index in Kenya

The second objective of the study was to estimate the effect of crude oil price shock on inflation in Kenya. Figure 4.2 illustrates the impulse response of Kenya's consumer price index to a unit standard deviation shock on crude oil price.

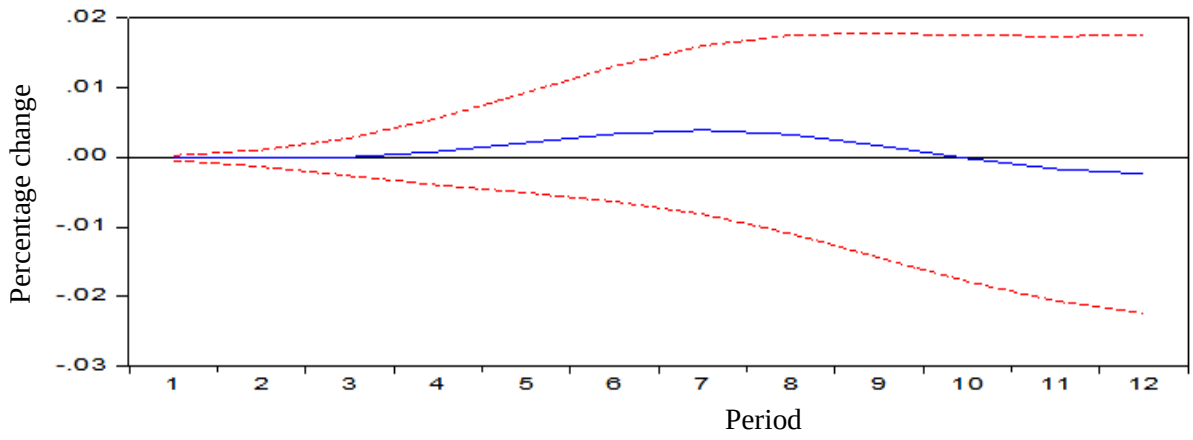


Figure 4.2: Impulse response of CPI to a one S. D oil price Shock

Figure 4.2 suggests that a unit standard deviation shock on crude oil prices elicits a two-quarter lagged response from Kenya's CPI. In the third quarter however, inflation starts accelerating reaching peak levels in the seventh quarter after which it starts to decline but does not seem to resume its normal path.

Variance decomposition of crude oil price provides a clearer impression of the response of CPI to oil price shock. Literature suggests that a rise in oil prices leads to a rise in inflation. A surprising result from the study however shows that the contribution of oil to changes in domestic price level is fairly low at 0.189 percent one year after an oil shock. This contribution peaks at 0.225 percent in the sixth quarter but stabilizes at 0.20 percent over the three year horizon (see Appendix 4, Table A7).

The lagged response of CPI to oil price shocks in Kenya in the short term could possibly be attributed to a fall in consumption due to fears of inflation by consumers and government efforts to maintain price stability in the wake of an oil price shock. As time passes however, the increased cost of production is factored into the prices of goods and services leading to inflation. This result is similar to the findings of Aanye (2012) on the impact of oil price shocks on the macroeconomy of Nigeria.

4.7.3: Effect of Crude Oil Price Shock on Money Supply in Kenya

The third objective of the study was to estimate the effect of crude oil price shock on money supply in Kenya. Figure 4.3 illustrates the impulse response of Kenya's money balances to a unit standard deviation shock on crude oil price.

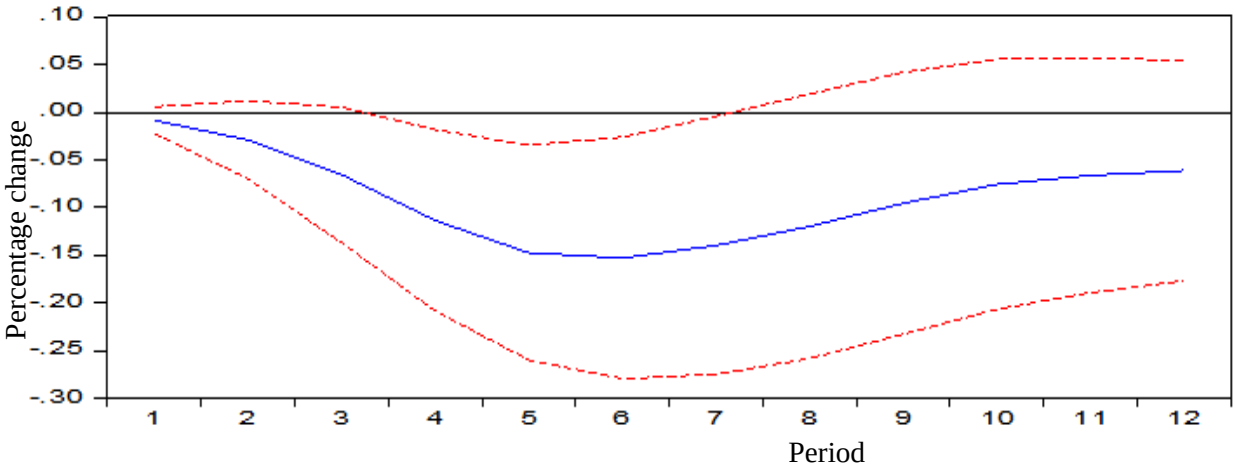


Figure 4.3: Impulse response of money supply to a structural one S. D oil price Shock

Figure 4.3 suggests that money supply in Kenya exhibit an immediate and sustained negative reaction to an oil price shock from the first quarter through to the sixth quarter. After the sixth quarter, money balances start increasing but the effect of the shock does not seem to die out even in the longer horizon.

Variance decomposition of oil price suggests that oil price shocks contribute 2.48 percent to changes in money supply over the three year horizon. This contribution is however sluggish, rising from zero in the first quarter to a stable value of over two percent after seven quarters (see Appendix 4, Table A7). These results may imply that Kenyan authorities resort to fiscal and monetary measures aimed at cutting the supply of money following an oil price shock. The rationale here could be to check expected inflation. A common reaction to inflationary pressure by the Central Bank of Kenya is to raise the rate of interest. Leduc and Sill (2004) however, argue against such a measure and hold that raising interest rate may further worsen the impact of the shock.

4.7.4: Effect of Crude Oil Price Shock on Kenya's Real Domestic Growth

The fourth objective of the study was to estimate the effect of crude oil price shock on Kenya's real GDP growth. Figure 4.4 illustrates the impulse response of Kenya's real GDP to a structural unit standard deviation shock on crude oil price.

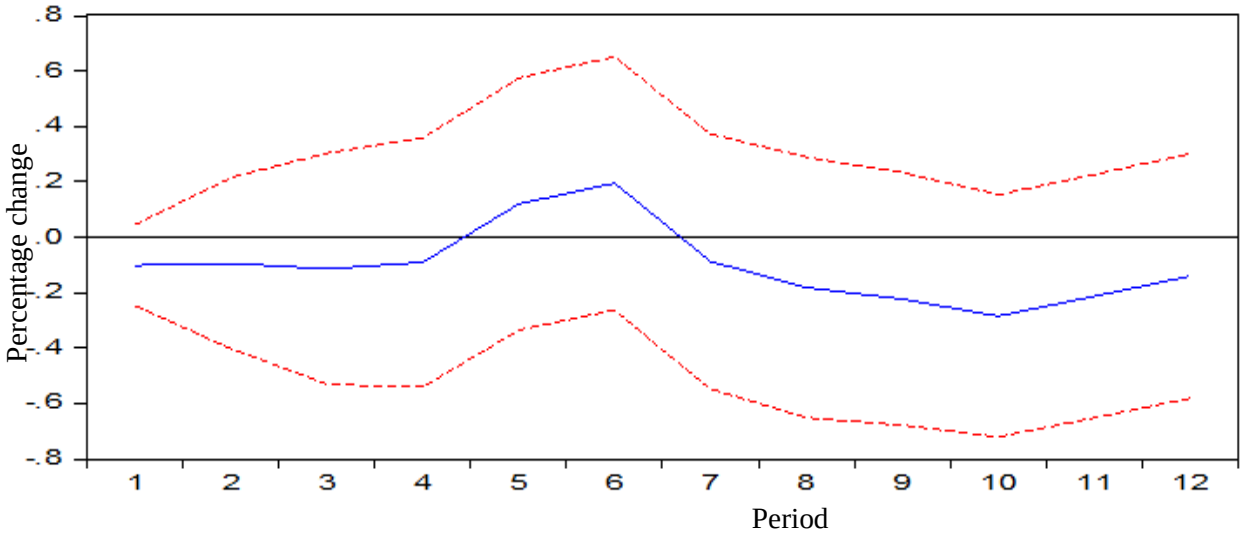


Figure 4.4: Impulse response of real GDP growth to a one S. D oil price shock

Figure 4.4 suggests a moderate negative response of real GDP growth to an oil price shock in the first three quarters. It rises between the third and the fifth quarter then shows consistent decline. The largest negative impact of oil price shock to real GDP growth in Kenya is felt after two and a half years after which domestic output growth starts to recover.

Forecast error variance decomposition shows that Kenya's domestic output growth response to oil price shock is fairly low at 0.1 percent in the first four quarters after a shock. The contribution of oil price shocks to Kenya's GDP growth however gradually rises from 0.07 in the fourth quarter to 3.46 percent over the three year period (see Appendix 4, Table A7). This has the implication that oil price shocks have a significant effect on Kenya's real GDP growth with the impact being persistent over the longer horizon. Khan (2012) observed similar results on the Iranian economy. This finding however differs slightly from that of Lee *et al.* (1995) who found that the greatest impact of an oil shock to GNP growth of the United States is felt in the third quarter. This could be explained by the effectiveness of the different policy reactions employed by the two countries in mitigating the effect of the shock.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1: Summary

Kenya, like most developing economies is faced with hard economic realities. With a rising oil import bill, fluctuating crude oil prices pose one of the major threats to achieving a high and stable economic growth. Studies on the effects of oil price shocks on net oil importing countries have reported dramatically varied results. Studies on the oil price-macroeconomic performance of Kenya consent that oil demand usually mimic economic activity, rising at boom and declining during recession. The key novelty of the study was the broad based attempt to identify the various channels through which oil price shocks affect economic activity.

The specific objectives of the study were to estimate the effect of crude oil price shock on each of the macroeconomic variables: real exchange rate, inflation, money supply and real GDP growth. The time scope of the study was set from the first quarter of 1991 to the fourth quarter of 2014. Existing quarterly data of each of the variables was used in the analysis on the basis of the Structural VAR approach. Pair wise granger causality analysis was conducted to investigate the relationship between every two pairs of variables. To meet the objectives of the study, innovation accounting through impulse response functions and variance decomposition analysis was done. Time series data was sourced from the World Bank's development indicators, the Central Bank of Kenya's website and the Kenya National Bureau of statistics.

Granger causality tests found no causality between crude oil prices and any of the four macroeconomic variables. The study found that there exist a bi-directional causality between real exchange rate and CPI in Kenya. There also exists a unidirectional causality from CPI to real GDP and from real GDP to real exchange rate.

The first objective of the study was to estimate the effect of crude oil price shock on Kenya's real exchange rate. Results show that following an oil price shock, the Kenyan shilling depreciates with the shock contributing 2.16 percent of real exchange rate volatility in the first four quarters. This contribution however rises gradually to 2.34 percent in the 12-quarter horizon.

The second objective of the study was to estimate the effect of oil price shock on inflation in Kenya. The study found that a unit standard deviation shock on crude oil price elicits a two-quarter lagged response from Kenya's CPI. The contribution of oil price to changes in the domestic price level is fairly low at 0.189 percent over the first four quarters after the shock. Following the shock, inflation starts accelerating in the third quarter reaching peak levels in the seventh quarter after which it starts to decline. In the long run, oil price shocks contribute 0.20 percent to the volatility of domestic price level.

The third objective of the study was to estimate the effect of crude oil price shock on money supply in Kenya. The results suggest that money supply in Kenya exhibit an immediate and sustained negative reaction to an oil price shock from the first quarter through to the sixth quarter. The contribution of crude oil price to variations in money supply rises from an initial zero in the first quarter after the shock to a stable value of over two percent after the seventh

quarter. Over the 12-quarter period, a unit standard deviation shock on crude oil price results to a 2.48 percent variation in money supply in Kenya.

The fourth objective of the study was to estimate the effect of crude oil price shock on real GDP growth in Kenya. Results suggest a moderate, negative response of real GDP growth in the first three quarters. The contribution of oil shocks to variations on GDP growth gradually rises from zero in the first quarter with the largest impact of the shock being felt in the 8^{th} quarter after the shock after which domestic output growth starts to recover. Over the 12-quarter period, an oil price shock contributes 3.46 percent of variations in Kenya's real GDP.

5.2: Conclusions

This study concludes that crude oil price shocks have a significant effect on Kenya's macroeconomic performance. This is consistent with existing literature on effects of oil shocks net oil importing countries. The study found no causality between oil prices and the domestic variables. However there was bi-directional causality between real exchange rate and Kenya's CPI and a unidirectional causality from CPI to real GDP and from real GDP to real exchange rate. Following an oil price shock, the Kenyan currency depreciates reaching its peak level in the seventh quarter after the shock after which it gradually appreciates. Oil price shock explain a relatively small portion of less than one percent of forecast error variance in the domestic price level both in the short run and long run. Money supply exhibit an immediate and sustained negative reaction to the shock which peaks in the sixth quarter but does not die out even in the longer horizon. Oil price shocks have a negative and significant effect on real GDP growth with the impact being persistent over the longer horizon.

5.3 Policy Implications

In the view that oil price shocks have detrimental effects on Kenya's macroeconomic performance, the government should adopt prudent fiscal and monetary policies in relation to oil prices. This could be through elimination of some taxes on crude oil imports and introduction of oil price subsidies. Crude oil price subsidies are necessary, since increased taxation only work to reinforce the negative impact of crude oil price shocks on the economy. Taxes on crude oil imports should thus be reduced and if possible completely removed. This is because removal of taxes will go a long way to reduce the cost of production of producers. In addition, oil price subsidies and reduced taxation as is the case in Ghana, are likely to induce private investment and foster growth. Increased investments would provide an opportunity for increased government revenue through taxation.

Efforts by the Energy Regulatory Commission (ERC) should be directed towards finding more environmentally friendly and relatively cheaper sources of energy to reduce the country's dependency on crude oil. This will encourage households and firms to shift to the new sources of energy. Current government efforts to enhance green energy production can be considered as a step in the right direction. The government could consider cheaper substitutes to crude oil such as Compressed Natural Gas (CNG) or Ethanol. Given the fact that Kenya has an unexploited production capacity of sugar cane which can provide the raw material for production of ethanol, the nation should consider investment in its production as an alternative to crude oil. This could help to reduce the country's dependence on crude oil and ameliorate Kenya's trade balance problems resulting from crude oil importation.

All efforts should be made to find a lasting solution to the perennial power rationing and power blackout problems in the country. Power rationing obliges firms to resort to the use of either petrol or diesel powered generators which tend to increase their cost of production and reduce output. This negatively affects the growth of the economy.

Finally, in reacting to oil price shocks, it is important that monetary policy should aim at ensuring that inflation expectations are not adversely affected by the unavoidable first-round direct and indirect effects of an oil price shock on the price level and that they remain anchored to price stability (Berument *et al.*, 2009). By preventing oil price shocks from having 'second round' effects on inflation expectations, monetary policy can contain the unfavourable consequences of these shocks on both inflation and growth .

5.4: Contributions to Existing Knowledge

This study contributes to the understanding of the transmission channels of crude oil price shocks on Kenya's economy. The study identifies the nature of causality among the variables included in the study. Utilizing the Structural VAR approach, the study performed innovation accounting to estimate the effect of crude oil price shock on each of the four macroeconomic variables: real exchange rate, domestic price level, money supply and output growth.

5.5 Limitations and Areas for Further Research

The study limits itself to the analysis of the effects of oil price shocks on four macroeconomic variables Kenya. However, the results obtained only constitute a small portion of the domain of associations and further research on the relationship between oil prices and a host of many other macroeconomic variables are required. For example, the effects of oil price shocks on fiscal

balance, unemployment, current account, interest rates and industrial production can also be explored. In line with some sections of literature, the asymmetric specification of oil price could also be factored in the analysis. Considering the volatility of oil prices and real exchange rate, use of higher frequency data, say monthly data could also be explored.

REFERENCES

Akram, M. (2011). Do Crude Oil Price Changes Affect Economic Growth of India, Pakistan and Bangladesh? A Multivariate Time Series Analysis. Hogskolan Dalarna D class thesis Dalarna University, Dalarna

Aligula, E., Wasike W. and Mutua, J. (2007). The Effects of Oil Price Volatility on the Kenyan Economy. In 11th African Oil and Gas, Trade and Finance Conference and Exhibition (pp.1-8). Nairobi: KIPPRA

Aliyu, S. U. R. (2009a).Oil Price Shocks and the Macroeconomy of Nigeria: A Non-linear Approach. *Research Journal of International Studies*, 11(2), 4-15.

Alom, F. (2011). Economic Effects of Oil and Food Price Shocks in Asia and Pacific Countries: An Application of the SVAR model. Paper provided by New Zealand Agricultural and Resource Economics Society in its series 2011 Conference, August 25-26, 2011, Nelson, New Zealand No. 115346

Alyousef, N. (2012). Determinants of Crude Oil Prices between 1997-2011. Paper presented at the 31st Conference of the United States Association for Energy Economics and the International Association of Energy Economists, 2012

Atil, A., A. Lahiani and D. K. Nguyen. (2014). Asymmetric and Non-linear Pass-Through of Crude oil Prices to Gasoline and Natural Gas Prices. *Energy Policy Elsevier*, 65,567-573

Berument, H., Ceylan, N.B. and Dogan, N., 2010. The Impact of Oil Price Shocks on the Economic Growth of Selected Countries. The Energy Journal 31(1), 149–176.

Breitung, J., R. Bruggemann and H. Lutkepohl (2004). Applied Time Series Econometrics. New York, Cambridge University Press.

British Petroleum. (2014). Statistical Review of World Energy, 2014. Available at,

BP-statistical-review-of-world-energy-2014-full-report.pdf,http://www.bp.com (Accessed 21st March 2015)

Chuku, A.C., Akpan, U.F., Sam, N.R. and Effiong, E.F., 2011. Oil Price Shocks and the Dynamics of Current Account Balance in Nigeria. *OPEC Energy Review* 35,119–139

Cologni A. & Manera, M. (2008). Asymmetric Effects of Oil Price Shocks on Output Growth: A Markov-Switching Analysis for the G-& Countries. *Economic Modeling*, 26(1), 1-29.

Cuñado, J. and Pérez de Gracia, F. (2003). Do oil price shocks matter? Evidence for Some European countries. *Energy Economics*, 25, 137–154.

Dornbusch, R., s. Fischer and R. Startz (2001). *Macroeconomics*. 8ed, Mcgraw-Hill

Energy Information Administration (2014).World Energy Outlook, available at, www.worldenergyoutlook.org/pressmedia/recentpresentations /PresentationWEO2014launch.pdf(Accessed 22Feb 2015)

Farzanegan, M. R. and Markwardt, G. (2009). The Effects of Oil Price Shock on the Iranian Economy. Energy Economics, 31(1), 134 - 151

Ferderer, J. P. (1996). Oil Price Volatility and the Macroeconomy: A Solution to the Asymmetry Puzzle. *Journal of Macroeconomics*, 18, 1–16.

Feussi, S.R. (2013). Impact of oil price Fluctuations on Economies in the Age of Globalization. Phd Thesis,State University of New York, New York.

Gatuhi, S. K. and Macharia, P. (2013). Influence of Oil Prices on Stock Market Performance in Kenya. Unpublished Thesis, Jomo Kenyatta University of Agricultre and Technology, Nairobi

Gounder, R. and Bartleet, M. (2007). Oil price Shocks and Economic Growth: Evidence for

Newzealand, 1989-2006. Paper presented at the New Zealand Association of Economists Annual Conference, Christchurch, 27-29th June.

Hamilton, J. D. (1983).Oil and the Macroeconomy Since World War Two. *Journal of Political economy*, 91, 228–248.

Hamilton, J. D. (1996). This is What Happened to the Oil Price-Macroeconomy Relationship. *Journal of Monetary Economics*, 38(2), 215–220.

Hamilton, J. D. (2003). What is an Oil Shock? Journal of Econometrics, *113* (2), 363–398

Hamilton, J. D. (2008). Understanding Crude Oil Prices. NBER working paper series, No. 14492, Cambridge.

Hamilton, J. D. (2009) .Causes and Consequences of the Oil Shock of 2007-08. NBER Working Paper No. 15002

Hooker, M. A. (1996). What Happened to the Oil Macroeconomic Relationship? *Journal of Monetary Economics*, 38(2), 221-222

Hunt, L. C., Judge, G. and Ninomiya, Y. (2003). Underlying Trends and Seasonality in UK Energy Demand: A Sectoral Analysis. *Energy Economics*, 25(1), 93-118

Jiménez-Rodríguez, R. and Sánchez, M. (2004). Oil price shocks and real GDP growth: empirical evidence for some OECD countries. European Central Bank, Working Paper No. 362.

Jiménez-Rodríguez, R. and Sánchez, M. (2005). Oil price shocks and real GDP growth: empirical evidence from some OECD countries. *Applied Economics*, 37(2), 201-228

Khan, M. A., and Ahmed, A. (2014). Revisiting the Macroeconomic Effects of Oil and Food Price Shocks to Pakistan Economy: A Structural Vector Autoregressive(SVAR) Analysis. *OPEC Energy Review*, 38(2), 184-215

Killian, L. (2008). The Economic Effects of Energy Price Shocks. *Journal of Economic Literature*, 46(4), 871-909

Kiptui, M. (2009). Oil price Pass-Through into Inflation in Kenya. Kenya School of Monetary Studies Research Centre. Working Papers No. 151

Kotut, C.S., Menjo, K.I. & Jepkwony, J. (2013). An Econometric Approach to the Economic Impact of Petroleum Oil Price Fluctuation in Kenya. *Journal of Economics and Sustainable Development*, 7(3), 123-234

Korhonen, I. and Mehrotra A. (2009). Real Exchange Rate,Output and Oil: Case of Four Large Producers. Bank of Finland, Turku

Leduc, S. and Sill, K., (2004). A Quantitative Analysis of Oil Price Shocks, Systematic Monetary Policy, and Economic Downturns, *Journal of Monetary Economics*, 51, 781–808

Mork, K. A. (1989). Oil and the Macroeconomy When Prices Go Up and Down: An extension of Hamiltons Results. *Journal of Political Economy*, 97, 740-744

Mork, K. A., O. Olsen and H. T. Mysen (1994). Macroeconomic Responses to Oil Price Increases and Decreases in Seven OECD Countries. *Energy Journal*, 15(4), 19-35

Mucheru, M. E. (2014). Monetary Policy Reaction Function in the presence of Oil Price Shocks in Kenya. Master Thesis, Kenyatta University, Nairobi

Mugambi, K. *et al.*,(2012). Kenya Now a Proven Opportunity in Oil and Gas Exploration. National Oil Corporation of Kenya. Presentation to the 5Th East African Petroleum Conference and Exhibition 2011

Njangiru, P. N. (2013). Relationship between Oil Price Volatility and Economic Growth of Kenya. Master Thesis, University of Nairobi, Nairobi

Painter, D. (1986). Oil *and the American Century: Political Economy of US Foreign Policy*. John's Hopkins University Press, Maryland

Pushkarev, V. B. (2013). Relationship between Oil and GDP: The case of Kazakhstan. Master Thesis, Charles University, Prague

Rautava, J. (2004). The Role of Oil Prices and the Real Exchange Rate in Russia's Economy-A Cointegration Approach. *Journal of Comparative Economics*, 32(2), 315-327

Riman, B. H. Akpan, S. E and Offiong, A. I. (2013). Asymmetric Effects of Oil Price Shock on Exchange Rate Volatility and Domestic Investment in Nigeria. Unpublished Thesis, University of Calabar, Calabar

Rogoff, K. (2002). Dornbusch's Overshooting Model after Twenty-five Years. IMF Staff Working Papers, Vol.49, Special Issue, International Monetary Fund

Sadorsky, P. (1999). Oil Price Shocks and Stock Market Activity. *Energy Economics*, 2, 449-469

Suleiman, M. (2013). Oil Demand, Oil Prices, Economic Growth and the resource Curse: An empirical Analysis. University of Surrey, England.

Stern, D. I. (2003). *Energy and Economic Growth*. Rensselaer Polytechnic, New York

Stock, J. H. and Watson, M.W. (2001), Vector Autoregressions. *Journal of Economic Perspective*, 15(4), 101-1115

Tang, W., L. Wu and Z. Zhang (2010). Oil Price Shocks and their Short and Long Term Effects on the Chinese Economy. *Energy Economics*, 32(3), S3-S14

West African Monetary Agency. (2008). Impact of Oil Price Fluctuations on Key Convergence Criteria in Ecowas Member States. West African Monetary Agency, Freetown

World Bank. (2015). World Development Indicators. Available at, www.data.worldbank.org/data-catalogue/commodity-price-data, March ,15th Feb, 2015

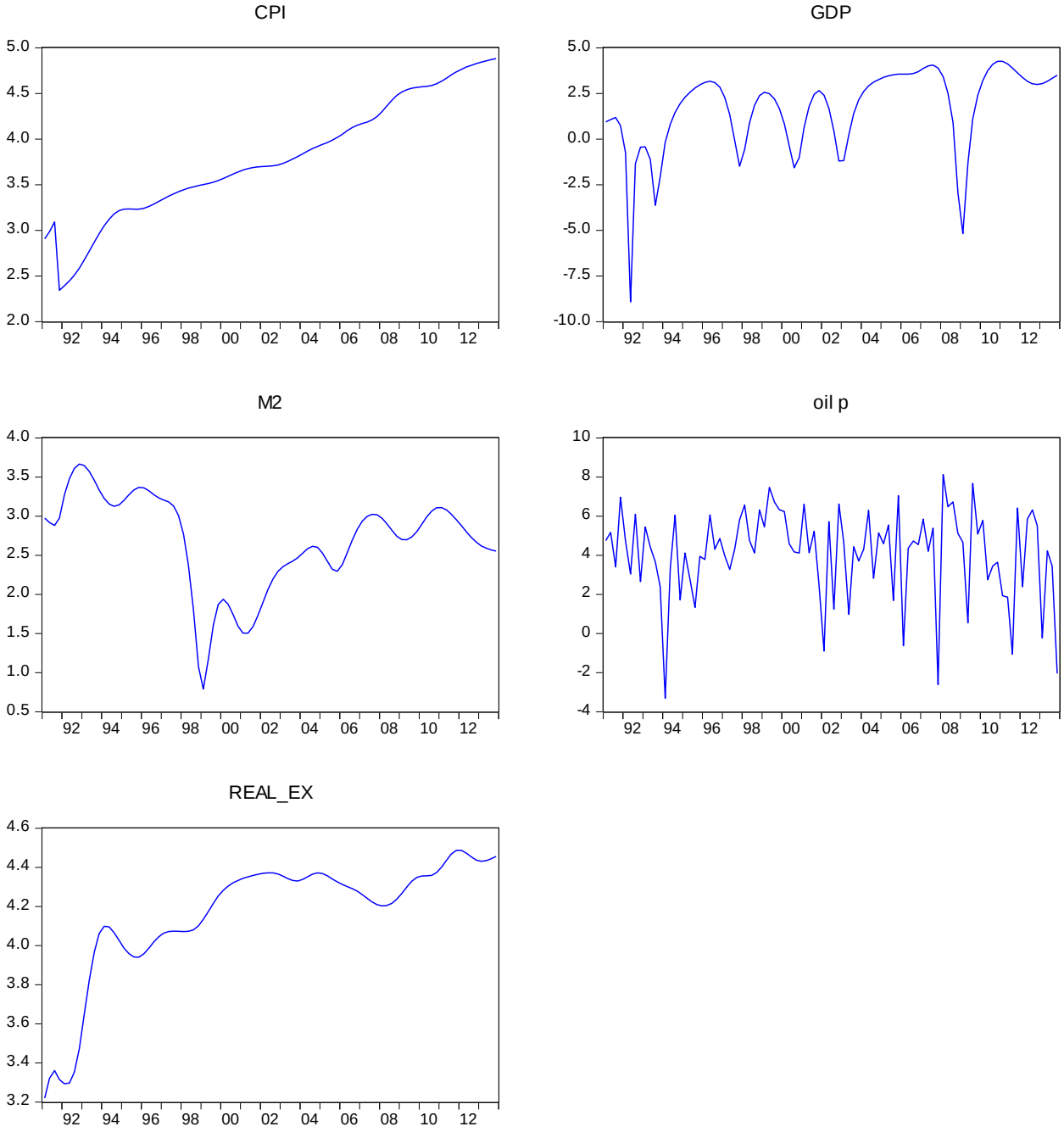
Zaytsev, O. (2010). The Impact of Oil Price Changes on the Macroeconomic Performance of

Ukraine. Master thesis, Kiev School of Economics, Kiev. Available at: http://www.kse.org.ua/uploads/thesis_final_Zaytsev.pdf (accessed January 2 2015).

APPENDICES

Appendix 1: Time Series Data

Figure A1: Raw Data Time Graphs



Where: OIL P is the Oil Price; Real EX is the Real Exchange Rate; CPI is the Consumer Price Index; M2 is the money supply and GDP stands real GDP growth rate.

Table A1: Refined Data

Period	CPI	GDP	M2	Oil P	Real EX
1991Q1	2.906901	0.940007	2.97553	4.74795	3.220075
Q2	2.985682	1.061257	2.917771	5.171012	3.321432
Q3	3.091042	1.175573	2.879198	3.405857	3.36107
Q4	2.342767	0.726924	2.974136	6.959401	3.314473
1992 Q1	2.392041	-0.75243	3.272939	4.729241	3.292886
Q2	2.445495	-8.91947	3.478878	3.034645	3.297275
Q3	2.508469	-1.34902	3.608068	6.087139	3.352323
Q4	2.584752	-0.44754	3.66411	2.65415	3.472488
1993 Q1	2.67474	-0.43198	3.646176	5.442591	3.64575
Q2	2.771727	-1.12044	3.571288	4.416549	3.821576
Q3	2.869219	-3.63467	3.458819	3.64587	3.965701
Q4	2.962692	-2.08144	3.333397	2.393896	4.060465
1994 Q1	3.048505	-0.1743	3.22691	-3.32146	4.098819
Q2	3.121929	0.808988	3.155024	3.342947	4.095651
Q3	3.178943	1.462596	3.125951	6.051553	4.066657
Q4	3.216072	1.936096	3.143199	1.717323	4.026255
1995 Q1	3.231981	2.292061	3.200168	4.108247	3.988086
Q2	3.233946	2.568797	3.27179	2.762564	3.958243
Q3	3.23079	2.788926	3.333833	1.325376	3.94093
Q4	3.2312	2.966025	3.367313	3.942599	3.940218
1996 Q1	3.241908	3.100359	3.360703	3.780191	3.957604
Q2	3.26175	3.158413	3.324865	6.064128	3.986319
Q3	3.287572	3.096228	3.275817	4.303524	4.017981
Q4	3.316365	2.844674	3.231796	4.849605	4.045065
1997 Q1	3.345613	2.289875	3.206229	3.981221	4.06237
Q2	3.373944	1.347337	3.180893	3.270211	4.071135
Q3	3.400354	-0.09144	3.126606	4.312805	4.073887
Q4	3.423937	-1.4893	3.00542	5.815987	4.072981
1998 Q1	3.444105	-0.5664	2.766251	6.565578	4.071065
Q2	3.461266	0.879931	2.378874	4.755385	4.07216
Q3	3.476017	1.846046	1.803639	4.108247	4.080595
Q4	3.488903	2.381897	1.075446	6.314852	4.100438
1999 Q1	3.500647	2.558555	0.787693	5.447847	4.13343
Q2	3.512774	2.482047	1.170819	7.462441	4.174086
Q3	3.526946	2.192944	1.608113	6.714491	4.215858
Q4	3.54472	1.670508	1.869908	6.328417	4.253144
2000 Q1	3.566882	0.837458	1.936337	6.227031	4.282229
Q2	3.591623	-0.36686	1.875821	4.587089	4.304068
Q3	3.616669	-1.57552	1.741318	4.171344	4.320472
Q4	3.639952	-1.02265	1.590846	4.11081	4.33304

2001 Q1	3.659853	0.6324	1.502799	6.604227	4.34309
Q2	3.675908	1.78983	1.505071	4.123573	4.351274
Q3	3.687907	2.443834	1.58914	5.22161	4.358061
Q4	3.695607	2.659395	1.729955	2.494065	4.363903
2002 Q1	3.699318	2.401065	1.897062	-0.89257	4.36892
Q2	3.701679	1.689129	2.05788	5.718679	4.371963
Q3	3.705876	0.446706	2.192776	1.241153	4.371575
Q4	3.715034	-1.20698	2.291403	6.618895	4.366267
2003 Q1	3.731333	-1.18596	2.351583	4.656506	4.355478
Q2	3.753629	0.237502	2.389813	0.97716	4.342682
Q3	3.780007	1.392591	2.423387	4.438407	4.33254
Q4	3.80866	2.151711	2.467023	3.706336	4.329886
2004 Q1	3.837999	2.613535	2.526595	4.303524	4.337668
Q2	3.866805	2.909064	2.582687	6.29433	4.35134
Q3	3.894047	3.111528	2.613951	2.826846	4.364652
Q4	3.9188	3.260167	2.600591	5.148276	4.371647
2005 Q1	3.940887	3.377082	2.528331	4.583048	4.368147
Q2	3.962743	3.46561	2.420568	5.540171	4.356513
Q3	3.987231	3.524633	2.321488	1.683134	4.340706
Q4	4.016923	3.552175	2.293383	7.045059	4.324849
2006 Q1	4.052734	3.55168	2.379205	-0.62942	4.312205
Q2	4.090355	3.551953	2.531396	4.358574	4.301716
Q3	4.124826	3.587898	2.693297	4.725478	4.291123
Q4	4.151827	3.69079	2.831559	4.542189	4.278065
2007 Q1	4.169651	3.859434	2.931437	5.843095	4.260952
Q2	4.185409	4.006675	2.994796	4.196036	4.241745
Q3	4.207862	4.046814	3.023643	5.385196	4.223482
Q4	4.244917	3.889905	3.016662	-2.61867	4.209422
2008 Q1	4.29994	3.412009	2.972435	8.12192	4.202574
Q2	4.363654	2.51266	2.901221	6.481275	4.204339
Q3	4.425715	0.899917	2.81828	6.722139	4.215522
Q4	4.478018	-2.91945	2.743983	5.120647	4.236644
2009 Q1	4.51569	-5.17768	2.700857	4.666229	4.266649
Q2	4.540914	-1.32912	2.696715	0.540054	4.299518
Q3	4.55689	1.098158	2.731469	7.675892	4.328703
Q4	4.566325	2.392022	2.800769	5.075314	4.348366
2010 Q1	4.571976	3.210955	2.893908	5.781854	4.355384
Q2	4.577675	3.752682	2.987981	2.742361	4.356086
Q3	4.587458	4.093388	3.063827	3.441959	4.358972
Q4	4.60517	4.25782	3.10735	3.636154	4.372395
2011 Q1	4.632895	4.252261	3.109867	1.926349	4.400957
Q2	4.666999	4.117267	3.078648	1.856439	4.436287
Q3	4.702848	3.892524	3.02305	-1.05527	4.467897

Q4	4.736374	3.62381	2.952412	6.410365	4.486508
2012 Q1	4.764778	3.37066	2.876419	2.387845	4.486205
Q2	4.788491	3.16485	2.80013	5.847398	4.472409
Q3	4.808579	3.030027	2.728224	6.31315	4.453211
Q4	4.825991	2.986842	2.666693	5.508595	4.437102
2013 Q1	4.841531	3.040697	2.620939	-0.23307	4.431099
Q2	4.855712	3.165275	2.589605	4.220426	4.434297
Q3	4.868957	3.326601	2.56854	3.449101	4.443577
Q4	4.881665	3.495998	2.552737	-2.0433	4.455775

Where: OIL P is the Oil Price; Real EX is the Real Exchange Rate; CPI is the Consumer Price Index; M2 is the money supply and GDP stands real GDP growth rate.

Appendix 2: Diagnostic Tests

Table A2: Residual Normality Test

VAR Residual Normality Tests
Orthogonalization: Estimated from Structural VAR
Null Hypothesis: residuals are multivariate normal
Date: 10/07/15 Time: 17:14
Sample: 1991Q1 2014Q4
Included observations: 92

Component	Skewness	Chi-sq	df	Prob.
1	-0.407738	2.355214	1	0.1249
2	0.334551	1.585596	1	0.2080
3	-0.161942	0.371526	1	0.5422
4	-0.363044	1.867182	1	0.1718
5	-0.314347	1.399865	1	0.2367
Joint		7.579383	5	0.1810

Component	Kurtosis	Chi-sq	df	Prob.
1	1.430224	8.727362	1	0.1031
2	1.392108	9.156332	1	0.0025
3	1.435973	8.663559	1	0.2032
4	2.875664	0.054752	1	0.8150
5	1.880699	4.437126	1	0.0352
Joint		31.03913	5	0.1927

Component	Jarque-Bera	df	Prob.
1	11.08258	2	0.1439
2	10.74193	2	0.0046
3	9.035085	2	0.0109
4	1.921934	2	0.3825
5	5.836992	2	0.0540
Joint	38.61851	10	0.1927

Table A3: Serial Correlation LM Test

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 10/07/15 Time: 17:10
Sample: 1991Q1 2013Q4
Included observations: 92

Lags	LM-Stat	Prob
1	67.29764	0.0000
2	27.37382	0.3375
3	19.88047	0.7531
4	64.08521	0.0000
5	17.93575	0.8451
6	27.43318	0.3346
7	18.95008	0.7995
8	30.41747	0.2090
9	24.58340	0.4859
10	15.88716	0.9181
11	34.48699	0.0979
12	32.72061	0.1382

Probabilities from chi-square with 25 degrees of freedom.

Table A4: Residual Heteroskedasticity Test

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 10/07/15 Time: 17:12
Sample: 1991Q1 2014Q4
Included observations: 92

Joint test:

Chi-sq	df	Prob.
1091.598	1050	0.1813

Individual components:

Dependent	R-squared	F(70,14)	Prob.	Chi-sq(70)	Prob.
res1*res1	0.916002	2.181016	0.0528	77.86019	0.2430
res2*res2	0.872372	1.367050	0.2641	74.15159	0.3445
res3*res3	0.820893	0.916650	0.6191	69.77590	0.4851
res4*res4	0.990120	20.04359	0.0000	84.16023	0.1190
res5*res5	0.914005	2.125712	0.0586	77.69041	0.2472
res2*res1	0.748833	0.596283	0.9195	63.65080	0.6904
res3*res1	0.786249	0.735668	0.8032	66.83116	0.5853
res3*res2	0.875662	1.408522	0.2428	74.43129	0.3362
res4*res1	0.731790	0.545686	0.9495	62.20219	0.7351
res4*res2	0.921982	2.363497	0.0377	78.36843	0.2306
res4*res3	0.856935	1.197964	0.3701	72.83946	0.3848
res5*res1	0.830918	0.982860	0.5533	70.62806	0.4565
res5*res2	0.925455	2.482953	0.0305	78.66370	0.2237
res5*res3	0.910522	2.035184	0.0696	77.39436	0.2546
res5*res4	0.873819	1.385025	0.2546	74.27462	0.3408

Appendix 3: SVAR Estimation Output

Table A5: SVAR Estimates

Structural Vector Autoregression Estimates
Date: 10/07/15 Time: 16:51
Sample (adjusted): 1992Q4 2014Q4
Included observations: 90 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	OIL_P	REAL_EX	CPI	M2	GDP
OIL_P(-1)	-0.283729	7.34E-05	4.89E-05	-0.002596	0.028704
	(0.15166)	(0.00010)	(9.4E-05)	(0.00400)	(0.04143)
	[-1.87078]	[0.70749]	[0.52271]	[-0.64829]	[0.69286]
OIL_P(-2)	-0.052626	0.000141	0.000111	-0.008476	-0.025266
	(0.15662)	(0.00011)	(9.7E-05)	(0.00414)	(0.04278)
	[-0.33602]	[1.31621]	[1.15266]	[-2.04979]	[-0.59058]
OIL_P(-3)	-0.094744	-2.05E-05	0.000136	-0.008435	0.013818
	(0.15674)	(0.00011)	(9.7E-05)	(0.00414)	(0.04282)
	[-0.60446]	[-0.19161]	[1.40682]	[-2.03814]	[0.32274]
OIL_P(-4)	-0.216454	6.51E-05	8.60E-05	-0.002677	0.068269
	(0.16275)	(0.00011)	(0.00010)	(0.00430)	(0.04446)
	[-1.32997]	[0.58451]	[0.85613]	[-0.62295]	[1.53562]
OIL_P(-5)	-0.137331	-9.21E-06	-5.40E-05	-0.004030	0.017304
	(0.16742)	(0.00011)	(0.00010)	(0.00442)	(0.04573)
	[-0.82028]	[-0.08047]	[-0.52210]	[-0.91178]	[0.37838]
OIL_P(-6)	0.173358	-0.000167	-2.49E-05	-0.004500	-0.081027
	(0.16152)	(0.00011)	(0.00010)	(0.00426)	(0.04412)
	[1.07327]	[-1.51331]	[-0.24982]	[-1.05510]	[-1.83644]
OIL_P(-7)	0.184649	-0.000280	-0.000136	-0.003249	0.031445
	(0.15885)	(0.00011)	(9.8E-05)	(0.00419)	(0.04339)
	[1.16241]	[-2.58183]	[-1.38808]	[-0.77469]	[0.72467]
REAL_EX(-1)	80.96357	2.996289	-0.046519	4.732653	-4.911826
	(186.036)	(0.12721)	(0.11483)	(4.91200)	(50.8177)
	[0.43520]	[23.5530]	[-0.40511]	[0.96349]	[-0.09666]
REAL_EX(-2)	-403.8114	-3.702844	-0.028584	-14.25146	45.71440
	(592.761)	(0.40534)	(0.36588)	(15.6509)	(161.918)
	[-0.68124]	[-9.13516]	[-0.07812]	[-0.91058]	[0.28233]
REAL_EX(-3)	801.7782	2.504104	0.376575	17.26546	-81.38791
	(898.758)	(0.61459)	(0.55476)	(23.7303)	(245.504)
	[0.89210]	[4.07446]	[0.67881]	[0.72757]	[-0.33151]
REAL_EX(-4)	-1009.888	-1.411122	-0.625007	-14.15709	58.64655
	(905.276)	(0.61904)	(0.55879)	(23.9024)	(247.285)
	[-1.11556]	[-2.27952]	[-1.11851]	[-0.59229]	[0.23716]

REAL_EX(-5)	897.2676	1.105483	0.473937	12.23195	-13.10840
	(689.095)	(0.47121)	(0.42535)	(18.1945)	(188.233)
	[1.30210]	[2.34603]	[1.11424]	[0.67229]	[-0.06964]
REAL_EX(-6)	-522.7616	-0.702431	-0.199464	-9.250614	-2.787934
	(364.221)	(0.24906)	(0.22482)	(9.61667)	(99.4904)
	[-1.43529]	[-2.82032]	[-0.88723]	[-0.96193]	[-0.02802]
REAL_EX(-7)	145.8858	0.188340	0.043171	3.207048	0.914596
	(95.1695)	(0.06508)	(0.05874)	(2.51280)	(25.9965)
	[1.53291]	[2.89405]	[0.73490]	[1.27628]	[0.03518]
CPI(-1)	-81.48465	0.003534	3.353050	-0.949478	20.86596
	(139.193)	(0.09518)	(0.08592)	(3.67518)	(38.0220)
	[-0.58541]	[0.03713]	[39.0263]	[-0.25835]	[0.54879]
CPI(-2)	240.5083	0.039081	-4.519584	1.401484	-83.69595
	(380.958)	(0.26051)	(0.23515)	(10.0586)	(104.062)
	[0.63133]	[0.15002]	[-19.2202]	[0.13933]	[-0.80429]
CPI(-3)	-257.9512	-0.103812	2.941419	0.724534	93.63360
	(380.700)	(0.26033)	(0.23499)	(10.0518)	(103.992)
	[-0.67757]	[-0.39877]	[12.5173]	[0.07208]	[0.90039]
CPI(-4)	129.5354	0.058574	-0.770858	-0.584005	-21.95733
	(146.353)	(0.10008)	(0.09034)	(3.86423)	(39.9778)
	[0.88509]	[0.58528]	[-8.53312]	[-0.15113]	[-0.54924]
CPI(-5)	-45.18246	-0.011662	-0.021439	-0.949889	-16.28196
	(39.9655)	(0.02733)	(0.02467)	(1.05523)	(10.9170)
	[-1.13054]	[-0.42671]	[-0.86907]	[-0.90018]	[-1.49144]
CPI(-6)	20.56682	0.026482	0.015721	0.634828	12.33177
	(26.5979)	(0.01819)	(0.01642)	(0.70228)	(7.26549)
	[0.77325]	[1.45598]	[0.95757]	[0.90396]	[1.69731]
CPI(-7)	-4.532455	-0.006189	0.002943	-0.220707	-5.422375
	(12.0591)	(0.00825)	(0.00744)	(0.31840)	(3.29407)
	[-0.37585]	[-0.75047]	[0.39537]	[-0.69317]	[-1.64610]
M2(-1)	-1.757546	-0.011558	0.001546	2.540667	0.431386
	(5.34482)	(0.00365)	(0.00330)	(0.14112)	(1.45999)
	[-0.32883]	[-3.16244]	[0.46870]	[18.0034]	[0.29547]
M2(-2)	0.518627	0.025134	-0.004988	-3.110922	-0.318955
	(14.5165)	(0.00993)	(0.00896)	(0.38329)	(3.96534)
	[0.03573]	[2.53201]	[-0.55664]	[-8.11644]	[-0.08044]
M2(-3)	0.371326	-0.031054	0.007420	2.613400	-0.100239
	(21.5280)	(0.01472)	(0.01329)	(0.56841)	(5.88057)
	[0.01725]	[-2.10946]	[0.55838]	[4.59772]	[-0.01705]
M2(-4)	-0.626401	0.029623	-0.006686	-1.828847	0.660903
	(23.6580)	(0.01618)	(0.01460)	(0.62465)	(6.46241)
	[-0.02648]	[1.83111]	[-0.45788]	[-2.92779]	[0.10227]

M2(-5)	-3.225135	-0.024030	0.003790	1.032366	-0.895473
	(21.2461)	(0.01453)	(0.01311)	(0.56097)	(5.80357)
	[-0.15180]	[-1.65397]	[0.28898]	[1.84033]	[-0.15430]
M2(-6)	3.657128	0.014410	0.001769	-0.392640	1.911228
	(14.3184)	(0.00979)	(0.00884)	(0.37806)	(3.91121)
	[0.25541]	[1.47169]	[0.20012]	[-1.03858]	[0.48865]
M2(-7)	-0.972309	-0.005107	-0.003766	0.040320	-1.116162
	(5.40072)	(0.00369)	(0.00333)	(0.14260)	(1.47526)
	[-0.18003]	[-1.38285]	[-1.12963]	[0.28275]	[-0.75659]
GDP(-1)	0.092627	-0.000788	-7.75E-05	0.010794	1.585798
	(0.50767)	(0.00035)	(0.00031)	(0.01340)	(0.13868)
	[0.18245]	[-2.27040]	[-0.24727]	[0.80528]	[11.4353]
GDP(-2)	-0.038778	0.001343	0.000205	-0.011054	-1.270395
	(0.84349)	(0.00058)	(0.00052)	(0.02227)	(0.23041)
	[-0.04597]	[2.32760]	[0.39445]	[-0.49633]	[-5.51367]
GDP(-3)	-0.057117	-0.001759	0.000137	0.015798	0.803787
	(0.90001)	(0.00062)	(0.00056)	(0.02376)	(0.24585)
	[-0.06346]	[-2.85742]	[0.24662]	[0.66482]	[3.26946]
GDP(-4)	-0.054853	0.001469	0.000132	-0.001012	-0.552814
	(0.77531)	(0.00053)	(0.00048)	(0.02047)	(0.21178)
	[-0.07075]	[2.77118]	[0.27566]	[-0.04944]	[-2.61028]
GDP(-5)	-0.041656	-0.000969	-0.000217	-0.009115	0.397686
	(0.55517)	(0.00038)	(0.00034)	(0.01466)	(0.15165)
	[-0.07503]	[-2.55231]	[-0.63219]	[-0.62180]	[2.62239]
GDP(-6)	0.175319	7.12E-05	0.000250	-0.002484	-0.324374
	(0.43225)	(0.00030)	(0.00027)	(0.01141)	(0.11807)
	[0.40559]	[0.24079]	[0.93765]	[-0.21766]	[-2.74721]
GDP(-7)	0.088416	-0.000356	-0.000290	0.001493	0.166600
	(0.32411)	(0.00022)	(0.00020)	(0.00856)	(0.08853)
	[0.27280]	[-1.60609]	[-1.44732]	[0.17449]	[1.88177]
C	50.60481	0.082355	0.022956	1.104764	-12.32268
	(32.7578)	(0.02240)	(0.02022)	(0.86492)	(8.94811)
	[1.54482]	[3.67652]	[1.13534]	[1.27730]	[-1.37713]
R-squared	0.174604	0.476300	0.691996	0.893285	0.532553
Adj. R-squared	-0.123535	0.273262	0.589093	0.688489	0.384377
Sum sq. resids	304.0992	0.000142	0.000116	0.212000	22.69074
S.E. equation	2.491206	0.001704	0.001538	0.065776	0.680497
F-statistic	0.736114	29995.92	358769.6	207.0983	19.35710
Log likelihood	-174.7846	444.6801	453.3849	134.1276	-64.48026
Akaike AIC	4.959639	-9.616003	-9.820821	-2.308884	2.364242
Schwarz SC	5.994173	-8.581468	-8.786287	-1.274350	3.398776
Mean dependent	4.051555	4.233519	3.871888	2.641046	1.877971
S.D. dependent	2.350262	0.190452	0.594534	0.613078	2.001262

Determinant resid covariance (dof adj.)	6.90E-14
Determinant resid covariance	4.39E-15

Log likelihood	801.9500
Akaike information criterion	-14.63412
Schwarz criterion	-9.461445

Appendix 4: Forecast Error Variance Decomposition

Table A6: Variance Decomposition of Oil Price

Period	S.E.	OIL_P	REAL_EX	CPI	M2	GDP
1	0.491206	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.596899	99.31094	0.265079	0.176697	0.194167	0.053114
3	0.628612	97.23267	1.191881	0.172815	1.350622	0.052014
4	0.640398	96.92344	1.397181	0.188280	1.417391	0.073708
5	0.678493	95.40759	1.949449	0.192339	1.730620	0.720002
6	0.688281	94.82668	2.165583	0.224516	1.993967	0.789249
7	0.768821	94.66199	2.120086	0.212693	2.241722	0.763509
8	0.801433	94.36734	2.182986	0.210437	2.236857	1.002383
9	0.820670	93.08533	2.293757	0.208475	2.214860	2.197576
10	0.830751	92.50840	2.279651	0.207697	2.267747	2.736504
11	0.848685	91.97365	2.295506	0.205480	2.437480	3.087879
12	0.855841	91.52168	2.338446	0.204957	2.480406	3.454510

Cholesky ordering: Real Ex, CPI, M2 and GDP

Where: OIL P is the Oil Price; Real EX is the Real Exchange Rate; CPI is the Consumer Price Index; M2 is the money supply and GDP stands real GDP growth rate.